Yale gets a large-scale testing facility that would have been prohibitively expensive if Yale had tried to duplicate it in New Haven. A support lab in America for a project like this one might have 30 technicians, but the one in Fudan has 150.

"The gains are very much two-way," said Levin. "Our investigators get substantially enhanced productivity, and the Chinese get their graduate students trained, and their young faculty become collaborators with our professors, who are the leaders in their fields. It builds human capital for China and innovation for Yale." Graduate students from both universities go back and forth, forging relationships that will no doubt produce more collaborations in the future. At the same time, he added, a lot of legal preparation went into this collaboration to make sure that Yale would be able to harvest the intellectual property that is created.

"There is one world of science out there," said Levin, "and this kind of international division of labor makes a lot of sense." Yale, he said, also insisted that the working conditions at the Chinese labs be world-class; and, as a result, it has also helped to lift the quality of the Chinese facilities. "The living conditions of the lab animals are right up to U.S. standards," remarked Levin. "These are not mouse sweatshops."

Put all the above together and you have America's secret sauce—a mix of institutions, laws, and cultural norms that produce a level of trust, innovation, and collaboration that has enabled us to constantly renew our economy and raise our standard of living. There is nothing about the flat world—nothing—that Americans cannot handle, as long as we roll up our sleeves, educate our young people the right way for these times, and tend to and enrich the secrets of our sauce. So are we doing that? That's what the next two chapters are about. But let me give you a hint: The answer is no.

EIGHT

The Quiet Crisis

Close games for the Americans were rare in previous Olympics, but now it appears to be something the Americans should get used to.

—From an August 17, 2004, AP article from the Athens Olympics titled "U.S. Men's Basketball Team Narrowly Beats Greece"

Chinese pity comes from their belief that we are a country in decline. More than a few Chinese friends have quoted to me the proverb *fu bu guo san dai* (wealth doesn't make it past three generations) as they wonder how we became so ill-disciplined, distracted and dissolute. The fury surrounding Monica-gate seemed an incomprehensible waste of time to a nation whose emperors were supplied with thousands of concubines. Chinese are equally astonished that Americans are allowing themselves to drown in debt and under-fund public schools while the media focus on fights over feeding tubes, displays of the Ten Commandments and how to eat as much as we can without getting fat.

—James McGregor, a journalist-turned-businessman based in China, and a former chairman of the American Chamber of Commerce in China, writing in *The Washington Post*, July 31, 2005

You could find no better metaphor for the way the rest of the world can now compete head-to-head more effectively than ever with America than the struggles of the U.S. Olympic basketball team in 2004. The American team, made up of NBA stars, limped home to a

bronze medal after losing to Puerto Rico, Lithuania, and Argentina. Previously, the United States Olympic basketball team had lost only one game in the history of the modern Olympics. Remember when America sent only NCAA stars to the Olympic basketball events? For a long time these teams totally dominated all comers. Then they started getting challenged. So we sent our pros. And they started getting challenged. Because the world keeps learning, the diffusion of knowledge happens faster; coaches in other countries now download American coaching methods off the Internet and watch NBA games in their own living rooms on satellite TV. Many of them can even get ESPN and watch the highlight reels. And thanks to the triple convergence, there is a lot of new raw talent walking onto the NBA courts from all over the world—including many new stars from China, Latin America, and Eastern Europe. They go back and play for their national teams in the Olympics, using the skills they honed in America. So the automatic American superiority of twenty years ago is now gone in Olympic basketball. The NBA standard is increasingly becoming a global commodity—pure vanilla. If the United States wants to continue to dominate in Olympic basketball, we must, in that great sports cliché, step it up a notch. The old standard won't do anymore. As Joel Cawley of IBM remarked to me, "Star for star, the basketball teams from places like Lithuania or Puerto Rico still don't rank well versus the Americans, but when they play as a team—when they *collaborate* better than we do—they are extremely competitive."

Sports writer John Feinstein could have been referring to either American engineering skills or American basketball skills when he wrote in an August 26, 2004, AOL essay on Olympic basketball that the performance of the U.S. basketball team is a result of "the rise of the international player" and "the decline and fall of the U.S. game." And the decline and fall of the U.S. game, argued Feinstein, is a result of two long-term trends. The first is a steady decline "in basketball skills," with American kids just wanting to shoot either three-point shots or dunk—the sort of stuff that gets you on ESPN's *SportsCenter* highlight reel—instead of learning how to make precise passes, or go into the lane and shoot a pull-up jumper, or snake through big men to get to the basket. Those skills take a lot of hard work and coaching to learn. Today, said

Feinstein, you have an American generation that relies almost completely on athleticism and almost not at all on basketball skills. And there is also that ugly little problem of ambition. While the rest of the world was getting better in basketball, "more and more NBA players were yawning at the notion of playing in the Olympics," noted Feinstein. "We have come a long way from 1984, when Bob Knight told Charles Barkley to show up to the second Olympic training camp at 265 pounds or else. Barkley showed up weighing 280. Knight cut him that day. In today's world, the Olympic coach wouldn't even have checked Barkley's weight in the first place. He would have sent a limousine to the airport to get him and stopped at Dunkin' Donuts on the way to the hotel if the player requested it . . . The world changes. In the case of American basketball, it hasn't changed for the better."

There is something about post–World War II America that reminds me of the classic wealthy family that by the third generation starts to squander its wealth. The members of the first generation are nose-to-the-grindstone innovators or entrepreneurs; the second generation holds it all together; then their kids come along and get fat, dumb, and lazy and slowly squander it all. I know that is both overly harsh and a gross generalization, but there is, nevertheless, some truth in it. American society started to coast in the 1990s, when our third postwar generation came of age. The dot-com boom left too many people with the impression that they could get rich without investing in hard work. All it took was an MBA and a quick IPO, or one NBA contract, and you were set for life. Who needed an education? Who needed to sweat over an engineering degree? But while we were admiring the flat world we had created, a lot of people in India, China, and Eastern Europe were busy figuring out how to take advantage of it. Lucky for us, we were the only economy standing after World War II, and we had no serious competition for forty years. That gave us a huge head of steam but also gradually bred a sense of entitlement and a culture of complacency. That is, a pronounced tendency in recent years to extol consumption over hard work and investment, immediate gratification over long-term thinking and sacrifice. When we got hit with 9/11, it was a once-in-a-generation opportunity to summon the nation to sacrifice, to address some of its pressing fiscal,

energy, science, and education shortfalls—all the things that we had let slide. But our president did not summon us to sacrifice. He summoned us to go shopping.

In the previous chapters, I tried to explain why both classic economic theory and the inherent strengths of the American economy leave me convinced that Americans can thrive and claim the jobs of the new middle—provided we get ready to compete, get every individual to think about how he or she can upgrade his or her educational skills, and keep investing in the secrets of America's sauce. This chapter is about why we are not doing those things and what will happen if we don't change course.

The truth is, we're in a crisis now, but it is a crisis that is unfolding very quietly. We're a bit like a person who is sleeping on an air mattress, and the air is slowly coming out—so slowly you barely feel it, until your head hits the cement. By then, it's really hard to reinflate the mattress. It is "a quiet crisis," explained Shirley Ann Jackson, the 2004 president of the American Association for the Advancement of Science and president of Rensselaer Polytechnic Institute since 1999. (Rensselaer is America's oldest technological college, founded in 1824.) And this quiet crisis involves the steady erosion of America's scientific and engineering base, which has long been the source of American innovation and our rising standard of living.

"The sky is not falling, nothing horrible is going to happen today," said Jackson, a physicist by training who chooses her words carefully. "The U.S. is still the leading engine for innovation in the world. It has the best graduate programs, the best scientific infrastructure, and the capital markets to exploit it. But there is a quiet crisis in U.S. science and technology that we have to wake up to. The U.S. today is in a truly global environment, and those competitor countries are not only wide awake, they are running a marathon while we are running sprints. If left unchecked, this could challenge our preeminence and capacity to innovate."

Shirley Ann Jackson knows of what she speaks, because her career exemplifies as well as anyone's both why America thrived so much in the past fifty years and why it won't automatically do the same in the next

fifty. An African-American woman, Jackson was born in Washington, D.C., in 1946. She started kindergarten in a segregated public school but was one of the first public school students to benefit from desegregation, as a result of the Supreme Court ruling in *Brown v. Board of Education*. Just when she was getting a chance to go to a better school, the Russians launched Sputnik in 1957, and the U.S. government became obsessed with educating young people to become scientists and engineers, a trend that was intensified by John F. Kennedy's commitment to a manned space program. When Kennedy spoke about putting a man on the moon, Shirley Ann Jackson was one of the millions of American young people who were listening. His words, she recalled, "inspired, assisted, and launched many of my generation into science, engineering, and mathematics," and the breakthroughs and inventions they spawned went well beyond the space program. "The space race was really a science race," she said.

Thanks in part to desegregation, both Jackson's inspiration and intellect were recognized early, and she ultimately became the first African-American woman to earn a Ph.D. in physics from MIT (her degree was in theoretical elementary particle physics). From there, she spent many years working for AT&T Bell Laboratories, and in 1995 was appointed by President Clinton to chair the U.S. Nuclear Regulatory Commission.

As the years went by, though, Jackson began to notice that fewer and fewer young Americans were captivated by national challenges like the race to the moon, or felt the allure of math, science, and engineering. In universities, she noted, graduate enrollment in science and engineering programs, having grown for decades, peaked in 1993, and despite some recent progress, it remains today below the level of a decade ago. So the science and engineering generations that followed Jackson's got smaller and smaller relative to our needs. By the time Jackson took the job as Rensselaer Polytechnic's president to put her heart and soul into reinvigorating American science and engineering, she realized that a "perfect storm" was brewing—one that posed a real long-term danger to America's economic health—and she started speaking out about it.

"The phrase 'the perfect storm' is associated with meteorological events in October 1991," said Jackson in a speech in May 2004, when "a powerful

weather system gathered force, ravaging the Atlantic Ocean over the course of several days, [and] caused the deaths of several Massachusetts-based fishermen and billions of dollars of damage. [Meteorologists emphasized] the unlikely confluence of conditions [which] converged to bring about an event of devastating magnitude. [A] similar worst-case scenario could arrest the progress of our national scientific and technological capacity. The forces at work are multiple and complex. They are demographic, political, economic, cultural, even social." At heart, this perfect storm involves the collision of an older generation of American engineers and scientists who are retiring at the same time that a younger generation is not stepping into their shoes in sufficient numbers—and at the same time that the foreigners who used to make up the difference are either staying home or being kept out of America for security reasons. Individually, each of these forces would be problematic, added Jackson. In combination, they could be devastating. "For the first time in more than a century, the United States could well find itself falling behind other countries in the capacity for scientific discovery, innovation, and economic development."

Although knowledge has always mattered, it matters more than ever today. As economist Jeffrey Sachs has pointed out, until the scientific revolution began in the seventeenth century, virtually everyone everywhere was living on the edge of subsistence. But after three centuries of technological and scientific advances, subsistence is no longer the norm. Steam power, machine tools, electricity, and ultimately computers and the Internet have enabled individuals to become vastly more productive. So now the Industrial Age and the Information Age are giving way to the Talent Age. The flattening of the world has brought the tools of the Industrial Age and the Information Age to more people and places than ever. As these tools have become commodities, widely dispersed to everyone, business strategist John Hagel III noted, the "only sustainable edge" for companies and countries is the distinctive talents and entrepreneurship of their workforce. Economics can always be win-win. But those who will win the most today, added Hagel, will be those who are best and fastest at attracting talent.

That is why I insist that wealth in the age of flatness will increasingly

gravitate to those countries who get three basic things right: the infrastructure to connect as efficiently and speedily as possible with the flat world platform, the right education programs and knowledge skills to empower more of their people to innovate and do value-added work on that platform, and, finally, the right governance—that is, the right tax policies, the right investment and trade laws, the right support for research, the right intellectual property laws, and, most of all, the right inspirational leadership—to enhance and manage the flow with the flat world.

Unfortunately, the United States has serious gaps developing in all of these areas. In the Cold War, one of the deepest concerns of American society was the putative missile gap between us and the Soviet Union, which threatened America from outside. Today, we should be concerned about the gaps in our education, infrastructure, and ambitions that threaten to weaken us from within. These gaps are our dirty little secrets. If we continue to ignore them, then this won't be a quiet crisis anymore, said Rensselaer's Jackson, "it will be the real McCoy."

Dirty Little Secret #1: The Numbers Gap

Dirty little secret number one is that the generation of scientists and engineers who were motivated to go into science by the threat of Sputnik in 1957 and the inspiration of JFK are reaching their retirement years and are not being replaced in the numbers that they must be if an advanced economy like that of the United States is to remain at the head of the pack. According to the National Science Foundation, half of America's scientists and engineers are forty years or older, and the average age is steadily rising.

Just take one example—NASA. An analysis of NASA records conducted by the newspaper *Florida Today* (March 7, 2004), which covers the Kennedy Space Center, showed the following: Nearly 40 percent of the 18,146 people at NASA are age fifty or older. Those with twenty years of government service are eligible for early retirement. Twenty-two percent of NASA workers are fifty-five or older. NASA employees over sixty

outnumber those under thirty by a ratio of about three to one. Only 4 percent of NASA workers are under thirty. A 2003 Government Accounting Office study concluded that NASA was having difficulty hiring people with the sufficient science, engineering, and information-technology skills that are critical to its operations. Many of these jobs are reserved for American citizens, because of national security concerns. Then–NASA administrator Sean O'Keefe testified before Congress in 2002: "Our mission of understanding and protecting our home planet and exploring the universe and searching for life will not be carried out if we don't have the people to do it." The National Commission on Mathematics and Science Teaching for the Twenty-first Century, chaired by the former astronaut and senator John Glenn, found that two-thirds of the nation's mathematics and science teaching force will retire by 2010.

Traditionally we made up for any shortages of engineers and science faculty by educating more at home and importing more from abroad. But both of those remedies have been stalled of late.

Every two years the National Science Board supervises the collection of a very broad set of data trends in science and technology in the United States, which it publishes as *Science and Engineering Indicators.* In preparing *Indicators* 2004, the NSB said, "We have observed a troubling decline in the number of U.S. citizens who are training to become scientists and engineers, whereas the number of jobs requiring science and engineering (S&E) training continues to grow." These trends threaten the economic welfare and security of our country, it said, adding that if the trends identified in *Indicators* 2004 continue undeterred, three things will happen: "The number of jobs in the U.S. economy that require science and engineering training will grow; the number of U.S. citizens prepared for those jobs will, at best, be level; and the availability of people from other countries who have science and engineering training will decline, either because of limits to entry imposed by U.S. national security restrictions or because of intense global competition for people with these skills."

The NSB report found that the number of American eighteen- to twenty-four-year-olds who receive science degrees has fallen to seventeenth in the world, whereas we ranked third three decades ago. It said

that of the 2.8 million first university degrees (what we call bachelor's degrees) in science and engineering granted worldwide in 2003, 1.2 million were earned by Asian students in Asian universities, 830,000 were granted in Europe, and 400,000 in the United States. In engineering specifically, universities in Asian countries now produce eight times as many bachelor's degrees as the United States.

Moreover, "the proportional emphasis on science and engineering is greater in other nations," noted Shirley Ann Jackson. Science and engineering degrees now represent 60 percent of all bachelor's degrees earned in China, 33 percent in South Korea, 41 percent in Taiwan—and roughly 31 percent in the United States. The United States has always depended on the inventiveness of its people in order to compete in the world marketplace, said the NSB. "Preparation of the S&E workforce is a vital arena for national competitiveness. [But] even if action is taken today to change these trends, the reversal is 10 to 20 years away." The students entering the science and engineering workforce with advanced degrees in 2004 decided to take the necessary math courses to enable this career path when they were in middle school, up to fourteen years ago, the NSB noted. The students making that same decision in middle school today won't complete advanced training for science and engineering occupations until 2018 or 2020. "If action is not taken now to change these trends, we could reach 2020 and find that the ability of U.S. research and education institutions to regenerate has been damaged and that their preeminence has been lost to other areas of the world," the science board said.

These shortages could not be happening at a worse time—just when the world is going flat. "The number of jobs requiring science and engineering skills in the U.S. labor force," the NSB said, "is growing almost 5 percent per year. In comparison, the rest of the labor force is growing at just over 1 percent. Before September 11, 2001, the Bureau of Labor Statistics (BLS) projected that science and engineering occupations would increase at three times the rate of all occupations." Unfortunately, the NSB reported, the average age of the science and engineering workforce is rising.

"Many of those who entered the expanding S&E workforce in the

1960s and 1970s (the baby boom generation) are expected to retire in the next twenty years, and their children are not choosing science and engineering careers in the same numbers as their parents," the NSB report said. "The percentage of women, for example, choosing math and computer science careers fell 4 percentage points between 1993 and 1999." The 2002 NSB indicators showed that the number of science and engineering Ph.D.'s awarded in the United States dropped from twenty-nine thousand in 1998 to twenty-seven thousand in 1999. The total number of engineering undergraduates in America fell about 12 percent between the mid-1980s and 1998.

Nevertheless, America's science and engineering labor force grew at a rate well above that of America's production of science and engineering degrees, because a large number of foreign-born S&E graduates migrated to the United States. The proportion of foreign-born students in S&E fields and workers in S&E occupations continued to rise steadily in the 1990s. The NSB said that persons born outside the United States accounted for 14 percent of all S&E occupations in 1990. Between 1990 and 2000, the proportion of foreign-born people with bachelor's degrees in S&E occupations rose from 11 to 17 percent, the proportion of foreign-born with master's degrees rose from 19 to 29 percent, and the proportion of foreign-born with Ph.D.'s in the S&E labor force rose from 24 to 38 percent. By attracting scientists and engineers born and trained in other countries, we have maintained the growth of the S&E labor force without a commensurate increase in support for the long-term costs of training and attracting native U.S citizens to these fields, the NSB said.

But now, the simultaneous flattening and wiring of the world have made it much easier for foreigners to innovate without having to emigrate. They can now do world-class work for world-class companies at very decent wages at home. As Allan E. Goodman, president of the Institute of International Education, put it, "When the world was round, they could not go back home, because there was no lab to go back to and no Internet to connect to. But now all those things are there, so they are going back. Now they are saying, 'I feel more comfortable back home. I can live more comfortably back home than in New York City and I can do good work, so why not go back?'" This trend started even before the

visa hassles brought on by 9/11, said Goodman. "The brain gain started to go to brain drain around the year 2000."

As the NSB study noted, "Since the 1980s other countries have increased investment in S&E education and the S&E workforce at higher rates than the United States has. Between 1993 and 1997, the OECD countries [Organization for Economic Co-operation and Development, a group of forty nations with highly developed market economies] increased their number of S&E research jobs 23 percent, more than twice the 11 percent increase in S&E research jobs in the United States."

In addition, it said, visas for students and S&E workers have been issued more slowly since the events of September 11, owing to both increased security restrictions and a drop in applications. The U.S. State Department issued 20 percent fewer visas for foreign students in 2001 than in 2000, and the rate fell farther in subsequent years. While university presidents told me in 2004 that the situation was getting better, and that the Department of Homeland Security was trying to both speed up and simplify its visa procedures for foreign students and scientists, a lot of damage has been done, and the situation for foreign students or scientists wanting to work in any areas deemed to have national security implications is becoming a real problem. No wonder *New York Times* education writer Sam Dillon reported on December 21, 2004, that "foreign applications to American graduate schools declined 28 percent this year. Actual foreign graduate student enrollments dropped 6 percent. Enrollments of all foreign students, in undergraduate, graduate and postdoctoral programs, fell for the first time in three decades in an annual census released this fall. Meanwhile, university enrollments have been surging in England, Germany and other countries . . . Chinese applications to American graduate schools fell 45 percent this year, while several European countries announced surges in Chinese enrollment."

Some analysts have argued that it can be very misleading to quote the gross number of engineers graduating every year in India, China, and the United States—and therefore conclude that America must be falling behind—because accurate statistics are not only hard to come by, they often ignore the different quality of engineering degrees in the respective countries. For instance, a December 2005 study by Duke University's

Master of Engineering Management Program, entitled "Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India," concluded that the Indian and Chinese numbers often include graduates from less rigorous two- or three-year training programs—while the U.S. numbers usually capture only accredited four-year bachelor degree programs. The Duke study also differentiates between two groups of engineering graduates, what it calls "dynamic engineers" and "transactional engineers." Dynamic engineers, it says, "are individuals capable of abstract thinking and high-level problem solving using scientific knowledge." These dynamic engineers usually come out of at least four-year, accredited engineering programs, and their jobs are not easily outsourced. Transactional engineers, who often receive associate, technician, or diploma awards rather than bachelor's degrees, may possess engineering fundamentals, but not the experience or expertise to apply this knowledge to larger problems, the Duke study said. These jobs can be easily outsourced. America, the Duke study concluded, is still producing a relatively high proportion of dynamic engineers and computer scientists compared to India and China, and therefore remains very competitive.

I would add the following caveat to this caveat, though. First, I would bet that many of the engineering degrees being granted by American universities are going not to American citizens but to foreign students, who will return to their home countries. Second, yes, the average engineering degree in India or China today may not be the same quality as at the average accredited four-year American university. But let me put this in very simple language: There are many more Indians and Chinese than there are Americans and a much, much higher percentage of them are studying science, computer science, and engineering—in their home countries and in American universities. In a flat world, best practices travel fast. So I have no doubt that within the next twenty years the average quality of undergraduate engineering degrees in China and India will start to mirror the American average. Look at the trend lines, not today's snapshot.

Dirty Little Secret #2: The Education Gap at the Top

The most important reason for the numbers gap, of course, is our education gap. We simply are not educating, or even interesting, enough of our own young people in advanced math, science, and engineering. Consider the annual worldwide Intel International Science and Engineering Fair. About forty countries participate by nominating talent through local affiliate affairs. In 2004, the Intel Fair attracted around sixty-five thousand American kids, according to Intel. How about in China? I asked Wee Theng Tan, the president of Intel China, during a visit to Beijing. In China, he told me, there is a national affiliate science fair, which acts as a feeder system to select kids for the global Intel fair. "Almost every single province has students going to one of these affiliate fairs," said Tan. "We have as many as six million kids competing, although not all are competing for the top levels . . . [But] you know how seriously they take it. Those selected to go to the international [Intel] fair are immediately exempted from college entrance exams," and basically get their choice of any top university in China. In the 2004 Intel Science Fair, China came home with thirty-five awards, more than any other country in Asia, including one of the top three global awards.

No wonder that *Education Week*, which is read by teachers all over America, ran an article (July 28, 2004), with the headline "Immigrants' Children Inhabit the Top Ranks of Math, Science Meets." It said: "Research conducted by the National Foundation for American Policy shows that 60 percent of the nation's top science students and 65 percent of the top mathematics students are children of recent immigrants, according to an analysis of award winners in three scholastic competitions . . . the Intel Science Talent Search, the U.S. team for the International Mathematical Olympiad, and the U.S. Physics Team." The study's author, Stuart Anderson, attributed the immigrant students' success "partly to their parents' insistence that they manage study time wisely," *Education Week* said. "Many immigrant parents also encouraged their children to pursue mathematics and science interests, believing those skills would lead to strong career opportunities and insulate them

from bias and lack of connections in the workplace . . . A strong percentage of the students surveyed had parents who arrived in the United States on H-1B visas, reserved for professional workers. U.S. policymakers who back overly restrictive immigration policies do so at the risk of cutting off a steady infusion of technological and scientific skill," said Anderson, the executive director of the foundation. The article quoted Andrei Munteanu, eighteen, a finalist for the 2004 Intel competition, whose parents had moved from Romania to the United States five years earlier. Munteanu started American public school in the seventh grade and found it a breeze compared to his Romanian school. "The math and science classes [covered the same subject matter] I was taking in Romania . . . when I was in fourth grade," he said.

Help does not appear to be on the way. Every four years the United States takes part in the Trends in International Mathematics and Science Study, which assesses students after fourth grade and eighth grade. Altogether, the most recent study involved roughly a half million students from forty-one countries and the use of thirty languages, making it the largest and most comprehensive international study of education that has ever been undertaken.

The 2004 results (for tests taken in 2003) showed American students making only marginal improvements over the 2000 results, which revealed the American labor force to be weaker in science than those of its peer countries. The Associated Press reported (December 4, 2004) that American eighth graders had improved their scores in science and math since 1995, when the test first was given, but their math improvement came mainly between 1995 and 1999, and not in recent years. The rising scores of American eighth graders in science were an improvement over 1999 and lifted the United States to a higher ranking relative to other countries. The worrying news, though, was that the scores of American fourth graders were stagnant, neither improving nor declining in science or math since 1995. As a result, the United States slipped in the international rankings as other countries made gains. "Asian countries are setting the pace in advanced science and math," Ina Mullis, codirector of the International Study Center at Boston College, which manages the study, told the AP. "As one example, 44 percent of eighth-graders in Singapore

scored at the most advanced level in math, as did 38 percent in Taiwan. Only 7 percent in the United States did." Results from another international education test also came out in December 2004, from the Program for International Student Assessment. It showed that American fifteen-year-olds are below the international average when it comes to applying math skills to real-life tasks.

That may be partly explained by a 2005 study by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine titled "Rising Above the Gathering Storm." It found that in 1999, only 41 percent of American eighth-grade students received instruction from a mathematics teacher who specialized in mathematics, considerably lower than the international average of 71 percent. The education in American junior high schools, in particular, seems to be a black hole that is sapping the interest of young people, particularly young women, when it comes to the sciences.

In October 2005, my wife and I went up to New Haven to attend parents' weekend at Yale. We went out for a pizza lunch with our daughter and her roommates, and one roommate's boyfriend. I sat across from the boyfriend, Eric Stern, twenty-four, who was getting a Ph.D. from Yale in biomedical engineering, with an expertise in nanotechnology. Eric is precisely the sort of young person we want the American education system to keep churning out. His grandfather was a watchmaker, his father a medical doctor and science professor at Columbia, and so he got interested in science at a very young age—in part from hanging around in his father's lab and in part by building things with his grandfather. He was a Westinghouse science finalist in high school, got his undergraduate degree at Yale, and was speeding his way through graduate school, working on a government-funded project using nanotechnology to detect various toxins in the air, which could have wide application in the war on terrorism. Stern and I immediately fell into conversation about the state of science education in America today.

For starters, he said, "Look around at this table," motioning to the five Yale undergraduate women. "I am sitting at a table eating pizza with all

these smart women, and it never occurred to them to do science." They were all in the humanities. Why? I asked Stern. There were a variety of reasons, and they applied to both young women and men in America today, he said. To begin with, "People want to do stuff that is fun. But there is no fun in algebra or memorizing the multiplication tables. But [those fundamentals] eventually become freshman chemistry. And that's boring too. You can't say anything good about it. So it's not until you get to the senior level of advanced classes that you can start to have fun. But you need to have acquired all these fundamentals beforehand . . . and getting those fundamentals is not fun . . . The culture now is geared toward having fun."

Speaking of Yale, Stern told me, "I love it here, but none of my friends were really interested in what I did and, if I wanted to communicate what I did, man, I really had to make it interesting. [Yale's] business is making presidents, and they are great at it. It is not making scientists. But the presidents they make don't value the sciences, because they don't hang out with those kids—and who epitomizes that more than Bush?" Stern added, "I was at a wedding recently, and all my college buddies were there who are now [investment] bankers, and they were talking about how much they made. And I started figuring out how much I make, and it came to about $3 an hour for working eighty hours a week. But I never really think about it that way."

It appears that young Americans wanting to be lawyers started to swamp those wanting to be engineers and scientists in the 1970s and early 1980s. Then, with the dot-com boom, those wanting to go to business school and earn MBAs swamped engineering students and lawyers in the 1990s.

Stern said he believed that American culture is still producing some of the most creative scientists and engineers, though other societies are closing the gap due to their dedication to teaching fundamentals and their newfound interest in instilling more creative approaches to education in their systems. Which is why, added Stern, as important as it is for American kids to upgrade their foundational skills in math and science, we have to do it without giving up those things in our culture that also inspire and instill creativity. In that vein, he argued, it is crazy to see public

schools getting rid of art and music programs. "One very formative part of my life that led to creative thinking as well as a work ethic was music," he said. "I was a serious classical musician, which definitely teaches hard work—and, for that matter, hard work all on your own—not like practicing with a sports team. But it also teaches you to interpret themes and ideas in new ways to make them your own."

Thank goodness American society still produces young men like Eric Stern, but we should have no illusions: He and his scientific colleagues are a minority that is getting smaller. In American society today, added Stern, "the highest thing you can be is a doctor or lawyer or investment banker—not an engineer or scientist. What worries him, he added, is where is the innovation going to happen?

"Are we going to be trading our stuff, or China's stuff?" he asked. "I want to make sure we are trading our stuff." But that gets back to the need for our people to have sound fundamentals. So much of science and engineering is about work ethic—the willingness not only to slog through all the fundamentals but also to stick with an experiment even when it fails the first twenty times, said Stern. The thing that impresses him most about the Asian students, and the best American ones, he concluded, is their work ethic. "When a Chinese graduate student comes up to me in the lab and says, 'How do you work so hard?' that is the best compliment I can get."

I wish more young Americans felt that way, but the statistics say otherwise—and the problem is not just with math and science. It's now infecting plain old reading and writing. On December 16, 2005, *The New York Times* carried a story reporting that the average American college graduate's literacy in English had declined significantly over the past decade, according to a widely respected nationwide test. This is college grads—not dropouts! "The National Assessment of Adult Literacy, given in 2003 by the Department of Education, is the nation's most important test of how well adult Americans can read," *The Times* said. "The test also found steep declines in the English literacy of Hispanics in the United States, and significant increases among blacks and Asians. When the test was last administered, in 1992, 40 percent of the nation's college graduates scored at the proficient level, meaning that they were able to read

lengthy, complex English texts and draw complicated inferences. But on the 2003 test, only 31 percent of the graduates demonstrated those high-level skills. There were 26.4 million college graduates . . . Grover J. Whitehurst, director of an institute within the Department of Education that helped to oversee the test, said he believed that the literacy of college graduates had dropped because a rising number of young Americans in recent years had spent their free time watching television and surfing the Internet. 'We're seeing substantial declines in reading for pleasure, and it's showing up in our literacy levels,' he said."

Dirty Little Secret #3: The Ambition Gap

Our love of television and video and online games helps to explain our third dirty little secret, one that several prominent American CEOs would tell me only in a whisper. It goes like this: When they send jobs abroad, they not only save 75 percent on wages, they get a 100 percent increase in productivity. In a sense, that's understandable. When you take a low-wage, low-prestige job in America, like a call center operator, and bring it over to India, where it becomes a high-wage, high-prestige job, you end up with workers who are paid less but motivated more. "The dirty little secret is that not only is [outsourcing] cheaper and efficient," the American CEO of a London-headquartered multinational told me, "but the quality and productivity [boost] is huge." In addition to the wage compression, he said, one Bangalore Indian employee will do the work of two or three Europeans, and the Bangalore employees don't take six weeks of holidays. "When you think it's only about wages," he added, "you can still hold your dignity, but the fact that they work better is awful."

A short time after returning from India, I was approached in an airport by a young man who wanted to talk about some columns I had written from there. We had a nice chat, I asked him for his card, and we struck up an e-mail friendship. His name is Mike Arguello, and he is an IT systems architect living in San Antonio. He does high-end IT systems

design and does not feel threatened by foreign competition. He also teaches computer science. When I asked him what we needed to do in America to get our edge back, he sent me this e-mail:

> I taught at a local university. It was disheartening to see the poor work ethic of many of my students. Of the students I taught over six semesters, I'd only consider hiring two of them. The rest lacked the creativity, problem-solving abilities and passion for learning. As you well know, India's biggest advantage over the Chinese and Russians is that they speak English. But it would be wrong to assume the top Indian developers are better than their American counterparts. The advantage they have is the number of bodies they can throw at a problem. The Indians that I work with are the cream of the crop. They are educated by the equivalents of MIT back in India and there are plenty of them. If you were to follow me in my daily meetings it would become very obvious that a great deal of my time is spent working with Indians. Most managers are probably still under the impression that all Indians are doing is lower-end software development—"software assembly." But technologies, such as Linux, are allowing them to start taking higher-paying system design jobs that had previously been the exclusive domain of American workers. It has provided them with the means to move up the technology food chain, putting them on par with domestic workers. It's brain power against brain power, and in this area they are formidable. From a technology perspective, the world is flat and getting flatter (if that is possible). The only two areas that I have not seen Indian labor in are networking architects and system architects, but it is only a matter of time. Indians are very bright and they are quickly learning from their interaction with system architects just how all of the pieces of the IT puzzle fit together . . . Were Congress to pass legislation to stop the flow of Indian labor, you would have major software systems that would have nobody who knew what was going on. It is unfortunate that many management positions in IT are filled with non-technical managers who may not be fully

aware of their exposure . . . I'm an expert in information systems, not economics, but I know a high-paying job requires one be able to produce something of high value. The economy is producing the jobs both at the high end and low end, but increasingly the high-end jobs are out of reach of many. Low education means low-paying jobs, plain and simple, and this is where more and more Americans are finding themselves. Many Americans can't believe they aren't qualified for high-paying jobs. I call this the "American Idol problem." If you've ever seen the reaction of contestants when Simon Cowell tells them they have no talent, they look at him in total disbelief. I'm just hoping someday I'm not given such a rude awakening.

But the trouble starts in high school, if not sooner. In the summer of 2005, I received the following letter from Malcolm Davidson, a high school teacher in Washington state:

Dear Mr. Friedman, I teach fifth grade reading and social studies at the Annie Wright School, a private school in Tacoma, Washington. While many of the families I teach are ethnically diverse and well educated, most are white, upper middle class American families. I recently finished your new book "The World is Flat." Two of the chapters, "The Triple Convergence" and "The Quiet Crisis," I experienced years ago, long before you wrote them. Reading them made me realize that the world was flat. I wish that I could have shared these thoughts with you before you wrote these two chapters. Parent conferences are one of the more interesting aspects of my job; I never realized that they were such a cultural study, though. Two parent conferences two years ago were my flat earth moment. One conference was with Deven and Swati Vora. (Guess where the Vora family immigrated from?) As we chatted about their daughter Sonia, they told me not only did our school not give enough homework but also that it wasn't challenging enough. Later that day in another conference, Irena Mikeladze, an immigrant from Eastern Europe, wanted to know why her son Timothy had no science book and such a flimsy science curriculum. How could we be a competitive school when we didn't have a science book? Representing two different national characters, the three parents made me think. Sadly, many . . . white, American, middle class parents [told me] that the 5th grade work was too hard on their kids. They couldn't possibly complete it and have time to "be a kid." Soccer, gymnastics, [music] lessons and dinner out squeezed their education time. Some parents would ask for my colleagues and I to lighten the load. These worrisome parents merely set low expectations for children by running interference; the scary parents . . . think everything is great and never demand more. If their kids do OK and have fun, then they must be getting a great education. Our schools tend to live back in an 11/9 mindset. I know as a school, my school compares itself with schools down the road or in the next town. If my students' parents believe that we are better than the local public, parochial and private schools, then they are content. As you wrote, and I realized in the two conferences, the real competition is not from the next town or the neighboring state any more. You're right—in many ways we are fooling ourselves. In an academic sense we lost our hunger (except for cheerleading and football and failing bond measures). We're complacent and headed for trouble. Sadly, national leadership is worried about not leaving kids behind, and states like Kansas and Georgia seem more concerned with eliminating Darwin and adding intelligent design. If one puts his ear to the flat Earth, one can hear the competition from overseas. My goal as an educator is to stop being the best local school, or regional school, and start being the best on the planet.

Essentially, before the world start getting flattened, the United States was an island—an island of innovation and safety and growing incomes. And therefore it became a magnet for the world's capital and the world's talent. When your currency is the world's currency and every brain wants to come over and work in your backyard, you start to take things for granted.

Asian countries have not had that luxury. In the winter of 2004 I had tea in Tokyo with Richard C. Koo, chief economist for the Nomura Research Institute. I tested out on Richard my "coefficient of flatness"—the notion that the flatter one's country is, that is, the fewer natural resources it has, the better off it will be in a flat world. The ideal country in a flat world is the one with *no natural resources*, because countries with no natural resources tend to dig inside themselves. They try to tap the energy, entrepreneurship, creativity, and intelligence of their own people—men and women—rather than drill an oil well. Taiwan is a barren rock in a typhoon-laden sea, with virtually no natural resources—nothing but the energy, ambition, and talent of its own people—and today it has the third-largest financial reserves in the world. The success of Hong Kong, Japan, South Korea, and coastal China can all be traced to a similar flatness.

"I am a Taiwanese American with a father from Taiwan and with a Japanese mother," Koo told me. "I was born in Japan and went to Japanese elementary school and then moved to the States. There is a saying in China that whatever you put in your head and your stomach, no one can take away from you. In this whole region, that is in the DNA. You just have to study hard and move forward. I was told relatively early by my teachers, 'We can never live like Americans and Canadians. We have no resources. We have to study hard, work hard, and export hard.'"

A short time later I read a column by Steven Pearlstein, *The Washington Post*'s business columnist/reporter, under the headline "Europe's Capitalism Curtain." From Wroclaw, Poland (July 23, 2004), Pearlstein wrote: "A curtain has descended across Europe. On one side are hope, optimism, freedom and prospects for a better life. On the other side, fear, pessimism, suffocating government regulations and a sense that the best times are in the past." This new curtain, Pearlstein argued, demarks Eastern Europe, which is embracing capitalism, and Western Europe, which is wishing desperately that it would go away.

"This time, however, it is the East that is likely to prevail," he continued. "The energy and sense of possibility are almost palpable here . . . Money and companies are pouring in—not just the prestige nameplates like Bombardier, Siemens, Whirlpool, Toyota and Volvo, but also the network of suppliers that inevitably follows them. At first, most of the new

jobs were of the semi-skilled variety. Now they have been followed by design and engineering work that aims to tap into the largest concentration of university students in Eastern Europe . . . The secret isn't just lower wages. It's also the attitude of workers who take pride and are willing to do what is necessary to succeed, even if it means outsourcing parts production or working on weekends or altering vacation schedules—things that would almost certainly trigger months of acrimony and negotiation in Western Europe. 'The people back home, they haven't got any idea how much they need to change if they want to preserve what they have,' said Jose Ugarte [a Basque who heads the appliance manufacturing operations of Mondragon, the giant Spanish industrial cooperative]. 'The danger to them is enormous. They don't realize how fast this is happening . . .' It's not the dream of riches that animates the people of Wroclaw so much as the determination to work hard, sacrifice what needs to be sacrificed and change what needs to be changed to close the gap with the West. It is that pride and determination, says Wroclaw's mayor, Rafal Dutkiewicz, that explain why they are such a threat to the 'leisure-time society' on the other side of the curtain."

Dirty Little Secret #4: The Education Gap at the Bottom

If you look back to America in the first third of the last century, you will find the roots of the public education system we have today—a system that is now outmoded for a flat world. Back in the early twentieth century, America decided to organize its education system by delegating the power and responsibility for education to local school boards. We basically allowed each community to organize its own school system, with its own approach to teaching and textbooks, and its own salary structures—as opposed to doing it either on a national level, as most countries do, or on a state level as, say, Germany does. The net effect of this approach, argues Marc Tucker, president of the National Center on Education and the Economy, was a patchwork system in which we delegated education

power to local school boards "organized by wealth." That is, "these school board districts were essentially organized around patterns of residents," explained Tucker. "So it made it possible for relatively wealthy people to organize into self-taxing districts. And that meant that wealthy people, by associating with each other, could tax themselves at relatively low rates and still produce very high per capita per student school budgets" because of their bigger homes and higher property tax assessments. If you went to the other end of the spectrum, you found relatively poor people associated with each other in school districts, paying a much larger portion of their income in school taxes but nevertheless winding up with very low per-pupil expenditures. And in those communities you also had very high social noise and low expectations.

This was greatly reinforced by the advent of home mortgage subsidies and the highway construction subsidies after World War II, noted Tucker, which combined to create the suburbs as we know them. As a result, despite the gains of the civil rights movement, the 1960s witnessed growing de facto racial segregation in the schools, as white families with children largely abandoned the cities, leaving behind what we now know is an even more segregated (by race and class) city. All these postwar developments combined to create large metropolitan areas in the United States surrounded by suburbs that can be arrayed along a finely graded scale of race and class, in most cases with matching school districts.

Without any question the wealthiest school districts attracted the best teachers, principals, and curriculum planners, along with the most demanding parents and PTAs, while the poorest districts attracted the weakest teachers and principals and parents who had to work three jobs just to survive (leaving them with less time to help their kids with their homework). By contrast, other industrialized countries fund their schools according to what it will take to deliver a standard curriculum, and then they take the money out of the state's general budget.

Americans have always wanted and expected their public schools to be the agent of social mobility, the principal means by which poor people can lift themselves up by their bootstraps to grab the American brass ring. But that is no longer the reality in too many parts of the country today, because of the disparities in funding.

The reason America has managed to get by with this system for so long, added Tucker, was that beginning in the 1930s, when the mass-production economy became dominant, "we were actually doing something very efficient. We were educating a group of mass production workers at the level they needed and we poured money into the elite who could innovate." So if you went to an elite private school or a public school in a wealthy neighborhood, you got an education that reinforced innovation and creativity, while the worst public high schools focused on just getting kids through with the bread-and-butter basics. That was all fine as long as there were a lot of basic bread-and-butter mass-production jobs, paying decent wages, waiting on the other side of the high school gates.

Unfortunately, as the world has flattened out, those mass-production jobs are increasingly being automated or outsourced. There are fewer and fewer decent jobs for those without a lot of knowledge. There are several American cities, for instance, where thirty years ago the biggest employer was a manufacturing plant and today it is a medical center or a technology hub. So a poorly funded and staffed high school today is a pathway to a dead end. "There is no future down there anymore," said Tucker. "Therefore, we have to find a way to educate all of our young people to a very high standard. Otherwise, if you don't upgrade their skills, the only way the low-skilled can compete is by driving down their wages."

Dirty Little Secret #5: The Funding Gap

For now, the United States still excels at teaching science and engineering at the graduate level, and also in university-based research. But as the Chinese get more feeder stock coming up through their improving high schools and universities, "they will get to the same level as us after a decade," said Intel chairman Craig Barrett. "We are not graduating the volume, we do not have a lock on the infrastructure, we do not have a lock on the new ideas, and we are either flat-lining, or in real dollars cutting back, our investments in physical science."

Continued American technological leadership in building the jobs of

tomorrow, added Barrett, requires "a commitment to basic research funding today." Unfortunately, the 2004 Task Force on the Future of American Innovation found that federal funding for research in physical and mathematical sciences and engineering, as a share of GDP, actually declined by 37 percent between 1970 and 2004. In the fiscal year 2005 budget passed by the Republican-led Congress in November 2004, the budget for the National Science Foundation, which is the federal body most responsible for promoting research and funding more and better science education, was actually cut by 1.9 percent, or $105 million. History will show that when America should have been doubling the NSF funding, its Congress passed a pork-laden budget that actually cut assistance for science and engineering. There was tiny improvement in the fiscal 2006 budget—an increase of 2.4 percent. The Department of Energy's Office of Science, the most important funder of physics research in America, got only a 2.9 percent increase in fiscal 2005 and a 0.9 percent boost in 2006, which amounts to a budget cut after inflation. This is outrageous.

In his January 2006 State of the Union address, President Bush vowed to reverse this decline in a big way. We'll see. What should we be doing? The October 2005 National Academy of Sciences, National Academy of Engineering, and Institute of Medicine report, "Rising Above the Gathering Storm," which was put together by a blue-ribbon panel of scientists and entrepreneurs, concluded that for America to be prepared for the twenty-first century, it must increase federal investment in such research *by 10 percent a year over the next seven years.* It also recommended new research grants, each of $500,000 a year for five years, to be given to two hundred of the most outstanding early-career researchers. Republican congressman Vern Ehlers of Michigan, a voice in the wilderness, said the following, after Congress cut the NSF's 2005 budget: "While I understand the need to make hard choices in the face of fiscal constraint, I do not see the wisdom in putting science funding behind other priorities . . . Not only are we not keeping pace with inflationary growth, we are actually cutting the portion basic research receives in the overall budget. This decision shows dangerous disregard for our nation's future, and I am both concerned and astonished that we would make this

decision at a time when other nations continue to surpass our students in math and science and consistently increase their funding of basic research. We cannot hope to fight jobs lost to international competition without a well-trained and educated workforce."

The effects are starting to show. According to the National Science Board, the percentage of scientific papers written by Americans has fallen 10 percent since 1992. The percentage of American papers published in the top physics journal, *Physical Review*, has fallen from 61 percent to 29 percent since 1983. And now we are starting to see a surge in patents awarded to Asian countries. From 1980 to 2003, Japan's share of world industrial patents rose from 12 percent to 21 percent, and Taiwan's from 0 percent to 3 percent. By contrast, the U.S. share of patents has fallen from 60 percent to 52 percent since 1980.

Congress has a long history of wasting money on pork barrel highway projects. From now on, let's waste our money on test tube projects instead—just in case.

Dirty Little Secret #6: The Infrastructure Gap

Thomas Bleha, a former U.S. foreign service officer who was based in Japan, wrote a telling article for *Foreign Affairs* (May–June 2005) that began like this: "In the first three years of the Bush Administration, the United States dropped from 4th to 13th place in the global rankings of broadband Internet usage. Today, most U.S. homes can access only 'basic' broadband, among the slowest, most expensive, and least reliable in the developed world, and the United States has fallen even further behind in mobile-phone-based Internet access. The lag is arguably the result of the Bush Administration's failure to make a priority of developing these networks. In fact, the United States is the only industrialized state without an explicit national policy for promoting broadband."

Since it took over in 2001, the Bush team has made clear that its prior-

ities are tax cuts, missile defense, and the war on terrorism—not keeping the United States at the forefront of Internet innovation. Things have actually gotten worse since Bleha wrote his article, based on 2004 statistics. According to the data released in April 2005 by the International Telecommunication Union (ITU), America's global broadband penetration dropped from thirteenth place to sixteenth. The ITU ranked the United States at 11.4 broadband subscribers per 100 inhabitants as of December 31, 2004, which is less than half that of South Korea—the most wired country in the world—with 24.9 broadband subscribers per 100 inhabitants. "Norway, Israel and Finland each surpassed the United States in broadband penetration for the first time," the *National Journal* reported on April 25, 2005. "And an aggressive rollout in France almost pushed the U.S. even lower. High-speed Internet use in France doubled from 5.61 subscribers per 100 inhabitants at the end of 2003 to 11.2 per 100 last year, putting the nation at 17th, just one notch below the United States."

In the current administration's first three years, noted Bleha, President George W. Bush mentioned broadband just twice and only in passing. Not only that, but what the United States measures as broadband service—200 Kbps—"wouldn't cut the mustard in much of the rest of the world," noted Mark Lloyd, writing in the daily Progress Report for the Center for American Progress (October 7, 2004). In Japan, for instance, consumers pay the equivalent of $10 a month for service forty times as fast as 200 Kbps. The smartest countries, and cities, in the world are offering their residents not just the fastest broadband, but at the lowest prices to the widest areas.

Why should Americans care?

Broadband and information technologies are important not only because they are big global businesses in and of themselves, but also because they are critical to advancing productivity and innovation in every sector in the economy. The more you connect an educated population to the flat-world platform in an easy and affordable way, the more things they can automate, and therefore the more time and energy they have to innovate. The more they innovate, the more they produce things that improve the platform. It is a virtuous cycle, one that you always want to encourage to the greatest degree possible.

If the flat-world platform makes innovation and production so much

more efficient, "but your people can't take advantage of it, because they don't have the infrastructure or the education to do so," remarked Craig Mundie of Microsoft, "then sooner or later you are going to get hosed."

The Bottom Line

When I asked Bill Gates about the supposed American education advantage—an education that stresses creativity, not rote learning—he was utterly dismissive. In his view, the people who think that the more rote-oriented learning systems of China and Japan can't turn out innovators who can compete with Americans are sadly mistaken. Said Gates, "I have never met the guy who doesn't know how to multiply who created software . . . Who has the most creative video games in the world? Japan! I never met these 'rote people' . . . Some of my best software developers are Japanese. You need to understand things in order to invent beyond them."

One cannot stress enough: Young Chinese, Indians, and Poles are not racing us to the bottom. They are racing us to the top. They do not want to work for us; they don't even want to be us. They want to dominate us—in the sense that they want to be creating the companies of the future, ones that people all over the world will admire and clamor to work for. They are in no way content with where they have come so far. I was talking to a Chinese American who worked for Microsoft and had accompanied Bill Gates on visits to China. He said Gates is recognized everywhere he goes in China. Young people there hang from the rafters and scalp tickets just to hear him speak. Same with Jerry Yang, the cofounder of Yahoo!

In China today, Bill Gates is Britney Spears. In America today, Britney Spears is Britney Spears—and that is our problem.

And no wonder. Johns Hopkins University president Bill Brody remarked to me, "Over 60 percent of our graduate students in the sciences [at Hopkins] are foreign students, and mostly from Asia. At one point four years ago all of our graduate students in mathematics were from the PRC [Communist China]. I only found out about it because we use them as

[teaching assistants] and some of them don't speak English all that well." A Johns Hopkins parent wrote Brody to complain that his son could not understand his calculus professor because of his heavy Chinese accent and poor English.

There is an old techie adage that in places like China and Japan the nail that stands up gets hammered, while in Silicon Valley the nail that stands up drives a Ferrari and has stock options. Underlying that adage has always been a certain American self-confidence that whatever America lacks in preparing its kids with strong fundamentals in math and science, it makes up by encouraging its best students to be independent, creative thinkers. There is a lot of truth to that. Even the Chinese will tell you that up to now they have been good at making the next new thing, and copying the next new thing, but not *imagining* the next new thing. That may be about to change, though. Confident that their best K–12 students will usually outperform America's on the fundamentals of math and science, China is now focusing on how to unleash more creative, innovative juices among its youth.

In October 2005, on a visit to Beijing, I interviewed Wu Qidi, China's vice minister of education. Here's what she told me over tea in her office in the Ministry of Education—the newest and nicest government building in Beijing today: "Although we are enjoying a very fast growth of our economy, we own very little intellectual property. We are so proud of China's four great inventions [in the past]: the compass, papermaking, printing, and gunpowder. But in the following centuries we did not keep up that pace of invention. Those inventions fully prove what the Chinese people are capable of doing—so why not now? We need to get back to that nature."

Nurturing more "creative thinking and entrepreneurship are the exact issues we are putting attention to today," added Vice Minister Wu. Yes, this is easier said than done. It bumps head-on into a Chinese culture and politics that still emphasize conformity. But do not kid yourself: Cultures can change. And China is changing, particularly as more and more young Chinese are educated in America and Europe.

"Ever since the policy of reform and opening up, we are seeing a large number of scholars and teachers and professors going abroad," said

Vice Minister Wu, "and they are in the process of evolving and changing and they have imparted these changes to their students in classrooms. And now we are seeing that the world is changing and the Internet is changing our world so fast . . . I believe that arts will play an important role. It is even more important to have an integration in arts and science so people will have the creative and independent thinking . . . Among the teachers, some of them are not well trained to get the integration of arts and science."

She sounded to me just like Wayne Clough of Georgia Tech. And that is the point. *China is focused on overcoming its weaknesses—beginning with creative thinking—to match our strengths.*

It will take time, probably longer than China thinks. But when one looks at what China has been doing at the very top, I have no doubt that it will get where it wants to go. Let me take you for a little tour of Microsoft Research Asia, the research center that Bill Gates set up in Beijing to draw on Chinese brainpower. Microsoft has four major research centers in the world: in Cambridge, England; in Redmond, Washington, its headquarters; in Beijing; and most recently in Bangalore, India. Bill Gates told me that within just a couple of years of its opening in 1998, Microsoft Research Asia had become the most productive research arm in the Microsoft system "in terms of the quality of the ideas that they are turning out. It is mind-blowing."

In China, where there are 1.3 billion people and the universities are just starting to crack the top ranks, the competition for top spots is ferocious. The math/science salmon that swims upstream in China and gets itself admitted to a top Chinese university or hired by a foreign company is one smart fish. The folks at Microsoft have a saying about their research center in Beijing, which, for scientists and engineers, is one of the most sought-after places to work in all of China. "Remember, in China when you are one in a million—there are thirteen hundred other people just like you."

In other words, the brainpower that rises to the Microsoft research center in Beijing is already one in a million.

Kai-Fu Lee, who has since left Microsoft, was originally assigned to build the Microsoft research center in Beijing. My first question to him

was, "How did you go about recruiting the staff?" Lee said his team went to universities all over China and simply administered math, IQ, and programming tests to Ph.D.-level students or scientists.

"In the first year, we gave about 2,000 tests all around," he said. From the 2,000, they winnowed the group down to 400 with more tests, then 150, "and then we hired 20." They were given two-year contracts and told that at the end of two years, depending on the quality of their work, they would either be given a longer-term contract or granted a postdoctoral degree by Microsoft Research Asia. Yes, you read that right. The Chinese government gave Microsoft the right to grant postdocs. Of the original twenty who were hired, twelve survived the cut. The next year, nearly four thousand people were tested. After that, said Lee, "we stopped doing the test. By that time we became known as the number one place to work, where all the smart computer and math people wanted to work . . . We got to know all the students and professors. The professors would send their best people there, knowing that if the people did not work out, it would be their credibility [on the line]. Now we have the top professors at the top schools recommending their top students. A lot of students want to go to Stanford or MIT, but they want to spend two years at Microsoft first, as interns, so they can get a nice recommendation letter that says these are MIT quality."

They view this as "a once-in-a-lifetime income opportunity," said Lee of the team at Microsoft Research Asia. "They saw their parents going through the Cultural Revolution. The best they could do was become a professor, do a little project on the side because a professor's pay is horrible, and maybe get one paper published. Now they have this place where all they do is research, with great computers and lots of resources. They have administrators—we hire people to do the dirty work. They just could not believe it. They voluntarily work fifteen to eighteen hours a day and come in on weekends. They work through holidays, because their dream is to get to Microsoft." Lee, who had worked for other American high-tech firms before coming to Microsoft, said that until starting Microsoft Research Asia, he had never seen a research lab with the enthusiasm of a start-up company.

Today it has two hundred full-time researchers. Harry Shum, the

Carnegie-Mellon-trained engineer who now runs Microsoft Research Asia, has a very clear view of what Chinese innovators can do when given the right environment. ACM Siggraph is the premier global conference for computer graphics and interactive technologies. At Siggraph 2005, a total of ninety-eight papers were published from universities and research institutes all over the world. Nine of them—almost 10 percent—came from Microsoft's Beijing office alone, beating out MIT and Stanford. Said Shum: "In 1999, we had one paper published. In 2000, we had one. In 2001, we had two. In 2002, we had four. In 2003 we had three. In 2004, we had five, and this year we are very lucky to have nine." Do you see a pattern developing?

In addition, Microsoft Research Asia has already contributed more than one hundred new technologies for current Microsoft products—from Xbox to Windows. It's a huge leap in seven years, but, outside of hothouses like Microsoft, China still has a way to go.

"A Chinese journalist once asked me, 'Harry, tell me honestly, what is the difference between China and the U.S.? How far is China behind?' I joked, 'Well, you know, the difference between China high tech and American high tech is only three months—if you don't count creativity.' When I was a student in China twenty years ago we didn't even know what was happening in the U.S. Now, anytime an MIT guy puts up something on the Internet, students in China can absorb it in three months. But could someone here create it? That is a whole other issue. I learned mostly about how to do research right at Carnegie-Mellon . . . Before you create anything new you need to understand what is already there. Once you have this foundation, being creative can be trainable. China is building that foundation. So very soon, in ten or twenty years, you will see a flood of top-quality research papers from China."

Once more original ideas start emerging here, though, China will still need more venture capital and the rule of law to get them to market. "Some aspects of Chinese culture did not encourage independent thinking," said Shum. (Obviously, I would add, the Communist political structure also doesn't promote free thinking in every direction, either.)

"But with venture capital coming into this country, it will definitely inspire a new generation of Chinese entrepreneurs. I will be teaching a

class at Tsinghua University next year on how to do technology-based ventures . . . You have technology in [Chinese] universities, but people don't know what to do with it—how to marketize it."

Some of his young Chinese researchers demonstrated their new research prototypes for me. I noticed that several of them had little granite blocks lined up on their shelves. I asked one of them, who had seven or eight on her shelf, "What are those?" She said the researchers get them from Microsoft every time they invent "something that gets patented."

How do you say Ferrari in Chinese?

On December 15, 2004, the Council on Competitiveness hosted a National Innovation Initiative Summit at the Ronald Reagan Building in Washington, D.C., to release its long-term study "Innovate America: Thriving in a World of Challenge and Change"—a detailed bipartisan analysis by America's leading technologists and industrialists about how to re-energize American competitiveness through more research, education, and innovation. Several months after the report came out, the Council on Competitiveness was contacted by the Chinese embassy in Washington and told that China's vice minister of science and technology would be visiting and would like to invite council members for a lunch. Deborah Wince-Smith, the energetic president of the Council on Competitiveness, told me that her colleagues were happy to share their report with the Chinese visitor, as they had with other foreign delegations. But it wasn't necessary.

"He said that they had already translated the report and were planning to integrate it into their twenty-year strategic plan," said Wince-Smith, adding that while the council had taken the initiative to share their report with other countries, "the Chinese came to us—we didn't come to them." They had clearly been following the council's work very closely, which is published on its Web site. Wince-Smith said these days she is wondering "whether we are going to implement [the Innovate America report] or China is going to beat us to our own plan."

Don't laugh. The day the Innovate America report was released to

the public in Washington, the authors, who, as I said, were a very high-powered group of American educators and business leaders, begged the White House to have President Bush attend the ceremony, in the hope that he would use his bully pulpit to highlight their report and draw national attention to it. The president's aides refused the request, apparently because they thought it would dilute his message of the day.

And where was President Bush speaking that day? He was literally down the hall, in the very same Reagan Building, at the exact same time the Innovate America report was being issued. And what was the president doing that was more important? He was holding his own economic summit, speaking to a carefully selected audience that included many Republican campaign donors, to push his ultimately failed plan to partially privatize Social Security. The president spoke against a backdrop that was printed with the words "Securing Our Economic Future." So there was the president trying to take apart the old New Deal—just when he should have been using his office to promote a New New Deal for the twenty-first century. And down the hall, a bipartisan group headed by Sam Palmisano, CEO of IBM, and G. Wayne Clough, president of Georgia Tech, was offering up just such a New New Deal agenda at a National Innovation Summit and the president could not devote five minutes to it. But the Chinese immediately translated it. I am not making this up.

A short while later I spoke with Craig Barrett, the Intel chairman, who seemed exasperated that Washington, including both political parties, didn't seem to really grasp this quiet crisis—or at least not with the urgency that was required.

"We will hire the talent wherever it resides," said Barrett. "We still have some good students coming out of our schools." But if you look at where Intel is making a lot of its new engineering-level investments, he added, it's in four or five countries—Russia, China, and India and to a lesser extent Malaysia and Israel. These and other emerging markets are also where Intel is selling more and more of its chips.

Then Barrett added something about Intel that is so true in a flat world, but nevertheless shocking to many Americans. Intel, he said, can thrive as a company "even if we never hire another American." He was

quick to add that this is not Intel's intent or desire. "And we still do hire lots of Americans," said Barrett. "But today we can hire the best talent around the world and be very successful."

Intel has to seek IQ (and CQ and PQ) wherever it can, because that is what its competitors are doing. Remember, said Tracy Koon, Intel's director of corporate affairs, Intel's chips are made from just two things—sand and brains (silicon comes from sand)—"and right now the brains are the problem . . . We will need a stronger and more supportive immigration system if we want to hire the people who want to stay here. Otherwise, we will go where they are. What are the alternatives? I am not talking about data programmers or [people with] B.S. degrees in computer science. We are talking about high-end specialized engineering. We have just started a whole engineering function in Russia, where engineers have wonderful training—and talk about underemployed! We are beefing that up. Why wouldn't you?"

That is Shirley Ann Jackson's perfect storm—we don't let the talent in from abroad as much as we used to, the growing opportunities for our best companies shift more and more to foreign markets, and we don't do a better job educating our own kids to fill the gaps. If that storm comes to pass, American companies, like Intel, will just lift off American soil like rocket ships. They will hover over America. We will think of them as American companies, because they will be listed on the New York Stock Exchange and have post office boxes here, but they really will be flat-world companies. Where innovation happens really does matter, because that is where the best jobs are going to be located, and those best jobs spin off more good jobs and decent jobs in every community. It matters that Microsoft is headquartered in Redmond, Washington. It matters that Google is headquartered in Mountain View, California. And one day it will matter if they aren't.

"Standard of living is related to the average value add of your workforce," said Barrett, "and that is related to average educational level of your workforce. If you downgrade the average educational level of your workforce, relative to your competition, your standard of living will decline."

Look at the high-profile attention Congress has devoted to steroids in major-league baseball, Barrett said, and compare that with the attention it

has focused on the crisis in science education in major-league American cities. How long did it take us to have congressional hearings on steroids in major-league baseball? Almost immediately after the scandal broke. The science crisis? That can wait. Congress has pork to distribute. The president has other priorities.

"As my wife likes to tell me," said Barrett, "when you study history and look at every civilization that has grown up and died off, they all leave one remnant—a major sports coliseum at the heart of their capital."

Our fate can be different, but only if we start doing things differently. It takes fifteen years to train a scientist or advanced engineer, starting from when that young man or woman first gets hooked on science and math in elementary school. Therefore, we should be embarking immediately on an all-hands-on-deck, no-holds-barred, no-budget-too-large crash program for science and engineering education. Scientists and engineers don't grow on trees. They have to be educated through a long process, because, ladies and gentlemen, this really *is* rocket science.

The fact that we have not been doing this is a crisis. It may be a creeping and quiet crisis, but it is here and it is real. And as Paul Romer, the Stanford economist, has so perceptively warned:

"A crisis is a terrible thing to waste."