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GOLFING IN CENTURIES PAST

FOUR LETTERS THAT COULD ENERGIZE AMERICA

BY ROBERT SUN

"STEM is at the heart of new companies, industries, and jobs—nearly every means of national wealth creation."

OUR COUNTRY is in danger of becoming the world's first "derivative economy." Once renowned around the globe for our prodigious ability to manufacture, invent, and revolutionize, the U.S. is becoming a place where pastimes take precedence. Image is king, and quick money is the goal. Eighty years ago, banking profits accounted for less than five percent of all U.S. corporate profit. In recent years, they peaked at around 40%. College graduates are lured with the promise of making big money virtually overnight.

Today, America is known for storylines instead of production lines. Reality TV, video games, celebrity gossip, and other forms of entertainment have become multibillion-dollar industries that consume not just people's spare moments, but the majority of their day. "Personal fulfillment" drives the ambitions of millions; the quest for superficial success leads to the latest status symbol, the hottest trend, and the sexiest fashions.

Even in foundational sectors of the economy, real output is defined not by what you can make or build, but by what premise you can sell. Over the past few decades, our country's competitive position has weakened because the best and brightest minds have been siphoned off into Wall Street firms. The finance industry is the largest recruiter of mathematicians and physicists on college campuses—they lure not only the brightest business graduates, but those individuals who might have pursued amazing research and development careers. Those bright minds who previously created integrated circuits, lasers, and the like now are creating derivatives.

Nowhere else in the U.S. economy, in fact, has the word "derivative" been so thoroughly embraced than on the Street. "Derivative" actually defines an entire class of financial instruments that have no inherent worth—their values derive from the performance of other instruments. They essentially are bets on the movement of interest rates, credit risks, foreign exchange rates, and equities. The global market for derivatives mushroomed to a notional value of 1.2 quadrillion dollars—that is $1,200,000,000,000,000—in 2011, according to financial authority Paul Wilmott, more than 15 times the entire 2012 world gross domestic product of 79 trillion dollars.

Derivatives can be so complex that few truly understand them. When they "blow up," the results potentially are catastrophic—Societe Generale's $7,200,000,000 default and AIG's $18,000,000,000 implosion are just two well-known examples. Since 2000, the estimated losses from derivative meltdowns have exceeded $40,000,000,000. Because most major banks worldwide are highly leveraged—sometimes 50 to 1—any major loss is magnified, threatening to bring down other bulwark institutions with them.

Such pursuits have brought the U.S. economy to the verge of an abyss. Our national strengths, so apparent in the 20th century, are at risk of collapse in the 21st. This is not an argument to return to the good old days—far from it. The answer lies not in going backward, but forward to an era where a more educated, technical, and creative workforce fosters real innovation.

To remain at the forefront of global competitiveness, we must continue to shape the world economy. From medicine and health care to manufacturing, high technology, aeronautics, and energy production, the next 50 years will belong to those nations and workforces with skills in critical thinking, complex problem solving, deductive/inductive reasoning, and active learning, as well as inquisitiveness, creativity, and independence.

All are traits built on the same four-letter acronym: STEM. Virtually every economic study of the last 30 years has concluded that innovations in the STEM (Science, Technology, Engineering, and Mathematics) fields were the primary drivers of global growth. "Economic studies conducted even before the information technology revolution have shown that as much as 85% of measured growth in U.S. income per capita was due to technological change," states the National Science Foundation in its report, "Rising Above the Gathering Storm."

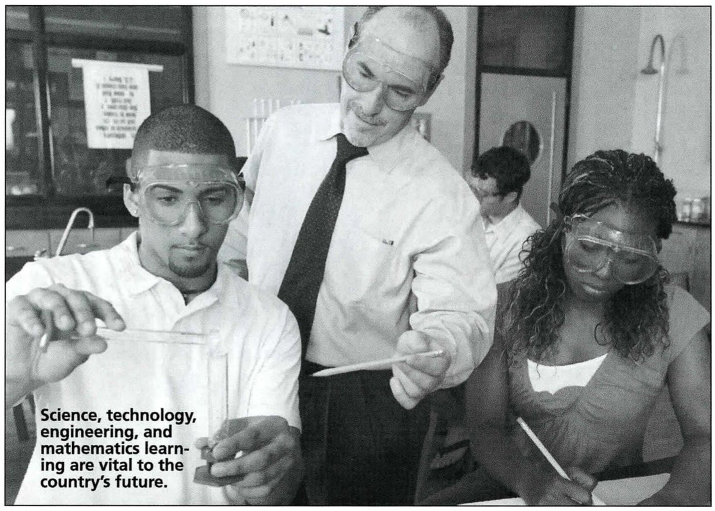
STEM is at the heart of new companies, industries, and jobs—nearly every means of national wealth creation. For this reason, since the start of the new millennium, the Federal government has been focusing on the importance of STEM to our national future.

In 2007, the Department of Labor issued a landmark report, "The STEM Workforce Challenge," detailing the importance of STEM to U.S. economic competitiveness and growth. One of its objectives was to identify industries in which STEM jobs are critically important: "Some of these industries are obvious: advanced manufacturing, biotechnology, chemical engineering, energy, actuarial science, and health care. Other industries may seem less obvious for their reliance on STEM knowledge and skills, such as construction, retail, transportation, and hospitality. . . . For example, mechanics in the trucking industry must deal with sophisticated computer technology in both diagnostics and repair procedures. In construction, the increased importance of math and technical knowledge on the construction site and in construction business offices has become an obstacle to entry into apprenticeship and other training programs for individuals who 15 years ago would have easily found their way into those programs."

Clearly, the need for workers who are passionate and skilled in STEM-related areas will remain strong. One of the ways to do that is to stop losing manufacturing to overseas companies. Management consultant Peter Drucker describes manufacturing as the "fertile ground of innovation—the mundane and unglamorous." By further developing highly competitive manufacturing capabilities at home, we can increase our need for indigenous skilled STEM workers and encourage even greater levels of innovation.

While the highest-performing STEM occupations comprise only about five percent of the national workforce, their influence is felt strongly throughout the U.S. economy, as they drive our breakthroughs in medicine, biotechnology, computer science, and other fields. As we have seen, the need for STEM education extends far beyond researchers, engineers, and designers—and what young person can expect to get a decent-paying job if they are not proficient with computers and other everyday technologies that require users to have critical thinking and problem-solving skills?

Proficiency in the thinking processes that STEM disciplines develop can be the great equalizer for this generation—and for those generations to come. It is unfortunate that so many people aspire to professional sports, Hollywood stardom, or other forms of riches when STEM education can provide a much more cer-



Science, technology, engineering, and mathematics learning are vital to the country's future.

tain path to a quality life. Only one in 10,000,000 can be a LeBron James or Lady Gaga—but anyone can use STEM skills to better his or her position and achieve success.

A 2012 study by the AFL-CIO's Department for Professional Employees underscores this fact. In the report, researchers cite figures from the U.S. Joint Economic Committee showing that "STEM workers earn 26% more than non-STEM workers, even after accounting for other factors that affect pay, such as age, gender, race, location, industry, and union status." The study found that the median weekly earnings for engineers ranged from a high of $1,757 for chemical engineers to a low of $1,336 for industrial engineers, while in computer-related fields, median weekly earnings ranged from a high of $1,558 for computer software developers to a low of $915 for computer support specialists.

Yet, years after the importance of STEM was identified and brought to the national consciousness, we still are failing to inspire America's young people to excel in STEM disciplines. Of the 2005 high school graduates who took the ACT test, 41% achieved the College Readiness Benchmark in mathematics and 26% achieved that benchmark in science. By 2012, those numbers only had risen to 46% and 31%, respectively. (ACT's College Readiness Benchmark is defined as those students who have approximately a 50% chance of earning a B or better and approximately a 75% chance of earning a C or better in a corresponding college course.)

The situation deteriorates further once students move through college. Georgetown University's Center on Education and the Workforce finds that 75% of K-12 students with an interest and aptitude in STEM never declare associated majors in college. Even more, 38% of students who start with a STEM major do not graduate with one.

We must start early, the moment children enter elementary school, to capture their interest in math, science, and technology and ignite their imagination in these subject areas.

Math, the foundation of science and technology, has a built-in advantage because students are spared the effort needed to acquire an extensive working vocabulary. Fluency in reading, for example, requires years of work to learn a minimum of 6,000 or more words. In math, you do not have to learn what a number such as "9" means; you only need to know how a 9 can relate to a 3 or a 6. Whereas a language like English describes things and concepts, the language of math describes relationships. Later on, a child can learn to appreciate and understand how things relate to each other in our entire universe.

Math also helps young people understand how objects are interconnected. With a strong grounding in math, students can assess and describe the interconnections, relationships, and patterns of physical objects and the various forces that propel them. To be truly innovative, people need to understand such connections. Math broadens and expands our view of the universe from the subatomic to the galactic level. Building solid mathematics skills in our nation's youth is a must. Math not only is the foundation for all STEM fields, but it enables a child to develop into a critical thinker in all intellectual pursuits.

So, why don't more children like math? Simply put, interest is a function of proficiency—and proficiency requires practice. Students do not practice more because they lack effective techniques that inspire them to improve. In sports, when we swing a bat and miss the ball, the feedback we receive through our senses is immediate. Typically, though, there is no equivalent feedback loop when solving math problems. With no opportunity for "active learning" to take place, math quickly can become meaningless and boring.

Introduce a system that provides immediate and engaging feedback, however, and math practice suddenly transforms itself. In a scientific study conducted by WestEd—an independent, nonprofit educational research organization—72% of students using specially designed online math games agreed with the statement, "Math lessons are fun." Teachers also overwhelmingly agreed that students enjoyed such online tools and sought out time to use them.

Through deep practice techniques, skills that might take months of conventional practice can be mastered in a matter of weeks, or even days. Deep practice consists of tackling a complex subject in manageable chunks, stopping when an error occurs, practicing that one skill until it is perfected, then continuing. Students learn by repeating, reassessing, and "fixing" their skills in the process of learning them, with immediate feedback and error correction. Once a solid math foundation is built, then it is critical to stoke long-term passions for STEM-related fields.

Our nation needs to create local "STEM Inspiration Centers" that allow children to explore STEM concepts using materials easily available from their neighborhoods. The inspiration for these projects will come from local individuals who already are thriving in STEM careers. These centers can offer children an opportunity to learn, explore, construct, and deconstruct things as they see fit. By doing so, they learn to function as a group and experience the value of teamwork in problem-solving. STEM Inspiration Centers also can provide presentations both live and on video. The now-famous TED talks are a great example of inspirational messages about what is possible in the world today. These centers can help children to understand the role that STEM has played, and will continue to play, in the building and strengthening of our nation.

For more than a century now, the most distinctive trait of American innovators has been their ability to become immersed in diverse fields and see the deeper interconnections that others miss. Time and again, they have demonstrated the ability to bring elements from far-flung fields together in new ways, to address a need, or solve a pressing problem. By creating a new generation of thinkers, our nation will continue to lead in future technologies that we cannot even imagine today.

As educators, administrators, community leaders, parents, and U.S. citizens, we must encourage and provide opportunities for students to explore patterns, discover unseen connections, and recover the underlying structures of their world. Children should have the freedom to explore, make mistakes, and learn from the experience as the true innovators in science, technology, engineering, and math always have done. Once they do, we will have begun to move away from the abyss that is the derivative economy—and will be restoring America's ability to thrive in the years ahead. ★

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