The Global Challenge to America's Engineering and Innovation Position

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"Analyses of current trends (in the U.S. science and engineering workforce)... indicate serious problems lie ahead that may threaten our long-term prosperity and national security."

—National Science Board, November 2003

That statement was published back in 2003. Since then, the global market has been somewhat of a double-edged sword for American manufacturing companies. While gear companies and other manufacturers have discovered potential new customers, they also have been engaged in a highly competitive climate and difficult global economy over the last couple of years. Perhaps, an overview of the changes and challenges is required to assess future prospects for 2012 and beyond.

Despite the fact the United States is still a leader in innovation and quality, it cannot compete with many of the emerging economies that produce goods cheaper and faster. Factor in new Southeast Asian trade deals that the U.S. administration opened in 2011, and more fuel may be added to the outsourcing fires. Until these economies become more complex and less cost effective, America will remain mostly a buyer, not a seller.

In 2011, only about $4 trillion (Ref. 11) of America's $15 trillion gross domestic product (Ref. 13) came from the manufacturing sector. Since the beginning of this current recession in 2008, 6.5 million jobs also have been erased across the services and goods sectors (Ref. 15). America needs to rebuild on its strengths to revitalize its position in the global marketplace.

Can the U.S. Maintain its Innovation Status?

In the marketplace for high-end products and ideas, the United States certainly can compete. Beyond the information technology hardware and software capability where America still excels today, the U.S. has an outstanding record in custom-designed mechanical components and devices. Many of these are gear-driven solutions, which is why gear companies in 2011 reported that they are busy and at capacity (Ref. 12). In addition to putting a man on the moon and exploring the surface of Mars, the U.S. is responsible for the development of commercial satellites, microwaves, industrial robots, light-emitting diodes, artificial hearts, robotic surgery tools and systems, cordless tools, cell phones, and many more inventions too numerous to mention.

Though these seminal products were created by U.S. engineers and scientists, many of the inventions were exploited by other countries for various reasons. Japan literally capitalized (an interesting word choice here) on the robotic technology developed by George C. Devol and Joseph

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F. Engelberger with their Unimation robots on which the whole industry was founded. The Japanese government invited Engelberger to lecture there in 1967, where he was welcomed by an audience of more than 700 executives and engineers (Ref. 4). American industry was slow at the time to catch on, while Japanese industry embraced robot technology. It was not until the 1980s that major companies like General Electric, Westinghouse and IBM plunged into the competitive fray already dominated by the Japanese, and then pioneered robotic neurosurgical tools in 1985 (Ref. 16).

According to the Robotic Industries Association—which represents some 265 leading robot manufacturers, suppliers and integrators—the resurgence of the automotive industry and positive growth in the food and consumer sectors show that North American robot orders jumped 41 percent in just the first half of 2011. These are the best numbers in almost six years. Currently, the United States uses 205,000-plus robots, with more than one million in place worldwide (Ref. 14).

Now the National Robotics Initiative will fund small and large programs spanning the next five years to infuse robots into educational curricula and research for new collaborative and innovative application areas. Supported to the tune of $500 million, it is the kind of program to accelerate innovation and development of the next generation of robots here in the United States. In fact, Precipart Corporation was sought out for its custom precision gear expertise on a prototype program to design the gear mechanisms for the methodical articulated movement of an artificial hand.

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Of course, there is no question that the United States is a standout in the aviation and aerospace industry. When the Boeing 787 Dreamliner finally completed its maiden flight in December 2009, it landed to the smiles and applause of thousands of engineers and more than 900 small subcontractors (Ref. 8) that helped create and produce it. Even though the 787

is an American success story, the contractor list also included companies from around the world. Boeing said that more than 70 percent of the 787 was outsourced, compared with 50 percent for the Airbus A350 plane (Ref. 8). Boeing considers its engineers and "highly skilled workforce a key asset to developing and delivering world-class aerospace products and services" (Ref. 2). Now that production is underway and the plane is in service, Boeing must book new orders after a three-year delay and reduce production learning curves to keep profitability flowing.

Education is a Priority

Back in 2007, President George Bush, through his Science, Technology and Innovation Office, aimed to strengthen America's competitiveness by improving math and science education and foreign language studies in high schools. He created the American Competitiveness Initiative and provided $5.7 billion initially and $136 billion over the next 10 years (Ref. 3). Funding was designated to train some 70,000 teachers for advanced placement classes in math and science. It was anticipated that 30,000 scientists and engineers would be hired to work as teachers, too. Leaders from the public and private sectors would come together with the education community to better prepare students for the 21st century. Yet the scores of U.S. youth in a global ranking continue to fall.

Educating America's youth should be a priority though, especially if the United States wants to remain competitive. For manufacturing, especially the gear industry, two large groups are needed: engineers to create and machinists to build.

Vocational schools and their respective database portals, however, promote some "sexy" career options, such as IT and technology, massage therapy, culinary and more. Machinist vocations are certainly not in neon type–even though machinist jobs are on the increase and average hourly wages can range from $15 to $25 (Ref. 10). High school counselors should be targeted as influencers to promote these craftsmen opportunities–alongside the highly touted ones in health care like nurses, physical therapists, radiologic technologists and nutritionists.

There is a dwindling pool of machinists nationally. In addition, many high schools over the last 25 years closed their shop classes and training programs as America's manu-

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facturing sector shrunk. Some schools then sent students to off-site training programs to become future mechanics for machines and automobiles. The resulting trend by school guidance counselors to recommend two- and four-year college and its higher paying jobs soon may create a potential void in the manufacturing workforce.

Current machinists are graying. As they begin to retire, they may not be around for the very critical on-the-job training that newly employed machinists require. Though the U.S. economy has shifted from a manufacturing to a service provider, the aerospace and defense industries reportedly will keep demand for machinists high. Yet, according to the U.S. Department of Labor, job opportunities will be good, but the number of workers learning to be machinists will not be sufficient to fill job openings projected through 2018 (Ref. 10).

According the U.S. Department of Education, about 16 million students were enrolled nationally in career and technical education during 2006–2007, compared to 9.6 million in 1999, exceeding the percentage of population growth numbers. With government rules subsequently relaxed for financial aid to these institutions and Pell Grant expansion, the third quarter of 2011 showed those schools increased federal monies to students by a 46 percent increase over the previous year. This support helped offset tuition required for students hard-pressed since the 2008 downturn with limited resources to keep them enrolled in training programs.

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Designing Careers Still Take Off

It is not rocket science to understand that innovation also comes from applying specialized knowledge to new and different situations. From their early days of the industrial revolu-

tion when engineers were machinist-types, mechanical engineers are still in demand to develop today's technologies and create better products for manufacturability, lower cost, and across different environments. Engineering schools are becoming attractive again as career choices narrow for young Americans.

Today, the American Society of Mechanical Engineers (ASME) touts a membership of 127,000 engineers and associated members worldwide. Mechanical engineering studies have sub-categories like construction and building, energy, environmental engineering and bioengineering, in addition to manufacturing and processing, aerospace and defense, transportation and automotive. Within these areas, there are sub-specialties as well.

The National Science Foundation found that between 2000 and 2008, the total number of four-year engineering degrees awarded in the U.S. increased by about 10,000—to 69,895 with about 82 percent of them male. Women receiving graduate degrees increased in the same period to about 22.5 percent (Ref. 5).

Students still must be better equipped in math and science. A study in late 2009 indicated that U.S. colleges and universities were graduating as many scientists and engineers as ever (Ref. 7). But the study warned that many of America's top students have been lured to careers in finance and consulting since the mid-to-late 1990s, with lower-performing students entering science, technology, engineering and mathematics. Students perceive engineering careers as unstable, since economic conditions seem to dictate hire/layoff calls and, also, foreign outsourcing continues.

Some groups, including IEEE, believe that the study is not specific enough and paints too broad a picture. Its real point is that scientists, like marine biologists or particle physicists, do not create jobs—engineers do. Furthermore, according to a Duke University study, the United States currently is producing more engineers annually than India (Ref. 19).

Perhaps the ASME has helped facilitate the increased pool of engineering students. Since 1996, it has partnered with a group called FIRST, or For Inspiration and Recognition of Science and Technology, to host a major robotics competition for middle and high school students. Using ASME members from the academic and cor-

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porate sectors who work with students, the program exposes young people to engineering and the problem-solving in the development of high-tech robots in a real-time schedule.

Gears are Inextricably Tied to Innovation

Gears remain intrinsic to mechanical engineering requirements. They are the devices that still perform the work. The importance of gears is showcased by the Smithsonian's Department of Innovation's new logo, which sports gears as a central graphic element. The Smithsonian also integrated them in its new theme, "Gears of Innovation Turn." Gears are inextricably tied to innovation.

The United States still leads the world when it comes to monies expended for research and the number of patents produced. America's higher education is not in trouble either. It is still the world's best with innovative curricula, as evidenced by the number of world leaders who have come here to take advantage of our educational offerings. With a renewed emphasis on engineering careers, gear manufacturers must take the initiative to develop better, smaller and new designs.

The idea is that America must continue to be forward thinking and take advantage of the economic downturn to create better students, skilled machinists, talented engineers and opportunities for mechanical devices that keep the United States positioned as a leader in engineering and innovation. Competition typically has served as a catalyst in driving Americans to achieve.

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