Those inclined to fret about the durability of American hegemony have recently turned up the volume. In a bracing editorial, “Losing Our Technical Dominance,” The New York Times decided the country was “losing ground to foreign competitors” – a trend the editors saw as “inevitable.”

For its part, BusinessWeek wondered whether there is “a way for the U.S. to stay on top.” And not to be outdone in the doomsday department, The San Francisco Chronicle calculated that one job in six in Northern California – many in high-tech – could vanish because of outsourcing. Adding an official stamp of approval to these widening anxieties, the National Science Board, overseers of the National Science Foundation, recently concluded that waning American innovation threatens “the economic welfare and security of our country.”

These dire warnings are worth taking seriously. Indeed, it is safe to conclude that American dominance in advanced commercial technologies is coming to an end. The more important question is what comes next. A gradual decline, in which the United States’ lead in civilian technologies narrows? Or a destabilizing decline brought about by a pell-mell race to a place in which low-wage countries – think China, India, Russia and Brazil – become the world’s innovation centers?

To be sure, innovations on American soil remain best-of-breed across a wide range of categories. In fact, just when we are discovering that our military can’t make fanatics bearing rocket-propelled grenades go away and that our financial system is creaking under the massive weight of government budget deficits, we are being told that the technological foundation of the economy is cracking. Without a fresh resolve (as well as new breakthroughs) the next technological generation may belong, not to Silicon Valley, but to Bangalore, Helsinki, Shanghai and Moscow.

First, a bit of good news. The attacks on Sept. 11 have influenced American research and development priorities only marginally.
While pressing national-security needs related to homeland security and the war on terrorism are influencing R&D on the margins, they are not distorting the R&D priorities of the federal government. Commercial competitiveness remains central to Washington’s technical agenda.

The reason is not a mystery. Many scientists and engineers believe that the government already possesses (or could easily obtain) the technologies needed to deter terrorists. The real challenge, they suggest, is mobilizing existing technology properly — for example, outfitting civilian aircraft with off-the-shelf military technology for foiling ground-to-air missiles.

Even if Washington did want to rally scientists around new priorities, it would be hard to carry off. Whereas a half century ago science and engineering research in the United States was largely financed and directed by the government, the private sector carries most of the load today. From the mid-1950s to the mid-1960s, the federal government provided two-thirds of all research and development spending in the country and industry provided the other third. The proportion is reversed today, with industry supplying $180 billion annually and government some $90 billion.

America’s software and semiconductor industries each spend about $10 billion on R&D annually, roughly equal to NASA’s entire R&D budget. And a single semiconductor company, Intel, spends about as much on research and development as the National Science Foundation.

Moreover, many of Washington’s research and development commitments simply won’t bend to new priorities. The Department of Homeland Security is spending $800 million this fiscal year on R&D. By contrast the National Institutes of Health — the nation’s front-line patron for biomedical research — is spending $28 billion. And only a small portion of the $800 million is devoted to the search for innovations from basic research. Most of the money is going toward applying existing skills to solve new problems.

**A Need for Talent**

In any event, the threat to America’s overall position in technology isn’t lack of financing. More money is available for R&D — and from more sources — than ever before. The problem is who will do the work. The supply of talented researchers is limited, and there aren’t nearly enough Americans to handle the available tasks. Growing more talent takes time and may simply not be possible. In the meantime, the United States relies on foreigners to close its researcher gap.

Silicon Valley has long been to technological innovation what Hollywood has been to entertainment. People from all over the world congregate along a 60-mile corridor of north-central California in order to invent the future — and, if they are lucky, to get rich. Without a vibrant Silicon Valley, United States dominance over global technology would surely wane.

This spring we were treated to the latest reminder of the Silicon Valley dream: Google’s decision to sell 10 percent of its shares to outside investors for something north of $2 bil-
lion. The Google story is the stuff of (American) myth. In just a few years, “googling” – using the company’s very efficient Internet search engine – became a billion-dollar business (from the advertisements that run alongside search results), a way of life (for those who rely on the Web for all manner of stimulation) and a symbol of America’s continued technological vitality.

Yet Google’s success masks a disquieting trend: the aging of Silicon Valley. The last few years have been tough on the mother ship of American digital invention. In the three years after the dot-com bust in 2000, Silicon Valley lost 10 percent of its technology jobs. Some of the job loss stemmed from the region’s high housing costs and poor transportation network; some of the rest was explained by the sharp fall in purchases of information technology products during the recession. Yet because of the rise of innovation clusters in Asia and Europe, the decline of Silicon Valley has inevitably raised the question of whether the balance of commercial technology in the world has shifted.

A shift in technology power does seem likely. For one thing, the 1990s were an aberration. American hegemony over innovation was never before as wide or deep as it was in that decade. European innovators were fearsome competitors in computing and software well into the 1960s, while the Soviet Union was a formidable rival in basic research until the 1980s.
The big question is not whether Silicon Valley thrives, but whether the region can dominate emerging fields in the way it has dominated computing, software and the Internet.

With the eclipse of Europe and the collapse of the Soviet Union, the United States found itself head-to-head with the Japanese, whose technological ambitions were shattered during the 1990s. Even at the height of U.S. dominance, however, new threats surfaced. Finland’s national champion, Nokia, grabbed the lead in wireless phones. It proved adept at innovating in both telecommunications software and small telecom devices, thrashing the American leader, Motorola, in an arena Americans felt they owned. Meanwhile, the rapid rise of India, China and the Asian tigers (especially Singapore) as centers for research and development and new technological products marked the limits of United States technological ascent.

The San Francisco Bay area, with Silicon Valley as its core, still receives one-third of all venture funds invested in the United States. But competition from international locations, including Taiwan, Israel and Finland, is growing. The tech gap is narrowing, and not merely because U.S. companies are shifting engineering and scientific jobs to lower-wage countries. Immigrants who have succeeded in Silicon Valley are returning home to form enterprises, and sometimes to grab work from American rivals.

THE NEXT WAVE OF GROWTH

Retrenchment in Silicon Valley, along with intensified global competition, has prompted much self-examination. A report by Joint Venture: Silicon Valley Network, an association of luminaries devoted to the renewal and growth of the region’s technology base, openly talks about the “next” Silicon Valley as if the current one were dying. Holding out the specter of Detroit and other once-great centers of excellence that stuck too long with aging technologies, the organization envisions a new wave of growth in the interplay of innovations in biomedicine, information technology and the engineering of ultra-small machines (a.k.a. nanotechnology).

Earlier this year, the Joint Venture group issued its yearly survey of the Valley, reporting that the loss of jobs had slowed but not stopped. To be sure, big victories are likely in the future, not only for Silicon Valley but also its satellites in San Francisco and the East Bay. The recent appearance of mad cow disease in the United States provides one neat example: a company in South San Francisco called InPro Biotechnology makes a high-speed test for the disease. And it doesn’t take a Bill Gates to tell you that means business.

Saving America’s beef herd may require electronic tags or smart sensors that provide individual medical histories for each cow. Safeguards for the food supply may thus be transformed by the combination of digital electronics and programming – two areas in which Silicon Valley excels.

Nanotechnology could also prove a jewel in the Bay Area’s crown. The region’s technology leaders already mass-produce some of the smallest machines ever devised. The region thus has the tools, know-how and funds to
stay on the leading edge of a new generation of devices that could transform health care and households.

The digitization of content, the marriage of media and electronics, will also create many new opportunities. The success of Apple’s iPod, which stores recorded music downloaded from computer networks, illustrates the extent to which the conventional computer industry can still grow through cannibalization of established media.

A RECORD OF INNOVATION

The big question is not whether Silicon Valley thrives, but whether the region can dominate emerging fields in the way it has dominated computing, software and the Internet. Because Silicon Valley worships at the altar of change, there’s no hint of another Detroit in the offing. Innovators move fast in Northern California. According to the Public Policy Institute of California, new technology firms in the region obtain their first-round of venture financing in an average 11.6 months – five months faster than the national average.

This lead in financing explains why Silicon Valley companies are so often first to conceive of new technologies, first to market them – and first to profit. “I’m blown away at the quality and quantity of the companies we’re seeing in Northern California,” said Mitchell Kertzman, a partner in the venture capital firm Hummer Winblad. “Almost every day we’re seeing real invention: brilliant people solving hard problems that matter.”

How large a lead over other regions, especially up-and-coming Asian centers like Bangalore, can Silicon Valley maintain? A look at Silicon Valley’s most successful companies suggests that the region will be hard to dislodge. Consider the experience of Intel, the world’s leading maker of computer chips, whose history parallels the rise of Silicon Valley. Trying to maintain its lock on leadership, Intel has invested in everything remotely related to the processing of digital information. “If we don’t get the next big thing, it won’t be because we didn’t know about it,” said one senior Intel executive.

Yet today there are more smart technologists in more places than perhaps at any time in history, and they are aided by the very technologies that Silicon Valley championed. The Internet enabled the low-cost diffusion of information, and low-cost information undermines the locational advantages that help to keep the Valley on top.

Silicon Valley is hardly destined to become an also-ran in global technology. Neither will the United States suddenly fade from view in
the ongoing innovation derby. But the challenges are not trivial. To flourish in an increasingly difficult environment, Silicon Valley’s own champions – the top companies, including Intel and Hewlett-Packard – are being forced to make tough choices, which strike sober observers as worrisome.

“Today’s corporate rhetoric, with its intense emphasis on high profitability and flexibility, is eliminating the very concept of loyalty to employees, or to the nation,” said Alex Pang, an historian of technology and research director at the Institute for the Future in Menlo Park. “I doubt that the founders of Hewlett-Packard – Stanford graduates who were among the nation’s first technology entrepreneurs 60 years ago – would have outsourced engineering and manufacturing (or call centers, or tech support, or R&D) to India and China as eagerly as companies are doing today.”

“I’m not certain that this can go on forever. There’s also an ideological assumption that government is bad, and that we’ve gotten where we are thanks to our own hard work,” Pang said, adding, “entrepreneurs view government as an obstruction, a brake on profits and growth – not something that makes markets and trade possible in the first place. Noblesse oblige is for chumps.”

“I think we may have passed the point where the Valley can exist as an organic, sustainable civic experiment,” he concluded.

The unpredictability of technological change mocks those who would claim to manage the process. Neither massive amounts of spending nor the application of effort can ensure United States dominance.

As The Economist shrewdly noted, “The most successful technologies develop in ways their inventors fail to foresee.” Other nations may race past America in specific areas, much as the northern Europeans seized the initia-
which already indirectly supports these University of California campuses through research contracts, should consider direct sub-
ventions in recognition of the vital role these campuses play in strengthening the nation’s technological profile.

**Improve science and math education from kindergarten through high school.** The United States depends on foreign countries for its scientists and engineers. While the country has long relied on help from its friends – think of the role played by émigré European physicists in the Manhattan Project – the level of dependence significantly increased in the 1990s. The proportion of foreign-born scient-
ists and engineers in the United States with bachelor degrees rose to 17 percent from 11; the proportion of foreign-born with master’s degrees rose to 29 percent from 19, while the proportion of PhDs from other countries rose to 38 percent from 24.

This is testimony to the near-universal appeal of the United States as a place to work and live. But such heavy reliance on foreign talent also highlights an economic vulnerability.

**Make Northern California more attractive to American talent.** One reason Silicon Valley depends so heavily on foreigners is the difficulty of attracting home-grown alternatives. Housing costs put the region out of reach for many experienced researchers and managers. Annalee Saxenian, a professor of regional planning at Berkeley, notes that “in 1995 the cost of living in Silicon Valley surpassed all comparable regions in the U.S. (including Boston, Los Angeles, Seattle, New York and Austin) and this dubious distinction has only increased since.”

“The housing issue has been a problem of our own making,” said Doug Henton, an econom-
ist in Mountain View, Calif., who specializes in high-tech issues. “We’ve restricted home building through zoning and other means.” Cost is only part of the problem. Traffic in the parallel corridors between San Jose and San Francisco, and San Jose and Oakland is among the worst in the nation. The awful commutes undermine the appeal of the region. And the problem can be solved only by investing heavily in mass transit.

**Promote public-private partnerships.** Re-
building Silicon Valley is not a matter of business as usual. Top-down federal initia-
tives, like the effort to promote nanotechnol-
gy or the quixotic campaign to send humans to Mars, carry the whiff of pork-barrel politi-
cs and often sap the commercial vitality that proponents of these scientific and technolog-
ical make-work projects profess to extol. To be sure, business and government must find common cause in maintaining a competitive edge. Government, however, supports science and engineering best when policymakers listen closely to both for-profit and non-
profit actors.

Success in spawning research and develop-
ment breakthroughs, and seeing them through to commercialization, requires flexibility. In-
creasingly, significant innovations are under-
written by government and corporations – and not just by U.S.-based ones, either. Hard and fast lines between profit and nonprofit enterprises are vanishing. Universities remain a spawning ground for valuable new ideas, sustaining “open” innovations such as free software.

But universities also profit from the suc-
cess of faculty and students. Stanford, for in-
stance, owns the intellectual property that underlies Google’s powerful search engine, but licenses the technology (apparently in-
definitely) to the company. Such novel ar-
rangements suggest that new models of pub-
lic-private partnerships will play a major role in renewing Silicon Valley and America’s tech-
nological capacity.