area students enrolled in the program recently. (Military leaders have indicated it is uneconomical to expand the number of ROTC programs to multiple campus sites that each serve a potentially small number of students.) The news release announcing the new arrangement noted that maintaining the current consortium arrangement is "best for the efficiency and effectiveness" of the operations. From Harvard's perspective, this means that issues of faculty appointments and class credit for ROTC courses within the College curriculum—potential deal-breakers—do not arise now.

Faust had previously indicated strong support for renewing ties to ROTC once the prohibition on military service by openly gay men and women was abolished. She attended commissioning ceremonies during Commencement week, and seemed to establish a strong rapport with General David H. Petraeus (now leading U.S. military operations in Afghanistan) when he spoke at the 2009 exercises. In the news release, Faust said, "Our renewed relationship affirms the vital role that the members of our Armed Forces play in serving the nation and securing our freedoms, while also affirming inclusion and opportunity as powerful American ideals. It broadens the pathways for students to participate in an honorable and admirable calling and in so doing advances our commitment to both learning and service."

Mabus called the agreement "good for the University, good for the military, and good for the country. Together, we have made a decision to enrich the experience open to Harvard's undergraduates, make the military better, and our nation stronger." The decision may have resonated for Mabus on several levels: he rose to the rank of lieutenant during his own navy service; holds a Harvard Law degree (J.D. '75); and was in Cambridge at the start of junior parents' weekend (daughter Elisabeth is a student in the College).

Harvard is also pursuing discussions to renew formal ties with ROTC programs serving other military branches. And Faust will form an ROTC implementation committee chaired by Cabot associate professor in applied science Kevin ("Kit") Parker, an army major who has served three tours in Afghanistan. (His bioengineering research has recently been expanded to include traumatic brain injury, prompted by his military experience.)

Twenty undergraduates now participate in ROTC programs, including 10 in NROTC. In addition to Faust's interest in restoring the program, Harvard may be enjoying a bit of geographic luck—in the proximity of the current ROTC operations just downriver at MIT—in gaining an ROTC presence on campus so quickly. Other institutions that have taken steps to re-establish ROTC in the wake of DADT's repeal, including Stanford and Yale, are less fortunately situated.

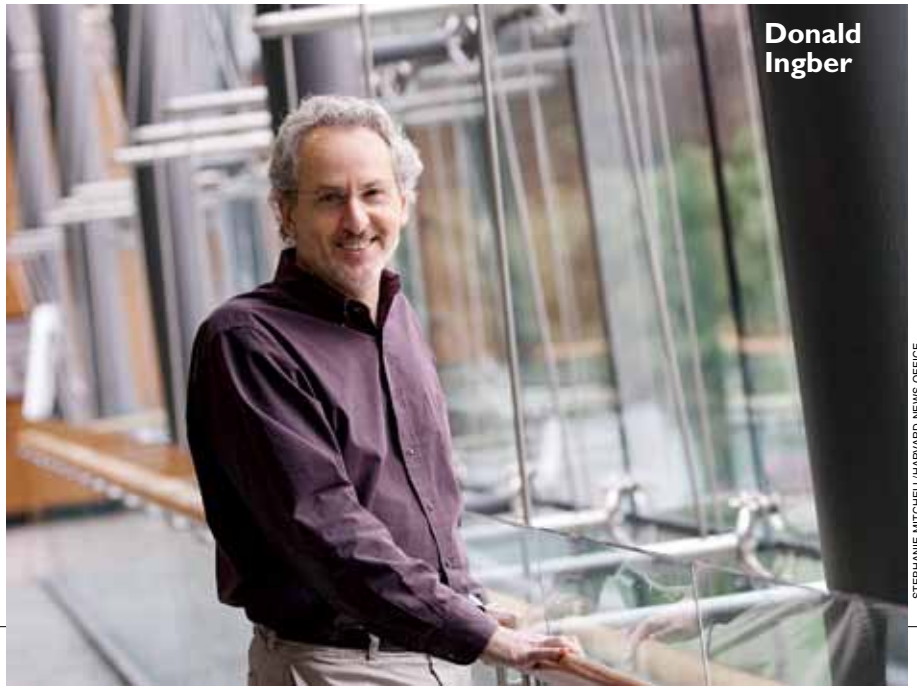
Designing from Life

As a piece of engineering, the human body is a marvel. It maintains its balance even while executing complicated movements; it senses and adapts to heat and cold. Every 20 seconds, it circulates blood through even its most far-flung extremities. It has cells capable of replacing wounded tissue, finding and destroying dangerous invaders, and interconnecting to produce thoughts and emotions. Utilizing all these functions, our bodies—and all living systems—can accomplish tasks far more sophisticated and dynamic than any artificial entity yet designed by humans.

Harvard's Wyss Institute for Biologically Inspired Engineering (wyss.harvard.edu) is taking on the ambitious task of applying the astounding capabilities of living systems to better engineer artificial ones. Its projects range widely: robots that self-organize, materials that adapt to the environment, medical devices that sense and respond to subtle biological rhythms, engineered cells that use nature's building blocks to manufacture fuel or attack a disease. But beyond pursuing research in these areas, the institute focuses on transforming its discoveries into devices—transferring ideas from academia into the hands of private industry. The two-year-old institute has a growing project portfolio and institutional and corporate partnerships that have the potential to expand Harvard's research in new ways. Its applications range from vibrating insoles that could help prevent falls in the elderly to a device that rapidly diagnoses sepsis, a potentially fatal condition.

The institute grew out of a larger initiative at Harvard to develop a vision for bioengineering. One faculty proposal was an institute for biologically inspired engineering; that received seed funding from the University in 2008. The following January, the program received an enormous boost when Swiss entrepreneur Hansjörg Wyss donated $125 million to launch the institute, the largest gift in Harvard history (see "Life Sciences, Applied," January-February 2009, page 34).

"My goal has always been to improve patient care," Wyss says. An engineer by training and chairman of the medical-device manufacturer Synthes, he became interested in the effort while meeting with several leaders in biology and medicine at Harvard; he saw an opportunity to create an institution that would help engineers


Donald Ingber

STEPHANIE MITCHELL/HARVARD NEWS OFFICE

and biologists work together and connect multiple disciplines to solve practical problems.

The intention was to build an entirely new organization at the University: not a traditional research center producing discoveries and scientific papers alone, but a place focused on creating new technologies and applications that—thanks to industrial collaborations—can directly benefit both human health and the environment. Don Ingber, Folkman professor of vascular biology at Harvard Medical School (HMS) and professor of bioengineering at the School of Engineering and Applied Sciences (SEAS), was named founding director. (He and David Mooney, Pinkas family professor of bioengineering, were instrumental in developing the original vision for the institute.)

The resulting Wyss Institute is, Ingber says, like "a start-up in the midst of the world's greatest academic environment." Wyss himself says Ingber "has done a fantastic job" in moving the institute's work forward. The institute is not housed within any Harvard school; its research staff includes 16 core and several associate faculty members representing the Faculty of Arts and Sciences, HMS, and SEAS, as well as Boston University, the University of Massachusetts Medical School, Beth Israel Deaconess Medical Center, Brigham and Women's Hospital, Dana-Farber Cancer Institute, and Children's Hospital Boston. The institute also has its own technical and administrative staff, and office and lab space in both the Longwood Medical Area and Cambridge.

COURTESY OF JAMES J. COLLINS/ RENDERING BY SOLUTION NEXUS

An early design concept for a vibrating insole to improve balance and sensation.

The institute's work aims to use lessons learned from biology to develop engineering innovations, Ingber says, because

HARVARD PORTRAIT

Photograph by Jim Harrison

The Yard Crew

Every spring, after the desiccating winds of winter, lush green grass sprouts in the Yard, reaching maturity just in time for Commencement—when throngs of jubilant students and proud parents promptly trample it again. Harvard Yard is a tough environment for plants of all kinds because it is so well loved and used. The team that tends this urban oasis on behalf of the institution and its barefoot summer scholars, its Frisbee players, and its casual passers-by works year-round to sustain the inviting plane of green that spreads beneath high-branching trees. Pictured in this February photograph, from left to right and front row to back, are foreman Art Libby, with Donald Ford and Ryan Sweeney; Ray Pacillo, Frank Lemos, and John Patti; Tiago Pereira, arborist Mark Muniz, and the crew's supervisor, associate manager for grounds Paul Smith, who has been caring for Harvard Yard for 19 years. "Winters are tough," Smith says, "but the other eight months are great." Come spring, they work at a whirlwind pace, mulching and mowing, sweeping walks, fixing irrigation lines, pruning shrubs and trees. When Smith started at Harvard, it took tons of fertilizer to revive the Yard's viridescent lawns each year. But today, he reports, the landscape is maintained organically: leaves and trimmings are raked and vacuumed up each fall, shredded and chipped, and later returned to the soil as "compost teas and humates." Earthworms, once scarce, are now abundant (although the crew still needs to aerate). Smith confesses he would never have believed how much more natural activity there is underfoot. His crew likes "working to make the grounds of a worldwide institution look nice. Within a city, it's a tough thing to do."

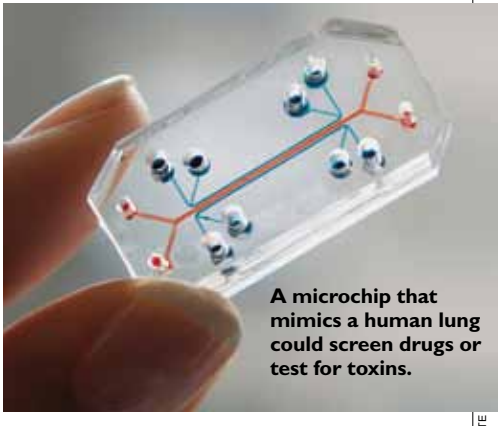
science has recently generated a great deal of fundamental knowledge about how living systems work. "We're really beginning to understand how nature builds," he explains. Those insights can be brought to bear on a wide array of disciplines, including materials science, architecture, medicine, computer science, and engineering. New engineering tools, meanwhile, make it possible to interface with biological systems in novel ways.

Perhaps most important, by bringing together scholars whose work already bridges traditional departmental divides—through fields such as genomics, tissue engineering, synthetic biology, and robotics—the institute offers opportunities for unexpected collaborations that can advance research even more. And rather than housing investigators' individual work in separate labs, Wyss projects are organized into six Enabling Technology Platforms, each focused on developing new technology capabilities that could have numerous applications.

Ingber is leading a project in the Biomimetic Microsystems platform that creates microchip-like devices containing living cells that can mimic the functions of real organs. Last June, the team announced that they had made a flexible, coin-sized chip containing chambers of human cells that reproduce the workings of a lung, even "breathing" by stretching and relaxing in response to changing air flow. Pharmaceutical companies are beginning to partner with institute researchers to explore whether these devices can be used to develop drugs and perform toxicology screenings without relying on laboratory animals. Meanwhile, the team's system for rapidly diagnosing sepsis is a significant advance beyond current practice, where identifying this dangerous condition definitively can take days.

Not all applications have a medical focus—others will affect the environment or improve industrial design and manufacturing. The Bioinspired Robotics platform, for instance—building on work by assistant professor of electrical engineering Robert Wood, its co-leader—is designing small, delicate robots that look like houseflies; such devices could help pollinate crops in places where bees are threatened (see "Tinker, Tailor, Robot, Fly," January-February 2008, page 8). Berylson professor of materials science Joanna Aizenberg is leading efforts in the Adaptive Architecture platform to develop materials with special properties inspired by objects in nature; lotus leaves, for instance, are extremely efficient at repelling water, and the Wyss team seeks to capitalize on this property to develop a material that could prevent ice formation on airplane wings.

Ingber explains that the platforms—the others are Anticipatory Medical Devices (developing electronic devices to detect and prevent medical problems before



A microchip that mimics a human lung could screen drugs or test for toxins.

RICHARD GROLEAU/WYSS INSTITUTE

H 375 HARVARD

You're going to see plenty more of this logo, as Harvard prepares to commemorate its anniversary in the next academic year.

Plans for celebrating the University's journey since 1636, and how it will evolve, are still in the making, but reflect "the opportunity to bring the members of our community together not just to mark our history and traditions but also to celebrate what is distinctive about Harvard today and what we aspire to be in the future," as University marshal Jackie O'Neill puts it—while maintaining a suitably reserved tone. A 375th anniversary is not a 400th, and the economy does not justify extravagance. The aim, O'Neill says, is to showcase contemporary Harvard—a place that has become progressively "more diverse, global, and outward-looking" since its last milestone, in 1986—in ways that emphasize exciting work by faculty members, engage students, and connect alumni. Likely elements include:

- A birthday party. It wouldn't be a proper occasion without merrymaking. Accordingly, Friday, October 14—coinciding with freshman parents' weekend, the Harvard Alumni Association's fall meeting, and the Harvard College Fund assembly—has been reserved for festive dinners and receptions for students, faculty and staff members, and alumni in the Houses and other sites, followed by processions, led by student performers from diverse cultural traditions, to Tercentenary Theatre. There, further artistic performances, a light show, and other entertainments are scheduled, along with socializing encouraged by dessert buffets and a community dance.
- Academic perspectives. Faculty panels on various subjects will be convened throughout the year, emphasizing the work of younger professors whose research, ideas, and teaching will shape the University and the world at Harvard's fourth-century birthday. A presidential forum may, separately, examine universities' roles in society.
- Alumni experiences. The University communications and development staffs are collaborating on "Harvard Stories," an interactive online library of video recordings of graduates talking about their formative experiences at the University, momentous memories, and more (inspired in part by National Public Radio's Story Corps series).
- A speaker series. Prominent alumni from various walks of life are expected to participate in campus lectures and perhaps panel discussions.

Reflecting continuity with tradition, a new Harvard picture book is being produced for the occasion (to be published by Harvard University Press). Reflecting change during the past quarter-century, this year's events will be coordinated through a dedicated website, launching in the summer. Reflecting the eternal verities, O'Neill (who worries about such things at each Commencement) is trying to assure clement weather on October 14. President Drew Faust is expected to unveil anniversary details during this year's Commencement exercises, on May 26.

Reenacting Early Action

Starting this fall, students will again have the option of applying to the College under a nonbinding early-action program.

In 2006, the College decided to eliminate early action for applicants as of the fall of 2007 and move to a single January 1 deadline. Administrators voiced concerns that early action favored students from affluent families and communities; then-president Derek Bok said students of lesser means tended to wait for the January deadline to apply, so that in April they could compare financial-aid offers from all schools that accepted them.

Although Princeton and the University of Virginia made similar changes, no other prominent institutions followed suit. Meanwhile, the number of applications to selective schools continued to swell, making admissions ever more competitive and increasing applicants' interest in an early option (and swamping admissions offices with thousands more files to review by the single spring deadline). Last November, Virginia announced it would reinstate early-action admissions beginning this fall. And after analyzing trends during the four intervening admissions cycles, Harvard said it had found that students from families *across* the income spectrum were showing greater interest in early admissions given the uncertain economy and competitive conditions.

"Many highly talented students, including some of the best-prepared low-income and underrepresented minority students, were choosing programs with an early-action option, and therefore were missing out on the opportunity to consider Harvard," said Faculty of Arts and Sciences dean Michael D. Smith. Princeton announced a similar policy change the same day: "In eliminating our early program four years ago, we hoped other colleges and universities would do the same, and they haven't," President Shirley M. Tilghman noted. "One consequence is that some students who really want to make their college decision as early as possible in their senior year apply to other schools early, even if their first choice is Princeton."

Under the restored early-action option, students who apply to Harvard College by November 1 will receive a decision and financial-aid information by December 15. Students who apply by the regular deadline of January 1 are notified on April 1; the deadline for all students to declare their intent to attend is May 1.

(Meanwhile, on March 30, the College announced that it had offered admission to 2,158 applicants to the class of 2015, out of 34,950, for an acceptance rate of 6.2 percent.)

• **Term bill.** In conjunction with the announcement, the College released the tuition, room, and board costs for the 2011-2012 academic year: a total of $52,560, an increase of 3.6 percent from $50,724 this year. Undergraduate financial aid will increase 1 percent, to $160 million. (Since 2008, the College has borne the full cost for undergraduates from families with incomes of $60,000 or less; from that level to $120,000, the annual cost scales up from 1 percent to 10 percent of family income, and remains at that upper level for those with incomes up to $180,000.)

Peer institutions have announced diverse tuition and financial-aid strategies for next year. Princeton—citing the economy and its own strong endowment and fundraising results—will raise undergraduate costs 1 percent (its lowest increase in 45 years), to $50,689. Yale, on the other hand, raised its term bill 5.8 percent, to $52,700, while boosting its financial-aid budget 8 percent (to $117 million) and redirecting that aid: students from families with incomes of $65,000 or less (formerly $60,000) will now receive full scholarships, while those with incomes from $130,000 to $200,000 will now pay an average of 15 percent of their income (up from 12 percent previously); those in the cohort between these ranges pay about 10 percent of income.

they happen), Programmable Nanomaterials, and Biomaterials Evolution—create a structure in which projects can build on one another; one platform may enable many different types of applications or fields of research. In choosing projects, the institute's leaders emphasize high-risk ideas that might not obtain support from conservative funding agencies that typically emphasize incremental advances.

The Wyss is meant in particular to help speed to market new products that might otherwise languish in research laboratories. An early example is a project initiated by James Collins, a professor of biomedical engineering at Boston University: vibrating insoles that can help prevent falls in the elderly. Collins had developed the technology in his lab, based on 15 years of work demonstrating that a small amount of noise introduced into certain systems can enhance the detection of a signal; in this case, providing faint random vibrations to the feet—so faint they are undetectable—actually boosts the sensory system's ability to detect balance cues. He has found that elderly people exposed to these vibrations can maintain their balance as well as much younger adults.

Wyss points to Collins's project as an example of how the institute can be transformative; a project like this, he says, "needs more than just a professor." Collins explains that the technology, though promising, had fallen into a gap where many academic projects stall: funding agencies support basic scientific work, he says, whereas "companies and investors generally want to invest in products, not projects." Moving beyond proof of principle requires a complete prototype that can be demonstrated to companies.

"The Wyss is incredibly well positioned to fill this gap," Collins says. He and a team there are working to transform the technology into a product, create a commercialization plan, and reach out to shoe and insole companies. Meanwhile, David Paydarfar, a Wyss associate faculty member based at the University of Massachusetts Medical School, is using related scientific techniques to develop a vibrating mat for newborns that could prevent sleep apnea, a potentially fatal problem in which breathing stops.

To turn ideas into commercial applications, the institute draws on professionals from various sources. Its administrative leadership has experience working in in-

dustry, and its staff includes an "advanced technology team" of more than two dozen technical experts drawn from both academia and industry who can guide the transformation of technologies into materials and devices. Although faculty members at the Wyss will continue to solicit grants and write scholarly papers, the goal will be to generate intellectual property, royalties, and investment opportunities.

A key innovation facilitating the Institute's work was the creation of a universal contract for all collaborations, streamlining the often onerous process of connecting people at multiple institutions, nonprofit and otherwise. To promote collaboration, the contract requires that work take place on site.

To further the applications it develops, the Wyss has actively courted partnerships with industry. In November 2010,

Learning about Teaching

In "Tackling Teaching and Learning" (March-April, page 42), about the Faculty of Arts and Sciences' renewed focus on pedagogy and educational outcomes, we asked readers to share examples of teaching that had worked for them, and to suggest improvements that Harvard might consider. Here is an edited sampling of the responses; read the full conversation, and contribute to it, at **http://harvardmag.com/teaching-and-learning.** —*The Editors*

In the late fifties, I was fortunate enough to enroll in Charlie Slack's and Sarnoff Mednick's experiential courses in psychological research and mental health. In the research course, we had a lab, human subjects, and equipment, and were expected to turn out a formal research paper a week. In the mental-health course, each student cared for a patient for an academic year. From there I went on to a research job at the Med School for which Harvard gave me a lot of academic credit. I learn best by doing things and tying book-learning to the enterprise at hand, and Harvard made that happen for me, getting my undying gratitude.

Jonathan Brown '57

Most Harvard faculty in my day (GSAS, 1970s) were either desperate to publish so they could get on a tenure track at some other university, or else well past the time they did their best work (also often at another university). One group had no time to focus on teaching, most of the other group lost whatever interest they had long ago. The best teaching experiences were with "prime of life" faculty working with their students to develop their most creative ideas. This very small number of faculty were excellent teachers, regardless of teaching technique, because they were so intellectually alive in the classroom. If the same thing is true today, Harvard needs more faculty who are actually doing their best work while they are at Harvard and with the time to pay attention to teaching.

Gregory Miller, A.M. '76

Our learners no longer want to be told, they want to discover. Rather than lectures and sound bites, give them the tools they require to find answers on their own. The modern educator is more of a guide than an expert. *Steve Hearst '88*

Harvard can enhance its teaching-learning process by relating the subject matter being taught—whenever possible—to present-day situations. Indeed, doing so will make the subject much easier to understand, and more relevant and effective as it relates to today's society.

A second way [to] enhance the educational process is by subdividing classes into groups of four or five students, with each group specializing in a critical area of the subject. After extensive research in a specific area, each group member can then present a 10- to 15-minute report to the entire class in an area [where] he or she has acquired exceptional knowledge.

A third way to enhance the learning process is for instructors to provide students with exams that require a great amount of critical thinking…rather than objective (or one-word) exams.

George Patsourakos

Looking back on my four-plus years as a Harvard graduate student, I see two courses that were outstanding in the amount of useful knowledge I learned. They were "Beginning Russian" (accelerated) and "Theory of a Complex Variable." Each was an extremely concentrated learning experience; the amount of material covered and the expectation of mastery were in each case much greater that those in other courses. Each was taught by a tenured professor who was expert in the material and thoroughly organized the presentation and homework. However, in both, the lecture was only a small part of the educational process. In Russian, the homework, explanations by the teaching fellow, and pronunciation drills by a native speaker were by far the most important content. In the math course, almost all learning resulted from the challenge of the homework; we students met together and jointly puzzled out the challenging assignments. I'm convinced that a gram of example—a well-taught course experienced—is worth a kilogram of pedagogy training.

Lyle McBride, Ph.D.'64

During my senior year, I wrote a thesis on *The Tempest* and directed a production of the show on the Loeb mainstage. My thesis adviser (a Ph.D. candidate) spent hours talking with me about the play, about my struggles to bring the play to life, about how the production had turned out, about how much I hated the play at times, about how I missed it once the show was over, and about how what I had planned to say in my thesis had changed because my understanding of the play was altered by the process of staging it. I thought I already knew a lot about Shakespeare, but I learned much more through directing the show and talking about it during my senior tutorial than I could have imagined. I am now a law professor, and I try to offer my students that same kind of active learning experience that helped me so much as an undergraduate at Harvard. *Molly Shadel '91*

HM

For coverage of faculty conversations about teaching in a global context and using University collections, see harvardmag.com/teaching-learning-conversations.

for example, it announced a multiyear partnership with Agilent Technologies; the company will support the development of tools and technologies in three platform areas: Biomaterials Evolution, Programmable Nanomaterials, and Biomimetic Microsystems.

"I think this is a terrific opportunity for Harvard," Wyss says. He believes that other universities are already seeking to replicate the institute's approach, both in bringing disciplines together and in emphasizing commercial applications of its work. For Ingber, the excitement clearly lies in having such resources and expertise in one place, in order to move projects forward quickly. He says that faculty members have been drawn to the Wyss because of the promise of accelerating their work, taking on riskier projects, and seeing them move more quickly beyond the laboratory into the real world.

—COURTNEY HUMPHRIES

The Public's "Hard Problems"

A YEAR AGO, prominent social scientists gathered at Harvard to highlight what they saw as the most pressing problems in their disciplines. Asked to choose problems that were either very urgent, very difficult, or both, these 12 eminent thinkers formulated a list of nearly three dozen "hard problems in the social sciences," then put the problems to the public for a vote (see " 'Hard Problems' in the Social Sciences," July-August 2010, page 60). The subsequent online forum also solicited suggestions of important problems that hadn't made the scholars' list, and 10 of the problems submitted by the public—including world peace, improving relations between Islam and the West, and defining humans' purpose—were also thrown into the voting mix.

The level of public interest and attention surprised even the organizers. The project's website attracted 7,000 visitors per month last April and May; a Facebook page drew 11,000 fans; and more than 500 people voted in the poll to decide which problems were *truly* the most urgent and most difficult.

As conscientious social scientists, the organizers subjected the poll results to

Yesterday's News

From the pages of the *Harvard Alumni Bulletin* and *Harvard Magazine*

1921 The Commencement audience witnesses for the first time a "considerable group" of women standing to be declared graduates of a relatively new department of the University, the School of Education.

1936 The United States Senate has approved a bill providing for a series of Harvard Tercentenary postage stamps as the University continues to prepare for its forthcoming anniversary.

1961 College diplomas are printed in English for the first time, rather than engraved in Latin, provoking protest from students and alumni. President Pusey compensates by conferring the degree in Latin for the first time since 1895.

1971 What is believed to be the first campus drug raid carried out by Cambridge police occurs after a potted marijuana plant is sighted on a dormitory windowsill.

1971 Susan Cochran '73, manager of the ski team, becomes the first Radcliffe student to win a Harvard H.

1986 Professor Walter J. Kaiser, marshal of Harvard's Phi Beta Kappa chapter, instructs his charges to enter Memorial Hall "boustrophedonically." Brandishing his silver-tipped baton, he adds, "I should tell you that *Life* magazine will be taking pictures of the procession. So do make a special effort to look intelligent." (Classics professor emeritus Mason Hammond informs bemused nonclassicists that *boustrophedonic* is a Greek term meaning "as the oxen turn at the end of a plowed furrow.")

1991 Derek Bok leaves office and donates his 1969 red, semi-automatic, sun-roofed VW bug, with 45,718 miles on it, to the Phillips Brooks House Association. PBH ultimately decides to auction off the car.

1991 The new head of University Dining Services, Michael P. Berry, impresses undergraduates with such culinary initiatives as themed dinners, more vegetarian options, and environmental awareness: "Cereal now comes in bulk dispensers instead of wasteful 'snack packs.'" A grateful senior class honors him with a picture of themselves.

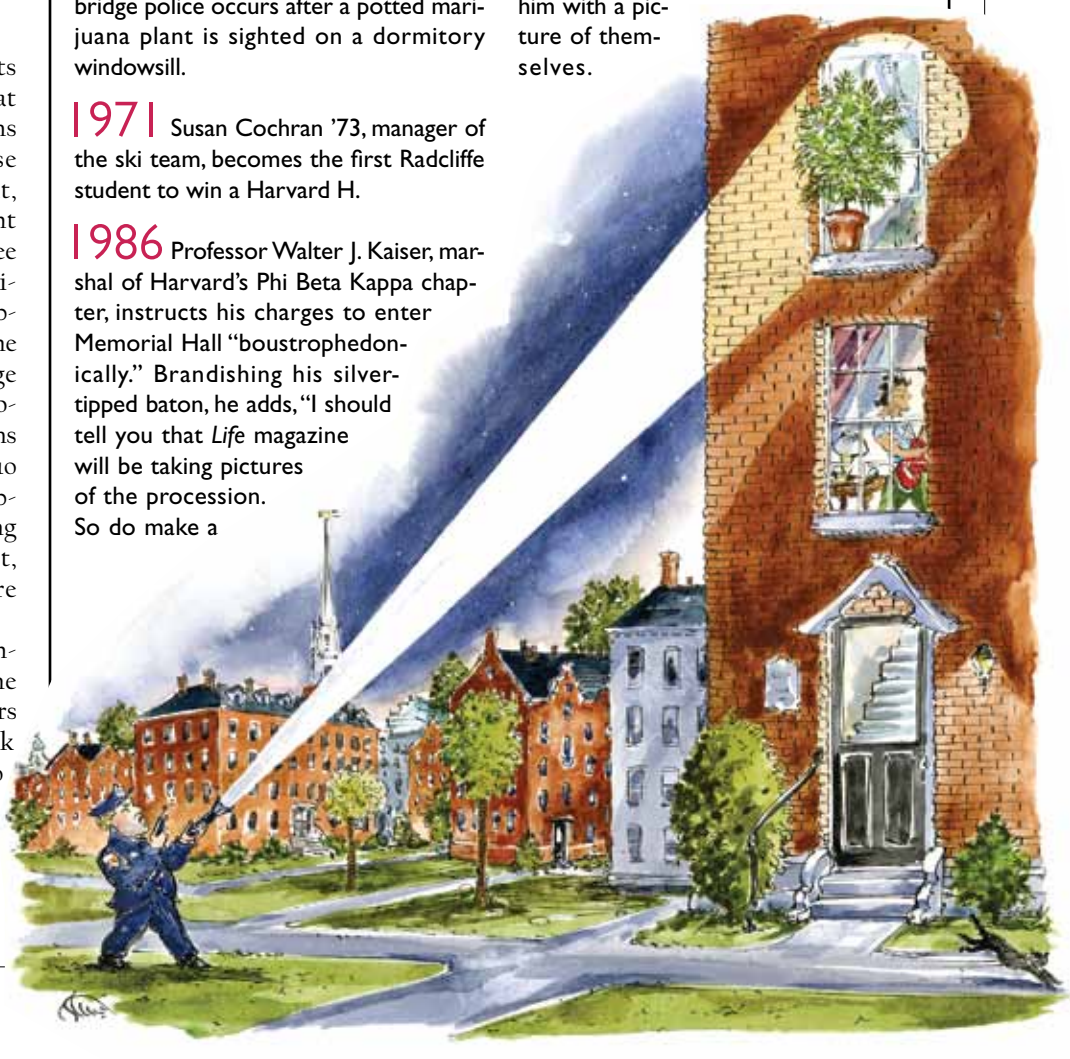


Illustration by Mark Steele