

Pablo G. Debenedetti

of Princeton University

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Meeting Pablo Debenedetti leaves a lasting impression—that of a quintessential “gentleman and scholar.” And the more one learns about Pablo, the more that initial impression deepens. Today, Pablo has achieved high levels of success as a scholar, an educator, and an academic administrator, garnering numerous and broadly recognized distinctions. Fewer know that Pablo has been an invaluable mentor to many, many undergraduates, graduate students, and younger colleagues. Here we have the opportunity to share some of these less well-known (but certainly no less important) qualities that our mentor and friend has in abundance.

GROWING UP IN ARGENTINA

Pablo was born March 30, 1953, in Buenos Aires, Argentina. Pablo was the younger of two boys born to Francine and Sergio Debenedetti. Pablo’s father’s family immigrated to Argentina from Italy in the late 1930s, while Pablo’s mother’s family originally hailed from France. Not surprisingly, Pablo grew up well versed in multiple languages, speaking Spanish, English, Italian, and French. His father was a civil engineer, at a time when Buenos Aires was in the midst of a construction boom. Pablo’s maternal uncle and paternal grandfather were also engineers. Pablo’s mother was a musician and one of the co-founders of the Collegium Musicum, a music school for children, in Buenos Aires. A talented pianist, she could be heard on the radio. So it’s not surprising that two of Pablo’s passions growing up, and to this day, are engineering and music. As a child, Pablo played both the



Pablo at Princeton’s June 2008 Commencement, receiving the President’s Award for Distinguished Teaching.

violin and piano. He also organized concerts and groups to attend concerts, and co-founded a youth division of the Mozarteum Argentino, a non-profit institution that promotes musical culture in Argentina and throughout South America. Pablo’s third passion growing up was soccer and at some point in his childhood he aspired to become a professional soccer player. As a young adult, Pablo also considered becoming a pianist.



Pablo, age 3, already displaying a proclivity for scholarship.

Fortunately for the engineering world, his father prevailed and dissuaded Pablo from either of these alternative vocations.

Pablo's primary education in Buenos Aires was at St. Peter's School and St. Andrew's Scots School where classes were taught in Spanish and English. Pablo has enjoyed returning to his primary schools for class reunions; at his 25-year reunion, he was a runner-up for the "Gone with the Wind" (think baldness) category, and recently attended his 40-year reunion. Upon graduating from high school, Pablo entered the University of Buenos Aires, commuting from home to campus daily. He began his studies in industrial engineering and subsequently switched to chemical engineering, graduating in 1978 with the degree Ingeniero Químico. As a university student, Pablo once fortuitously appeared on a popular Argentinian TV quiz show testing general knowledge called "*Gane y aprenda*" ("Earn and Learn") hosted by Roberto Galan, a well-known Argentinian TV and radio personality. Pablo won several rounds on the show, earning both cash and fame, before exiting in the semi-final round.

With his degree in hand, Pablo obtained a position as a process development engineer with the De Nora Company in Milan, Italy. De Nora has its roots in chlorine and chlorate chemical manufacturing, and today is a world leader in providing innovative electrochemical technologies. Pablo enjoyed his work as an engineer and living in Italy; he explored some new hobbies, such as cooking, for which he won an award in a local contest. After two years at De Nora, Pablo was offered an assignment at a plant in Brazil. Seeking to further his education in chemical engineering (and not counting Portuguese among his many languages), Pablo declined the Brazilian assignment, left De Nora, and entered the Chemical Engineering Department at MIT the fall of 1980 to pursue a Master's degree.

GRADUATE STUDY AT MIT

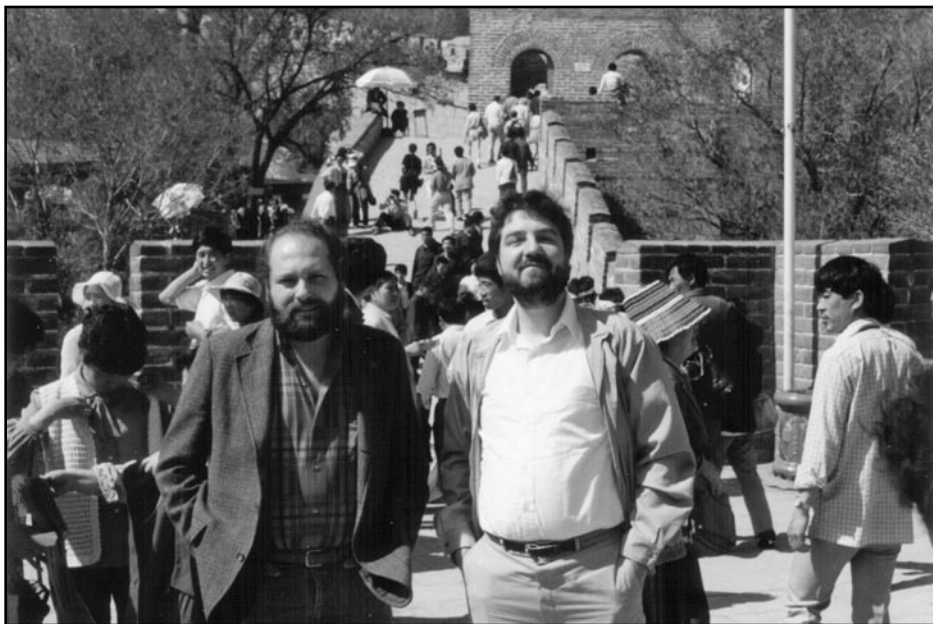
At MIT, Pablo chose to work for Professor Costas Vayenas (now at the University of Patras, Greece) for a Master's degree



Pablo (left), with his brother Claudio in Buenos Aires.

on "Steady State Analysis of High Temperature Fuel Cells," extending his experience and interest in electrochemical systems and conducting the first mathematical modeling of solid oxide fuel cells. Recalling his interactions with Pablo, Costas Vayenas writes, "Pablo made an everlasting impression on me and all members of the department as a truly outstanding person, happy with the successes of others, honest, humorous, eager to help everybody, always ready to tackle new scientific challenges, deep in his thinking, a true scholar. His broad classical education was evident in practically all his interactions but made a deep impression on me when he visited Patras a couple of years later. Pablo was quick to learn many Greek words and surprised everyone in the audience during his excellent seminar in our ChE department by his occasional clever use of Greek words and sentences. We drove to Olympia the next day and I realized that Pablo knew more about it than the vast majority of Greeks. Yet, in an effort to encourage Greeks to visit Olympia and other archeological sites, the Greek Government had established a rule that only 'foreigners' had to pay for a ticket. But, Pablo and I wondered, 'who is a Greek and who is a foreigner?' Isocrates had resolved this a long time ago by saying that, 'Greeks are those who participate in our education' (having read some Homer or Plato is enough). So, as I convinced him to do, Pablo was right to say, as we entered the site in Olympia, slowly and with a big smile: '*Hellinas emai*' ('Greek I am')."

Upon completing his Master's degree in 1981, Pablo decided to stay at MIT to pursue a Ph.D. with the renowned thermodynamicist Professor Robert (Bob) Reid. Thermodynamics research in the early 1980s was dominated by supercritical fluids, highly compressible systems that can pass from a dense, liquid-like state to a dilute gas with a change



Pablo with Thanos Panagiotopoulos at the Great Wall of China, June 1988.

in pressure, without encountering a phase boundary. Pablo's research was on diffusion and mass transfer in supercritical carbon dioxide and involved both experimental studies at high pressures and molecular dynamics calculations, using FORTRAN code that Pablo wrote from scratch, running on what would today be considered primitive and extremely slow computers.

Bob's group at the time was relatively small, consisting of five or six Ph.D. students and one or two Master's students. Bob made sure that the students had the freedom to pursue their research interests, even if they were not exactly in line with the promises he made to the funding agencies at grant application time. He was extremely generous with his time and took great interest in his students' overall well-being and personal development. As a result of the small size of the group as well as Bob's encouragement of open exploration and in-depth discussion, close friendships developed. Group meetings were frequently punctuated by heated arguments on science questions and constructive criticism of each other's work. Perhaps as a consequence of his close mentoring, a large fraction of Bob's group ended up in academic positions and still maintain close friendships and professional interactions (and graciously provided comments for this article). Sanat Kumar (now chair of Chemical Engineering at Columbia University), Richard Willson (now in Chemical and Biomolecular Engineering at the University of Houston), and Thanos Panagiotopoulos were recruited to Bob's group in 1982, and with Pablo, ended up being the last group of doctoral students that Bob mentored before retiring in 1985. Since Pablo was a few years older than the rest of the group, he was often mistaken for a faculty member when the group went out together, and group members presciently began calling him "Professor

Pablo" years before this title became accurate. Indeed, shortly after Pablo left MIT and joined Princeton, the remaining Reid Group members predicted (in 1986 or 1987) that Pablo would eventually become chair of his new department, a prediction that turned out to be spot-on.

Pablo was clearly on an academic path since early in his graduate student years. For example, in the fall of 1982, Bob Reid was away for a week-long conference in China, so he enlisted Pablo to substitute-lecture for him in the graduate Chemical Engineering Thermodynamics course (10.40). One of the authors of this article, who had just entered MIT as a graduate student, remembers vividly the strong impression Pablo made on the class with his

style, clear blackboard technique, and overall presence. A year later, Pablo (still a graduate student) was offered the rare opportunity to co-teach the entire semester of 10.40, splitting the lectures roughly 50/50 with Professor Howard Brenner. Pablo jumped at the chance, eager to pass along his excitement for (and vast knowledge of) thermodynamics to a new batch of eager graduate students in the span of about 7 weeks. Another of the authors had the unusual experience of taking this incarnation of 10.40 from Pablo (for an MIT Master's degree), followed by a nominally comparable course two years later (for a Princeton Ph.D. degree). While the latter course—which had a somewhat less ambitious syllabus, and spread the material over 12 weeks of lecture instead of 7—went down a bit easier, it was definitely less memorable. As another early example of Pablo's commitment to education, his second scholarly article was published in this very magazine while he was still a graduate student, a single-author paper entitled "The Thermodynamic Fundamentals of Exergy" [*Chemical Engineering Education*, **18**, 116 (1984)].

At the American Institute of Chemical Engineers Annual Meeting a year or so prior to his graduation, Pablo expressed his gratitude to his advisor by taking Bob Reid out to dinner. As the host, Pablo had the task of selecting the wine, even though his very limited experience in this area provided him with little basis to make an informed choice. By either keen intuition or dumb luck, he chose an excellent wine, which was much appreciated by Bob. Somehow, the statement "let him select the wine" found its way into Bob's letter of recommendation when Pablo started applying for faculty positions. When Bill Schowalter (then Chair at Princeton) started discussing wines on the way to the interview dinner and was told by Pablo that this is a topic on which he is



Pablo and Silvia on their wedding day, in Princeton's Prospect Gardens.

completely ignorant, Schowalter responded, "I hope that the other statements by Bob Reid in his reference letter are more accurate." The Princeton faculty must have believed the truth of Bob's other statements, as an offer was made to Pablo and eventually accepted.

FAMILY LIFE

Pablo and Silvia (nee Strauss) have been married for 24 years. They first met as teenagers, when they both attended St. Peter's and St. Andrew's Schools in Buenos Aires. They met again about a decade later when Silvia spent the summer of 1981 in Boston during a fellowship at the Appalachian Mountain Club. At their first meeting that summer, Silvia thought it was strange that Pablo was wearing heavy corduroy pants in the hot humid Boston weather. Later, she learned that Pablo's odd attire reflected the fact that he was spending all his time running computer programs in the heavily air-conditioned rooms which housed the (primitive and slow, but very power-hungry) computers. This also explained to Silvia why Pablo never answered his phone—he lived in the computer lab! They married in 1987, after Pablo had started at Princeton and before Silvia finished her Ph.D. at Yale, in a ceremony held in Princeton University's Prospect Gardens. Pablo and Silvia share the common profession of science educators: Silvia was a faculty member in the biology department at Montclair State University, organizer of Sigma Xi's K-12 science outreach programs at Princeton, and since 1999, has been teaching at



Pablo and Silvia's children, Gabriel and Dina, in 2009.

the Princeton Day School, where she has been chair of the middle school science department since 2000. From 2000-2004, the Debenedettis shared the joys and tribulations of concurrently chairing their respective departments.

In 1990, their son Gabriel was born; he is currently a politics major at Princeton University, and also the editor-in-chief of the *Daily Princetonian* newspaper. Their daughter, Dina, was born in 1993; she is currently in high school with strong interests in bioethics and medicine. Early in their time at Princeton, the Debenedettis inherited a dog from Bill and Jane Schowalter, when the Schowalters left for France on sabbatical and later for the University of Illinois. Today, the Debenedetti family is rounded out by 7-year-old Tigger, a Bernese Mountain dog. The Debenedettis enjoy traveling and as a family have visited China, as well as several European and South American countries. They also immensely enjoyed a year (1991-'92) at UC-Berkeley, where Pablo had the pleasure of spending his first sabbatical leave collaborating with Professor John Prausnitz '55 H'95. They were there during the Oakland fire; while they were required to vacate their residence, fortunately the house did not sustain any harm.

When not busy with work and family, Pablo enjoys several hobbies, notably a love for classical music and opera; he often attends the Metropolitan Opera in New York City. Pablo has amassed a vast collection of classical music CDs, encompassing multiple versions of the same piece. His favorite composer, by far, is J.S. Bach. He has a knack for identifying pieces, Opus number and all, and despite his best efforts, none of the other members of his family seem to have inherited this skill. A highlight for Pablo was a 10-day vacation in Salzburg, Austria, in 2004 with Silvia, when they attended many concerts, operas, and recitals. In stark contrast to Pablo's highly refined auditory interests, his favorite visual experiences are



Current and former Debenedetti Group members celebrate Pablo's election to the National Academy of Engineering at the Debenedetti home in 2000.

watching horror movies and the Three Stooges. While Pablo no longer plays soccer or coaches Gabriel in the Princeton town recreational leagues, he remains an ardent fan of the sport, particularly every four years when the World Cup occurs; don't look for Pablo on campus when Argentina or Italy is playing a match!

Pablo is also a history buff, a hobby first pursued by reading history books, and now by watching the History Channel. One area of particular interest is the two World Wars, as some of Pablo's relatives served in those conflicts; a second is the history of science and those who advanced it. Quoting former student Scott Shell, Ph.D. '05, now at the University of California – Santa Barbara: "Pablo's fervor for science seemed to be nearly matched by his love of science history. I remember that I had read a biography on Boltzmann my first year in graduate school; Pablo was elated to hear about it (more than I had expected) and we had several engaging conversations on the topic. Later, I saw this love in full view in his statistical mechanics course. Every third lecture or so would have a historical sidenote, where Pablo would discuss the life of a particular scientist who was relevant to that week's topic (Gibbs, Planck, Einstein, etc.). It was a wonderful way to provide a story line, full of mysteries and epiphanies, that created a high level of excitement for such a mathematical course. I was so impressed with this technique that I now routinely insert mini-biographies of the same sort in my classes. The students love it."

PRINCETON UNIVERSITY

Princeton's faculty members were overjoyed when Pablo accepted their offer over the competition, and when he

arrived as a new assistant professor in February 1985. Pablo was rapidly promoted to associate professor in 1990, to full professor in 1994, and to his current position as the Class of 1950 Professor in Engineering and Applied Science in 1998. At Princeton, Pablo has built a world-class program focusing on, over the years, the thermodynamics and statistical mechanics of liquids and glasses; particle formation from supercritical fluids; the thermodynamics of water and aqueous solutions; and most recently, the origin of chiral asymmetry in the terrestrial biosphere.

But what his students remember most about their time in his group was Pablo's individual attention to each and every one of them. Tom Truskett, Ph.D. '01, now at the University of Texas – Austin, writes: "One of the incredible things about

Pablo—which I've really grown to appreciate of late—is how successful he is about protecting substantial blocks of time for mentoring, *e.g.*, discussing science with his research group. During the period I was at Princeton as a Ph.D. student, a group of two or three of us would meet with Pablo and Frank Stillinger for hours of uninterrupted time on Friday afternoons. Looking back, so many key ideas came out of those productive discussions. As students, we were learning how to think rigorously and creatively about science in those meetings, probably the most valuable part of our education." From Andy Ferguson, Ph.D. '10, soon to join the University of Illinois at Urbana-Champaign: "During my first semester in the group, there was no statistical mechanics course offering until the following year, so Pablo provided me with the singular opportunity of one-on-one weekly meetings in which he educated me in the rudiments of statistical thermodynamics. Together we worked through a number of sample problems and fundamental concepts which stood me in good stead to commence my doctoral research with a sound theoretical grounding. At the time I certainly didn't appreciate the true value of his expert and generous mentoring—particularly when I was banging my head against my desk trying to wrap my first-year mind around grand potentials and Bose-Einstein condensation—but those Friday afternoons have since become one of my fondest memories of my graduate school career." And from Jane Werling, Ph.D. '01, now with Baxter Healthcare: "He struck the right balance between allowing his students enough freedom to learn independently (and make mistakes along the way) and keeping us focused and on track to complete the degree requirements."

Indeed, part of student mentoring is enriching the intellectual environment in which those students live. Pablo has enticed several long-term visitors to plant their flag at Princeton, not only Frank Stillinger (formerly at Bell Laboratories), but also Brian Pethica (former director of research at Unilever, and dean of science at Clarkson), and Vern Weekman (former director of research for Mobil Oil, and president of Mobil Solar Energy), who have interacted with undergraduates and graduate students all across Princeton's Chemical and Biological Engineering Department and beyond.

Pablo has always had a capacity for productive work that has astounded his students and colleagues alike. Mike Winters, Ph.D. '99, now at Merck, writes: "Thinking back, what I remember the most about Pablo was his work ethic. I recall that after a full day on campus he would often work from his home office until late into the night. I was always amazed by how much work Pablo could manage." But while working long hours on his teaching and launching his research program, Pablo still managed to have some fun even as an assistant professor. Carolyn Bolton, Ph.D. '89, recalls: "Pablo always has a joyful countenance! He loves people and he loves his work. In addition to people, Pablo loved dogs. The administrative secretary at the time, Betty Bixby, brought her poodle Sandy to work with her each day. Pablo loved kicking the ball down the hall for Sandy to fetch. Until that ill-fated day... Pablo kicked the ball, it took a bad hop, and bounced into Sandy's eye! The dog would never again come out into the hall to play with Pablo." Which, presumably, left Pablo with even more time to devote to his research and teaching. Or to helping Silvia host memorable dinners for his research group at their home, complete with "amazing" pasta dishes, thanks to Silvia.

Among Pablo's first research directions at Princeton was the study of metastable liquids. One of the authors remembers vivid discussions with Pablo at a thermodynamics conference in Helsingør, Denmark (site of "Hamlet's castle"), where Pablo advocated that the study of metastable liquids could provide insights into nucleation, protein stability, the glass transition, and the behavior of water in unusual environments that could have important technological applications as well as fundamental scientific interest. As usual, Pablo turned out to be correct in his foresight. Pablo's first decade at Princeton was capped in 1996 by the publication of his monograph, *Metastable Liquids: Concepts and Principles*, by Princeton University Press—today the standard reference in the field, which has educated several generations of graduate students



Pablo on-stage at Princeton Chemical Engineering's annual Bierabend (2000), with Jay Benziger and Rick & Jeffrey Register.

and researchers. This book quickly garnered substantial recognition throughout the academic community and beyond, winning the title of "Best New Professional/Scholarly Book in Chemistry for 1996" from the Association of American Publishers—as much for the clarity of the presentation as for the authoritative nature of the work.

Indeed, clarity in exposition, whether orally or in writing, has always been a hallmark of Pablo's, and something which he has consistently fostered in his students. From Jane Werling '01: "I remember how he unwaveringly insisted on clarity in thought, in writing, and in presentations, and his guidance in these areas still influences me today." And from Mike Winters '99: "As an advisor, he was excellent at returning comments and edits on draft manuscripts in a timely fashion. I learned a lot from him in terms of technical writing; he is an excellent writer and is able to clearly articulate his thoughts. Before presentations, Pablo would work with his students to improve their presentation skills."

Especially in today's world of incessant e-mails, one hallmark of Pablo's civility and gentlemanly grace stands out: important events still merit a thoughtful handwritten note from Pablo, in his distinctive blue-ink fountain pen, executed with impeccable penmanship (surely unmatched by any Princeton Chemical Engineering faculty member before or since). Whether it's a laudatory note to a faculty member who received an exceptional teaching evaluation, an encouraging note to a promising undergraduate struggling in thermodynamics, or a congratulatory note to a former student who received a distinction in his or her own career, those notes are still remembered fondly by their recipients many years later.

Pablo's leading scholarship has been recognized through major awards from the American Institute of Chemical Engineers (Professional Progress Award, 1997; William H. Walker Award, 2008; inclusion among the "100 Chemical Engineers of the Modern Era" at AIChE's 2008 Centennial), as well as the American Chemical Society (Joel Henry Hildebrand Award, 2008). In 2000, Pablo was inducted into the National Academy of Engineering, a capstone distinction for any engineer, "for microscopic theory, insight embodied in a scholarly monograph, and application of supercritical and metastable fluids."

For all his scholarly achievements, Pablo has devoted himself in equal measure to teaching. For several years, Pablo taught Princeton's undergraduate thermodynamics course, and those students lovingly tagged him with a nickname that still resonates today: "The Therminator." Chris Roberts, Ph.D. '99, now at the University of Delaware, writes: "Pablo has always been an excellent lecturer (*i.e.*, classroom teaching as well as in research), and in hindsight, this stems from his ability to distill complex problems to their essentials, and to do this and present it at a level appropriate to the audience. That approach is something that I try to emulate and pass along to my students, as it is a model for teaching and research (and many other things in life, it seems)." There are three qualities which stand out as descriptors of Pablo's teaching. First, he truly teaches his students how to think: to first conceptualize and then apply new ideas, rather than simply showing them a formulaic approach to solving particular types of problems. To reach this goal, Pablo firmly grounds his courses in the fundamentals of the subject, providing the students a solid base for their own work. Second—perhaps a corollary of the first—Pablo recognizes that different students learn differently, and a new concept may be best explained to different students in different ways. Both in lecture and in his office hours, he will tirelessly approach the exposition of a new concept from various directions until he finds the method that allows a particular student to internalize the idea. Third, Pablo always makes himself accessible to his students (all the more remarkable given his other obligations, and facilitated by the fact that he doesn't seem to need much sleep), and takes a personal interest in each one.

In 2008, Pablo's excellence in teaching was simultaneously recognized by Princeton with both the President's Award for Distinguished Teaching, and the School of Engineering and Applied Science's Distinguished Teacher Award. From among the dozens of letters provided by students in support of his nominations for each of these awards, certain particular quotes stand out. From a student writing about undergraduate ChE thermodynamics: "It is not often that a class is so well taught that beyond learning material, a student grows from the experience to become a more analytical and deep thinker. Professor Debenedetti's course in thermodynamics has certainly provided the framework for me to grow." Describing

an integrated freshman course in engineering, math, and physics: "As you can imagine, the transition between high school and college can be daunting, but Professor Debenedetti's easy demeanor and approachability made for a fun learning experience.... He even stayed with us students after hours in lab to make sure we could see and understand how solar cells worked. As we constructed mini fuel cell cars and took power output measurements, he would also tell stories about his family, Argentina, and occasionally—Astor Piazzola." Regarding graduate ChE thermodynamics: "Honestly, I don't like Thermodynamics.... But despite that, I really loved the class, just because of the way he taught it.... I now have a pretty thorough understanding of the material, and more importantly, a greater confidence in my ability to respond to intellectual challenge.... Watching the way Prof. Debenedetti conducted himself made me think that this is the way teaching should be done, and I know that he will always remain a role model for me throughout my professional career." About a course in statistical mechanics: "Professor Debenedetti delivered many lectures on complex mathematics and physics and did so with an eloquence that I have not seen (elsewhere) in my educational career. It was obvious that each lecture was carefully crafted from a variety of sources to provide the clearest and most intuitive understanding of the physical phenomena." And finally, from a student in undergraduate ChE thermo, describing a one-on-one meeting with Pablo: "Our meeting refueled my confidence and left me determined to do much better on the final exam. When I spoke to other students in the course about this experience, they all nodded in agreement. Some of them had also received handwritten notes and similar words of encouragement from Professor Debenedetti. One student pointed out that if it were not for Professor Debenedetti, she would have dropped the course."

Finally—as if exceptional distinction in both research and teaching were not enough for one person—Pablo has also taken on positions of increasing responsibility in academic administration at Princeton, first serving as director of Graduate Studies for Chemical Engineering (1990-'91 and 1992-'94, a role he reprised in 2006-'08), then as chair of Chemical Engineering for two terms (1996-2004), and currently as the first vice dean for Princeton's School of Engineering and Applied Science (2008-present). During Pablo's tenure as chair, both Athanassios Panagiotopoulos and Stanislav Shvartsman joined the Princeton faculty, and the Department of Chemical Engineering substantially expanded its laboratory facilities through the conversion of former teaching spaces when the latter moved into the new Friend Center for Engineering Education. Now as vice dean, one of Pablo's main projects has been planning the physical space for the Andlinger Center for Energy and the Environment, a 127,000-square-foot laboratory building to open in 2015. Pablo's achievements in these areas will be reflected in both the intellectual and physical landscapes of Princeton for many decades to come. □