AIP
PHYSICS TODAY

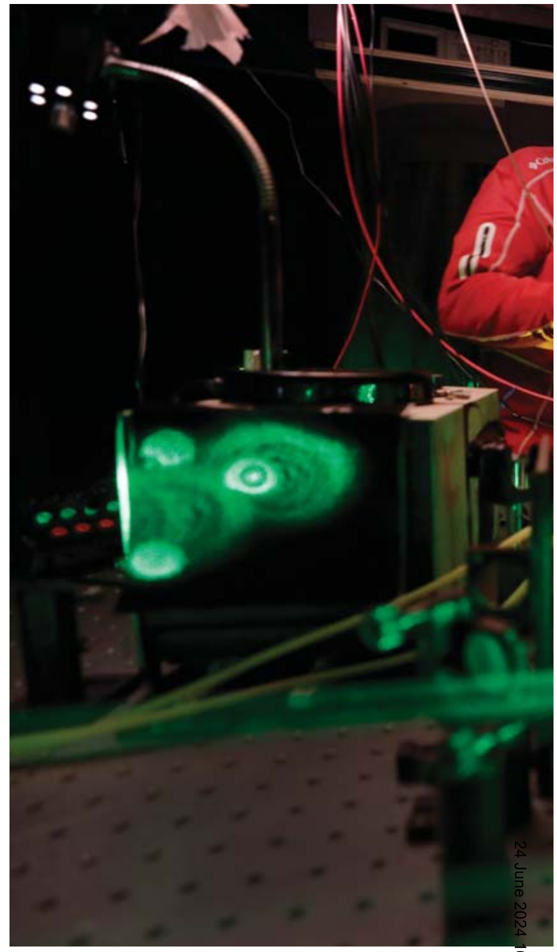
Commentary: The universe and the university: Physics preparation for academic leadership FREE

Gregory P. Crawford

Physics Today **72** (7), 10–11 (2019);
https://doi.org/10.1063/PT.3.4237

Commentary

The universe and the university: Physics preparation for academic leadership



No school or degree specifically prepares a person for becoming a university president, provost, dean, or other academic administrator. Institutions of higher learning instead seek people with demonstrated management talent in their specific disciplines and count on them to translate those skills to administration. The institutions often find that physicists have developed a powerful skill set for leadership.

My physics background equipped me for roles as dean, vice president, and president. I acquired the mind-set and skills to manage the major topics of concern in those positions: complexity management, data-driven decision making, design and long-range planning, communication, globalization, and diversity and inclusion. In academic administration, I depend every day on the lessons I learned in physics. Following are ways that a physicist's knowledge and skills can help in addressing the six topics of concern.

What physics taught me

▶ **Managing complexity.** A university is a very elaborate organization with widely diverse elements—faculty, students, staff, departments, curricula, laboratories, and so on. Physicists are taught to deal with extremely complex ideas and processes—as small as a subatomic particle or as big as the universe. I was drawn to physics by the interconnectedness of nature and the apparently simple laws that govern it. As my research career broadened, I studied ever more intricate systems—soft-matter materials, the underlying principles of thermodynamics, statistical physics, and often-unexpected responses to constraints, external forces, and stimuli. I explored how systems adapt, evolve, self-organize, and reveal complex patterns.

Academic leadership likewise involves both attention to detail and breadth of vision. A university community is organized, at least in theory, to align individual interests with the institution's vision. Fostering such a unifying vision for a complex organization is necessary for academic leadership today, and it is analogous to a physicist's understanding complex systems in nature.

▶ **Driving with data.** The accelerated dependence on data analytics in higher education means that quantitative skills are needed more than ever. Physicists are adept at comprehending data, identifying trends, and discovering patterns. From those data, they imagine things that have never been seen. They are equipped to recognize problematic data, misinterpretations, and hypotheses drawn from incorrect information. They must translate data into a story, starting with the question and narrating the path to the solution. Physicists tend to be great storytellers.

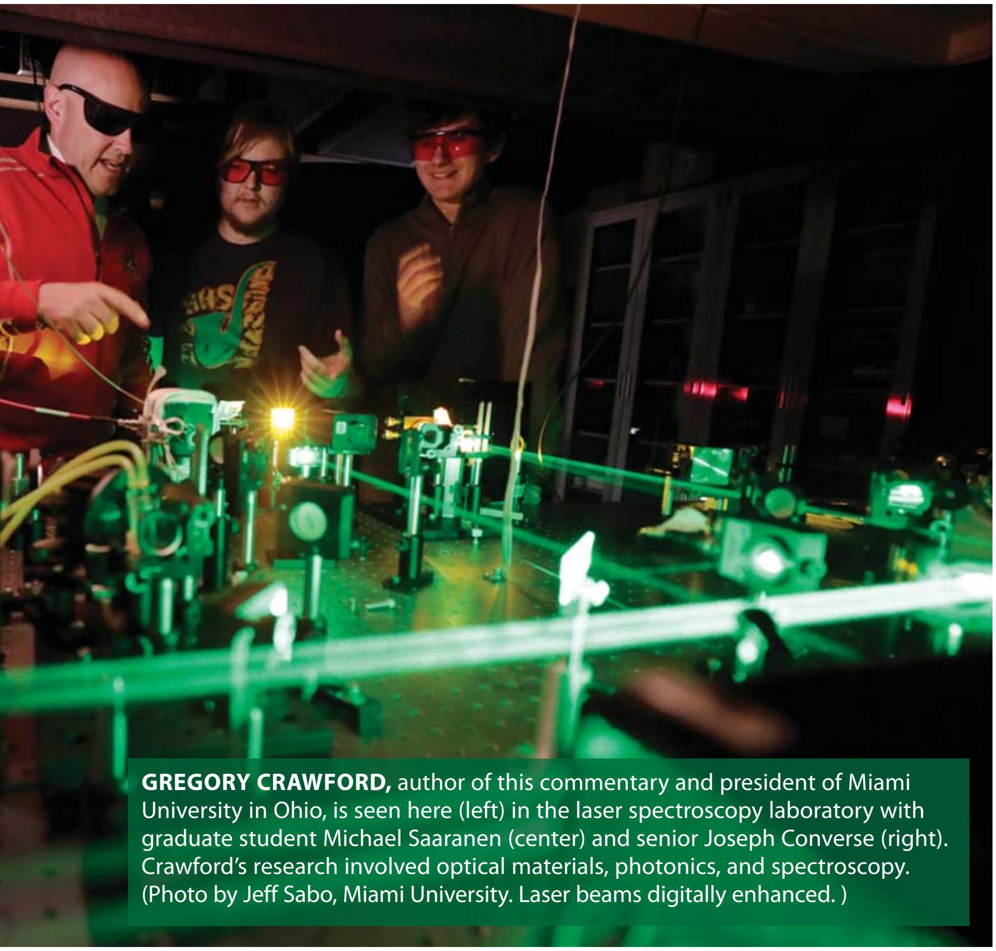
In academic oversight, much is driven by data, from devising financial models to leveraging artificial intelligence for student success. The capacity to analyze whether data are accurate and reliable and the skill to communicate the analysis with a compelling story are vital contributions physicists can bring to university administration.

▶ **Transcending barriers.** Today's global challenges are bigger than any single academic discipline can address. Universities need leaders who can break down silos and unite disparate expertise into powerful collaborations.

Physics touches many other disciplines, and it inspired me to be a perpetual student. My education first crossed boundaries from theoretical to computational to experimental physics, reached across different subdisciplines, and then moved from pure to applied physics. Collaborations broadened; I worked with chemists and mathematicians, then with various engineers, and even with medical doctors. We reached the best solutions by presenting and discussing disagreements with humility and openness. My physics background enabled me to cross all those boundaries.

Universities by definition embrace a broad range of disciplines, departments, colleges, and programs. The capacity to unify faculty and staff across them all and forge a shared vision and mission is a skill that physicists can bring to higher education.

▶ **Designing with purpose.** In the fast-moving modern environment, universities can no longer expect to create and execute long-term plans without constant attention to unexpected events. To physicists, a "problem" is not an obstacle but a question not yet answered, and we tend to be confident in the progress made using the scientific method. I designed experiments that could fail or succeed or that could cause the research team to pivot when we saw an anomaly more ex-



GREGORY CRAWFORD, author of this commentary and president of Miami University in Ohio, is seen here (left) in the laser spectroscopy laboratory with graduate student Michael Saaranen (center) and senior Joseph Converse (right). Crawford's research involved optical materials, photonics, and spectroscopy. (Photo by Jeff Sabo, Miami University. Laser beams digitally enhanced.)

citing than we had imagined. Academic leadership requires that collaborative approach of ideation, prototyping, and testing. Physicists can offer that kind of organizational thinking and processing.

▶ **Communicating with integrity.** Universities must communicate with a wide range of stakeholders—faculty, students, staff, parents, external partners, and the public—with transparency and integrity. Likewise, physicists must communicate their work to both their peers and the public in a clear and honest way. An important root of my approach is educational outreach; I started as a graduate student who taught modern physics to middle school students. That work trained me to make esoteric ideas exciting and accessible. As a professor, I learned to adjust the content level from middle schoolers to doctoral candidates. I might explain my research to young students in the morning and to my physicist peers at an afternoon conference. The balance instilled in me a capacity for clarity and the humility to accept criticism.

▶ **Engaging diversity.** Universities should be at the forefront of promoting diversity and inclusion, responding to the shifting demographics of society, and preparing students for the real world. Physics as an objective science naturally transcends national, ethnic, cultural, racial, religious, and other divisions. My global experience suggests that physicists all share a common language. In academic leadership, the common language is the mission, purpose, and core values that can unite people from all kinds of backgrounds. Physicists can bring such an inclusive mind-set.

What physics didn't teach me

Just as I constantly adjusted my approach as a physicist, my transition to academic stewardship required new learning. Some necessary undergraduate work, especially in liberal arts, complemented the rigorous quantitative side of my education. Those fresh perspectives made me a better physicist. For example, the objective nature of physics can obscure the fact that science is a human endeavor. Character matters in research, reporting, and interpersonal relationships. Physicists should ask not only can we do this but should we, and the best of them give attention to effects on human well-being. So should academic administrators. Moreover, academic leadership requires living with ambiguity, acting on incomplete data, and practicing negotiation in a way that physics typically does not. If you are a physicist interested in making this career change, consider the following areas:

▶ **Accepting ambiguity.** As a physicist, my work is unfinished until I have a clear, compelling, evidence-based result that makes a reliable contribution to the field. Until then, I must conduct more experiments to test my hypothesis or fill evidentiary gaps.

Unlike physics, academic administration involves such variables as human choice, intellect, emotion, and interpersonal and social issues. Universities are more complex than the physical world of action–reaction relationships; no fixed, natural laws govern the social, economic, and political environment. We must engage that world with wisdom, flexibility, and courage to adapt based on our best understanding of a given situation. That is a central feature of modern academic leadership.

▶ **Acting boldly.** Unlike physicists, who must have all the necessary data before they can publish or present results, academic leaders often must act on incomplete information, live with the consequences, and be able to pivot as circumstances require. Academic leaders must lead with confidence and courage in a rapidly evolving environment.

▶ **Building consensus.** Physicists build consensus through empirical evidence. Data are not subject to negotiation, and scientific conclusions are not reached through compromise. Academic leaders, however, must consider multiple perspectives and proposals. Higher education, like society, progresses not by discovering the hidden secrets of the universe but by engaging, respecting, and enlisting people to work toward success for all. Leading such a group requires personal qualities that inspire dedication and unity.

Individuals reach the top levels of academic leadership through multiple disciplinary paths, each providing a particular combination of knowledge, skills, mind-sets, and experiences. After a decade at three top-tier universities, I know my physics background equipped me for the administrative work I'm doing. I believe higher education will flourish as more professionals from physics bring their talents to serve as leaders. The dynamic and quantitative focus in those roles makes me grateful for the preparation I received in physics.

Gregory P. Crawford
(president@miamioh.edu)
Miami University
Oxford, Ohio

LETTERS

Reflections from gems in the old literature

A graduate school adviser, Christopher Shera, recently brought to my attention Ray Goldstein's article "Coffee stains, cell receptors, and time crystals: Lessons from the old literature" (PHYSICS TODAY, September 2018, page 32). The author, as it happens, was a key undergraduate mentor to me. I recall, during a summer at the Santa Fe Institute, helping Professor Goldstein set up a loudspeaker with a water-filled petri dish on top to produce Faraday instability patterns such as those shown in the article's figure 3b. Even more remarkable was the article's figure 1, which reminded me of making a movie of coffee-ring formation for Greg Huber in the summer of 2000. The video aired that evening on the nightly news in connection with a now highly cited paper.[1]

The main thread of Goldstein's article—the joy and value of reading "widely"—is important and deserves voicing. The task gets harder daily as the body of scientific literature keeps growing at an extraordinary rate. The article reminded me, an auditory scientist, of a once-forgotten 1948 paper by Thomas Gold that suggested the notion of an "active ear."[2] David Kemp's discovery of otoacoustic emissions 30 years later[3] reignited the idea, and it now lies at the foundation of modern cochlear mechanics. Gold's paper is acknowledged, cited, and widely celebrated.

My recollection of that paper reminded me of a quote by Werner Heisenberg: "What we observe is not nature in itself but nature exposed to our method of questioning." Beyond Goldstein's narrative, I'd suggest that seeing a wider context for the convoluted and technical details of our field is crucial. Making the broad connections helps us enormously.

Consider diffusion, a central heuristic in Goldstein's narrative. I like to pose simple yet intuitive scientific questions for my students. For example, How does one's brain work? The short answer is that we don't really know. The longer and better answer is that we have many of what we believe are essential bits and pieces, such as spiking neurons, excitatory and inhibitory interactions, and network plasticity. And at the core of those are key concepts learned in freshman physics: oscillations, electric potentials, capacitance, and others.

Diffusion, though, is only rarely found in first-year physics materials, yet it is essential to spiking neurons. Electrodiffusion lies at the heart of the Hodgkin–Huxley model, which was laid out in a classic set of papers.[4] It also is vital to interneuron communication and plastic changes such as connection weights in Hebbian theory. Although the role of diffusion is central to many of Goldstein's scientific examples, it is also important in everyday phenomena, which include the sensory and neural processes involved in reading this letter. Incidentally, diffusion can serve as a wonderful pedagogical means to introduce undergraduates to more sophisticated concepts—for example, multivariable functions, differential equations, probability, and bridging micro- and macroscopic domains.

Budding scientists may hear the term "diffusion," hit that Google Search button, and immediately find themselves at a Wikipedia page. A somewhat useful general resource, it is unlikely to have any clear indications that diffusion is "a

CONTACT PHYSICS TODAY

Letters and commentary are encouraged and should be sent by email to **ptletters@aip.org** (using your surname as the Subject line), or by standard mail to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at **http://contact.physicstoday.org**. We reserve the right to edit submissions.