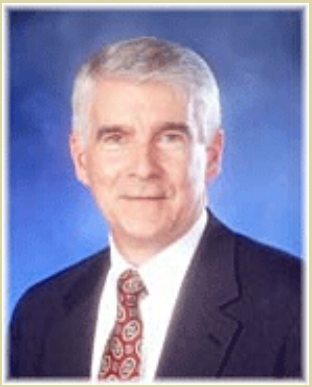
K-12 Establishment is Putting America's Industrial Leadership at Risk



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The following is adapted from a speech delivered on May 25, 2004, at a Hillsdale College National Leadership Seminar in Seattle, Washington.

There are some very worrisome trends in the United States with respect to our global share of science, technology, engineering and mathematics expertise. Our share of this expertise is decreasing significantly, both at the bachelor's and at the Ph.D. levels. I will provide below the basic data that show those trends, suggest the reasons behind them, explain the attendant risks and offer some solutions.

Recently, the National Science Foundation published data demonstrating that our country is producing far fewer engineers than are other parts of the world, particularly Asia. Note in Figure 1 [Figures 1-4 are on page 2] that among 24-year-olds in the year 2001 who had a B.S. or B.A. degree, only five percent in the U.S. were engineers, compared to 39 percent in China and 19 percent or more in South Korea, Taiwan and Japan. If you look at the actual number of engineers, Figure 1 shows that China is producing three times more than the United States. Figure 2 shows that the U.S. again comes out very low – even compared to European countries in terms of the percentage of bachelor's degrees awarded in the fields of engineering and science.

Figure 1: BS/BA Degrees Among 24-year-olds in 2001
Degrees (000) Engineering Engineering

	BS/BA	BS	%
United States	1,253.1	59.5	5%
China	567.9	219.6	39%
South Korea	209.7	56.5	27%
Taiwan	117.4	26.6	23%
Japan	542.3	104.5	19%

Figure 2: Engineering & Science Degrees as a % of all Bachelor Degrees

Singapore	68%	U.K.	28%
Germany	31%	S. Korea	36%
USA	17%	Sweden	24%
China	58%	Taiwan	34%
Belgium	22%		

Another disturbing trend is in the numbers of individuals receiving a Ph.D. in physical science and engineering. In 1987, 4,700 U.S. citizens received these degrees, compared to 5,600 Asians. In 2001, the U.S. figure had dropped slightly to 4,400 and the number of Asians had risen to 24,900. That is a dramatic shift. We should also note that the percentage of Asians getting science and engineering Ph.D.s at U.S. universities is declining. Indeed, 25 percent fewer Asians got such degrees at U.S. universities in 2001 than in 1996.

This data relating to physical science and engineering Ph.D.s was assembled by Professor R.E. Smalley, a Nobel Prize-winning scientist from Rice University. His disturbing conclusion: “By 2010, 90 percent of all Ph.D. physical scientists and engineers in the world will be Asian living in Asia.”

Why are these figures important? Traditionally, it has been our technical human talent that has driven our industrial success. Basic science, technology, engineering and mathematics knowledge is vitally important in the business world. For perspective, over 50 percent of the CEOs of our Fortune 100 companies come from a technical background. In addition, physical science and engineering capabilities at the Ph.D. level typically drive the kind of highly prized innovations that lead to the emergence of new industries. With expertise in these fields declining in the U.S. while rising in other parts of the world, we risk seeing our industrial leadership weaken.

One of the main reasons why U.S. production of science and engineering talent in universities is low in comparison to other countries is that U.S. K-12 math and science skill levels are quite weak. Note the data from the National Assessment of Educational Progress (NAEP) from the year 2000 provided in Figure 3. The scores of U.S. students across the 4th, 8th, and 12th grade levels are abysmal. For example, in science, only two percent of our 12th graders are rated advanced and only sixteen percent are rated proficient. (NAEP defines “proficient” as “solid academic performance for the grade assessed.”) Thirty-four percent of our 12th graders are only partially proficient in science, and almost half are below partial proficiency.

Figure 3: U.S. Students; National Assessment of Educational Progress; Year 2000 Math & Science Proficiency

	4th Grade		8th Grade		12th Grade	
	Science	Math	Science	Math	Science	Math
Advanced	4%	3%	4%	5%	2%	2%
Proficient	26%	23%	28%	22%	16%	14%
Partial Proficiency	37%	43%	29%	38%	34%	48%
Below Partial Proficiency	34%	31%	39%	34%	47%	35%

In Figure 4 we see the results of the International Math and Science Study. It rates the U.S. versus other countries and provides the percentile our students achieved. For example, in mathematics, our 12th graders rated at the 10th percentile. In other words, 90 percent of the countries did better than the U.S., and only 10 percent performed worse. While we do well in grade 4, we do mediocre in grade 8 and very poorly in grade 12.

For the past year I’ve been heading up a group called the Workforce/Education

Figure 4: Student Achievement in Math and Science; U.S. Relative Rank (percentile) versus Other Countries

	Math	Science
4th Grade	54	88
8th Grade	32	59
12th Grade	10	24
12th Grade Advanced Math & Physics	6	0

Subcommittee, which is part of the President's Council of Advisors on Science and Technology. Much of what I'm providing here is the work of that subcommittee, which was charged to determine whether we have sufficient science and engineering students to support our workforce needs.

Once our subcommittee assembled the necessary data, the key question became: Why are U.S. students so weak in science and mathematics? Many groups have studied this issue over the last ten years, and they have consistently identified two key problems.

First, many of our K-12 students are being taught science and math by unqualified teachers. In September 2000, the National Commission on Math and Science Teaching for the 21st Century noted that 56 percent of high school students taking physical science were being taught by "out of field" teachers – meaning that the teacher didn't major or minor in the subject in college. In mathematics, this figure was 27 percent. In January 2003, the Committee for Economic Development reported on the same topic for middle school students and found even more alarming data: 93 percent of science students and 70 percent of math students were taught by "out of field" teachers.

How can we expect a K-12 teacher who has no experience in the field to get a student excited about science or mathematics? It most likely won't happen – and it typically doesn't! The National Research Council reports that only 30 percent of students who enter a science track in grade 9 are still interested in science as a major when they graduate from high school and enter college.

The second key problem is weak curricula. In 2003, the American Association for the Advancement of Science rated less than ten percent of middle school math books to be acceptable, and no science books. The National Commission on Excellence has recommended that public high schools require three years of mathematics and two of science. But only 45 percent of high schools meet that standard with respect to math, and only 24 percent with respect to science.

Weak K-12 results in the U.S. are not a new problem. Twenty years ago, a famous report entitled "A Nation at Risk" was published and highlighted similar findings. Recently, the Koret Task Force of the Hoover Institution at Stanford University considered the failure of that report to bring about reform. The following is a key paragraph from their report summary:

"A Nation at Risk" underestimated the resistance to change from the organized interest of the K-12 public education system, at the center of which were two big teachers unions as well as school administrators, colleges of education, state bureaucracies, school boards, and many others. These groups see any changes beyond the most marginal as threats to their own jealously guarded power.

In light of this, we need the K-12 teaching community (the union leaders, the administrators and the teachers themselves) to take responsibility for the poor results they are achieving. We need them to get serious about accountability and teacher qualifications – two core elements of President Bush's "No Child Left Behind" program. We need them to implement the recommendation of the National Commission on Excellence, requiring three years of math and two years of science at the high school level. We need them to support new routes for teacher certification in order to increase the number of teachers qualified to teach math and science. We need them to ease their opposition to vouchers and charter schools, which will bring about the kind of competition that generates broad improvement. And we need them to stop promoting unprepared students to the next grade level.

Probably most important, the K-12 teaching community needs to implement good management practices, such as performance appraisal systems that identify superior teachers. It should then reward these top teachers with salary increases of 10 percent or more per year, leading to annual wages of over $100,000. Equally as

important, it needs to isolate the bottom 5-7 percent of teachers, put them on probation, and – if no progress is made within a reasonable period – terminate them.

In order to accomplish these reforms, the K-12 education community needs to tackle its budgets with gusto and re-allocate funds. The Department of Education points out that only 53 percent of K-12 education funding is currently spent on instruction. That is far, far too low a percentage.

We need for the K-12 teaching community to take responsibility and implement these reforms in an urgent manner. If they do not, all of us in our individual communities need to hold that community to account. Failure to address our immense shortcomings in science and math education is unacceptable and will inevitably lead to the weakening of our nation.

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