

Publisher: Richard S. Nicholson
Editor-in-Chief: Floyd E. Bloom
Editor: Ellis Rubinstein
Managing Editor: Monica M. Bradford
Deputy Editors: Philip H. Abelson (*Engineering and Applied Sciences*); John I. Brauman (*Physical Sciences*); Thomas R. Cech (*Biological Sciences*)

Editorial Staff

Assistant Managing Editor: Dawn McCoy
Senior Editors: Eleanore Butz, R. Brooks Hanson, Pamela J. Hines, Barbara Jasny, Katrina L. Kelner, Paula A. Kiberstis, Linda J. Miller, L. Bryan Ray, Phillip D. Szuromi, David F. Voss
Associate Editors: Gilbert J. Chin, Suki Parks, Linda R. Rowan
Letters: Christine Gilbert, *Editor*; Steven S. Lapham, *Assistant Letters Editor*; Charlene King, *Assistant Book Reviews*; Katherine Livingston, *Editor*; Jeffrey Hearn, *Editorial Assistant*
Editing: Valerie Jablow, *Supervisor*; Cara Tate, *Senior Copy Editor*; Jeffrey E. Cook, Harry Jach, Erik G. Morris, Christine M. Pearce
Copy Desk: Ellen E. Murphy, *Supervisor*; Sherri Byrand, Joi S. Granger, Beverly Shields, Kameaka Williams, *Assistant*
Editorial Support: Carolyn Kyle, *Editorial Assistant*; Josh Lipicky, Michele Listisard, Diane Long, Patricia M. Moore, Ted Smith, *Manuscript Assistants*
Administrative Support: Sylvia Kihara, Brent Gendleman
Computer Specialist: Roman Frillarte

News Staff

News Editor: Colin Norman
Features Editor: Tim Appenzeller
Deputy News Editors: Elizabeth Culotta, Joshua Fischman, Jean Marx, Jeffrey Mervis
News & Comment/Research News Writers: Linda B. Felaco (copy), Constance Holden, Jocelyn Kaiser, Richard A. Kerr, Andrew Lawler, Eliot Marshall, Elizabeth Pennisi, Kimberly Peterson (intern), Robert F. Service
Bureaus: Berkeley, CA: Marcia Barinaga; San Diego, CA: Jon Cohen; Chicago, IL: James Glanz; Boston, MA: Wade Roush
Contributing Correspondents: Barry A. Cipra, Ann Gibbons, Charles C. Mann, Anne Simon Moffat, Virginia Morell, Gary Taubes
Administrative Support: Scherraine Mack, Fannie Groom

Production & Art Staff

Production: James Landry, *Director*; Wendy K. Shank, *Manager*; Lizbeth A. Harman, *Assistant Manager*; Jennifer A. Gearhart, Daniel T. Helgerman, Cynthia M. Penny, *Associates*; Leslie Blizard, *Assistant*
Art: Amy Decker Henry, *Director*; C. Faber Smith, *Associate Director*; Katharine Sutliff, *Scientific Illustrator*; Holly Bishop, Elizabeth Carroll, *Graphics Associates*; Preston Morrighan, Patricia M. Riehn, *Graphics Assistants*
Technology Manager: Christopher J. Feldmeier

Science International: Europe Office

Editorial: Richard B. Gallagher, *Office Head and Senior Editor*; Stella M. Hurtley, Julia Uppenbrink, *Associate Editors*; Belinda Holden, *Editorial Associate*
News: Daniel Clery, *Editor*; Nigel Williams, *Correspondent*; Michael Balter (*Paris*), Patricia Kahn (*Heidelberg*), *Contributing Correspondents*
Administrative Support: Janet Mumford; Anna Sewell
Asia Office: Japan News Bureau: Dennis Normile; China Representative: Hao Xin

Science's Next Wave: <http://sci.aas.org/nextwave/>
Editor: John Benditt

EDITORIAL

Power Plants or Candle Factories?

In 1989, I chaired a panel of the National Research Council's Committee on Science, Education, and Public Policy (COSEPUP) that was charged with examining the uses of information technology (IT) in the conduct of research. Seven years later, our carefully drawn conclusions* seem extravagantly timid and understated.

From my viewpoint at the helm of a large public university system, IT's extraordinary evolution is beginning to drive truly revolutionary changes in all university functions, because information is the elemental material—the silicon, as it were—of education and research. Any fundamental change in our ability to handle information must necessarily lead to fundamental change in academic activities. In his book *Being Digital*,† Nicholas Negroponte shows how profoundly different are the handling of atoms (as in ink on paper) and the handling of bits. We are used to dealing with the book, a permanently defined text that has an author or authors and is someone's copyrighted intellectual property. In contrast, a collection of bits from or about, say, the Galileo probe of Jupiter, can easily be reconfigured across many media to serve the needs of an individual user. What then is it called, who authored it, and who owns it?

William A. Wulf‡ and others (myself included) have speculated that many universities may die or may change beyond recognition as a result of the IT revolution. When asked what his light bulb would mean for the candle industry, Thomas Edison reportedly replied, "We will make electricity so cheap that only the rich will burn candles." We are entering an era in which most colleges and universities must decide whether to change a little (and thus remain in the academic candle industry) or a lot (and launch themselves into the academic electrical business). Barring a catastrophic reduction in the nation's commitment to research, the 100 or so major research universities probably will persist in recognizable form. Several hundred institutions whose primary focus is the liberal education of full-time, campus-resident, recent high-school graduates will persist as well. That leaves about 3000 institutions of higher education serving the vast majority of the nation's 14,400,000 college and university students in ways that will inevitably be profoundly transformed by IT.

The U.S. higher education enterprise has changed radically in the past and has usually diversified in the process. The IT revolution will cause new institutions—and new kinds of institutions—to emerge. Indeed, some are already doing so. Some may be "virtual universities" that are delocalized across cyberspace. Others will successfully meld the best of the past with the opportunities of the future. Still others may fail to survive. It will be a time of turmoil and uncertainty. Resistance to radical change will probably be substantial within academe, many of whose members will argue that IT is a threat to the essential traditional values of real education and that its pervasive use can result only in pervasive mediocrity. I anticipate that much of higher education's clientele will decide otherwise. I expect that we will see academic examples of the phenomenon reported by a bank official who, when visiting a branch office, observed several unoccupied human tellers idly watching the progress of a long line of customers at the ATM.

The outcome of the IT revolution seems likely to be a substantially diversified higher education enterprise that is capable of delivering high-quality education and training tailored to the requirements of any citizen, in a society in which work and learning are intertwined throughout almost everyone's lifetime. IT can and will make that possible. The challenge for today's colleges and universities is to decide whether they want to be in the candle industry or the electrical business, and how to get there, survive, and prosper. There's room for both sectors. In the words of Negroponte, "The future will not be one or the other, but both."

Donald N. Langenberg

The author is chancellor of the University of Maryland System, former chancellor of the University of Illinois at Chicago, and former deputy director of the National Science Foundation.

*COSEPUP Panel on Information Technology and the Conduct of Research, *Information Technology and the Conduct of Research: The User's View* (National Academy Press, Washington, DC, 1989), p. 12. †*Being Digital* (Knopf, New York, 1995). ‡*Issues in Science and Technology* 11, 46 (1995).