EDITORIAL

HIGH TECH MANUFACTURING—CHALLENGES FOR THE 1990s

This issue's editorial is a reprint of the keynote address given by Michael Goldstein at the Computer Aided Gear Design Seminar held at the University of Northern Iowa, Cedar Falls, IA, on November 9, 1987.

When I was asked to give this speech, I received a set of specifications not unlike the ones engineers frequently receive from their bosses or customers. It was suggested that the speech be "general, inspirational, appropriate, meaningful, and comprehensive and no longer than twenty minutes." And so, with that in mind, I would like to relate a little story that I think typifies some of the things I want to talk about today.

On the sixth day of creation, God called all the angels together for a production meeting. He said, "I have some good news and some bad news. The good news is that the Creation of the World Project is coming along just great—much better even than We had imagined. The day/night idea is just the ticket, and the Market Research people tell us that oceans and especially the male/female business are going to be very popular. Production is well ahead of schedule. In fact, things are going so well, I'm going to give all of you the day off tomorrow.

"The bad news is that as soon as we're done, we have to file an environmental impact statement."

This little story summarizes one of the ironic truths about technological advances in general and the advent of the computerized workplace in particular. Overall, the results are spectacular—better even than any of us could have dreamed or imagined. A computerized workplace opens up markets and opportunities and ideas that were unheard of just two decades ago. But, as with every new invention, there are environmental impacts. Things change because of innovation, sometimes in ways we never expected. It's not that innovations bring problems with them; it's more a question of presenting us with new challenges to be met.

This is certainly the case with the introduction of the computer to the machine tool industry. CAD/CAM, CNC controls and related products that go with them have changed industry drastically. For the most part, these changes have brought nothing but good things. We can build tools and parts faster and cheaper. We can design and cut gears more accurately. We can manufacture ones that run better, longer, more silently and efficiently in smaller lots with faster changeover times. Design problems that a few years ago would take days, weeks or even months of work to solve can now be worked out in hours or even minutes, sometimes by means of computer simulations instead of with expensive prototypes. The moderately priced computer has become as much a part of the engineer's working equipment as his reference manuals, his calculator and, before that, his slip stick.

At the same time, the computerized workplace has brought challenges that we in industry will have to meet in the next decade.

New machines capable of state-of-the-art gear manufacture require educated workers. Getting and keeping such a workforce will be one of the basic challenges of the 1990s. Providing society and industry with people who have the high level of training and education necessary to meet this challenge will require some serious reordering of our priorities toward education in this country.

A good basic education is absolutely critical to the success, not only of the gear industry, but also of every other industry in the United States. In fact, it is critical to the well-being of the United States itself. Furthermore, "good" basic education is not going to be good enough. In our present highly competitive global business environment, "excellent" basic education is the least we can afford to settle for. And the painful reality is that at present, the public education system is not even coming close to providing us with this level of education. Our toughest competitors in global markets have emulated us in developing educational systems to provide them with the skilled workers they need, but now other nations are surpassing us in literacy and general skill levels. We see the results of this neglect of basics in our prospective employees and in our national educational statistics. It's unconscionable that the richest nation in the world can tolerate sending functional illiterates into the job market after twelve years of schooling—kids who cannot speak or write effectively, much less be trained to operate and maintain complex computer aided equipment.

Today 27 million adult Americans—one in five—meet this definition of functional illiteracy. It's unacceptable that in a world business environment where our strongest competitors routinely graduate some of the best prepared engineers in the world, we have allowed our government to cut educational spending by 14% in the last 9 years.

These facts indicate to me that our priorities have become terribly twisted. This kind of short-sightedness harms not only our near-term competitive ability, but also leaves a grim legacy to our children and to their children as well. John F. Kennedy said, "A child miseducated is a child lost." Anton Campanella, president of New Jersey Bell, echoes this same sentiment. He says, "We have to rely on the public schools to produce the people who will lead our business and our society. There are no 'spare' people. Society needs us all." In a world that is going to continue to become more complex and competitive, the United States cannot afford to lose a single child through simple indifference and neglect of public education.

But this is not the place to address everything that is wrong

with public education. It is enough to remind you that no brilliant technological breakthroughs or progress we make in education and research on other levels will be worth anything if we have not addressed the question of a solid, basic education for all our citizens. Training our society in fundamentals simply cannot be neglected. As businesspeople, engineers, taxpayers and parents we must demand that our educational system do better, and we must force the issue with our legislators and educators until it is done.

If we are to take full advantage of the abilities of computers, CAD/CAM and CNC equipment, providing a labor pool thoroughly trained in fundamentals is a minimum requirement. The advent of this kind of technology has increased the rate of change and advance in every area, including gear manufacturing. We have to provide employees with a way to keep up with the technological changes. Continuing education is essential for everyone at our companies, from the machine operators to senior engineers and corporate officers.

As publisher of GEAR TECHNOLOGY, I have always supported and encouraged continuing education. One of the main goals we set for ourselves at GEAR TECHNOLOGY was to be an on-going gear clinic that would help disseminate the best writing of an educational and teaching nature from all over the world. We have been an ardent supporter of the technical societies and various technical exhibits and conferences.

But obviously, meeting the challenge of staying current in a changing technical environment must go beyond subscribing to a magazine. There is no such thing as a free lunch, either in life or engineering, so we should not be surprised to discover that there is no quick cure for supporting and encouraging continuing education.

Companies committed to maintaining a top-notch work force should be supporting the following strategies:

- Encourage attendance at seminars, roundtables and shows—events like this one.
- Encourage not only membership, but also *active participation* in technical societies like SME, AGMA, ASME, and ASME/GRI. These societies provide a wealth of information and resources as well as intellectual stimulation and friendships.
- Provide funding for continuing education and encouragement for employees to complete degrees.
- Provide time for reading, writing and research in gearing and other important technical fields.

Knowledge and experience should be looked upon as a capital resource, a critical component in the ultimate success of our individual companies and our country as well.

In addition to these corporate approaches, we all must nurture our own commitment to our education and professional growth. Government and the company can only do so much. If we are not concerned with our own professional development, we cannot expect anyone else to be concerned either. Greater emphasis and higher priority must be given to investing in ourselves.

John Gardner, critic and observer of American life says, "A nation is never finished. You can't build it and then leave it standing as the pharoahs did the pyramids. It has to be *re-created* for each generation by believing, caring men and women. *It is now our turn*. If we don't care, nothing can save the nation. If we believe and care, nothing can stop us."

This emphasis on continuing education and personal growth, benefits not only our companies and our society, but it also is one of the best ways to prepare ourselves to meet the challenges of a changing future. These challenges make career planning a much more difficult process than it has been in the past. A rapidly changing economic environment and equally rapid advances in technology make the old days of going to work for one company for your whole career a thing of the past. One study estimates that in the next twenty years, professionally trained people may change careers—not just jobs or companies, but careers—as many as four times. In a volatile work environment, no one can afford to neglect his or her educational development.

But this presents another dilemma for the manufacturer. Supporting continuing education for a mobile work force is a gamble. The engineer whose education you have encouraged or paid for may be working for your closest competitor next year. This is yet another challenge to management—to create a work environment that encourages the forming of long-term working relationships.

The brightest and the best of our society are the ones who tend to take their own continuing education seriously. One inducement to stay at a company is a *tangible* commitment on the part of management to the idea of continuing education. This commitment can be demonstrated through sponsorship of attendance at technical conferences and workshops, such as this one, tuition rebates, flex time policies to allow employees to attend classes and the encouragement and funding of writing and research projects.

Improving education for everyone is not the only challenge presented to us in the high-tech work place. More corporate research and development is necessary to fully utilize the potential of the computer and its related products. New products and processes ultimately create new markets. But the average gear company, like other companies, is caught in a bind that makes financing basic gear research difficult. The gear manufacturer can devote only a small portion of his profits—assuming he has any—to research. He has capital investment to provide for, wages and incentives to pay, marketing and sales forces to support and stockholders to consider. In short, he is contrained by all the requirements of running a successful business.

Government cost cutting has hit hard in this area as well. In the 8 years between 1979 and 1986, federal funding for non-military research and development fell by 25%. Of course, we cannot expect the government to do all our

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research work for us. In spite of the constraints mentioned above, research and development by individual companies does need a higher priority than we have given it. We can no more afford to neglect it than we can afford to neglect capital investment or expanding sales markets.

One logical approach to this problem is to work more closely with universities, one of whose functions is to provide an atmosphere where basic research can be conducted. Unfortunately, our universities in general do not spend a great deal of time on gear related subjects. Only a handful of U.S. schools provide any kind of training related specifically to gearing. Yet two German universities, Munich and Aachen, offer doctoral programs in gearing, and judging from the number of research papers crossing my desk from Japanese universities, advanced gearing education is a priority there too. Seminars such as this one are certainly a step in the right direction; however, we need to encourage more cooperative ventures between the universities and industry.

The seeds of a brighter future are already being planted. AGMA has just successfully completed a combined Gear Expo and Technical Meeting in Cincinnati where the newest in products and research were presented to the industry. I have just received information from ASME/GRI of a program planned for December in Chicago which will be devoted entirely to the question of improving gear research in the United States. With imagination and continuing commitment on the part of business, government and the universities, this "training gap" could be closed.

Another challenge to the gear engineer brought about by the advent of the computer in the workplace is one that relates directly to the area of continuing education. One of the greatest time and labor saving innovations of the personal computer is the growth in the number of software programs available to help the gear design and manufacturing engineer. This software, filled with options and variables, can save the engineer enormous quantities of time and eliminate repetitive calculations. Some of these packages contain the experience of years and years of gear work done by their authors. This experience is available to the engineer for a few thousand dollars and the time it takes to call up the information on his own computer.

But this software contains a subtle trap. We must beware of the danger of using it as a crutch instead of a tool. If we allow such programs to become a substitute for our own personal design and engineering knowledge, we don't expand our own capabilities; we actually limit them. The time will eventually come when the engineer will be confronted by a problem for which the software has made no allowances. Then, only if he has not neglected his basic engineering and has not allowed himself to mentally stagnate, will he be able to confront the problem with innovative solutions of his own. There really is no short cut or substitute for solid, hands-on experience. As novelist Clarence Day says, "Information's pretty thin stuff unless mixed with experience." We need to remember that concepts are not produced by technology, only facilitated by them.

The most basic tool of every engineer has always been his or her curiosity. We must avoid the trap of letting marvelous labor saving devices, whose intention is to give us time for creative work, stifle that creativitity and curiosity. An engineer should always be willing to take the time to stroll the shop floor, take the machines apart, and learn what makes them work. He or she should address the computer and its software the same way. A software package that solves current design problems should never stop an engineer from asking *why* a particular solution works.

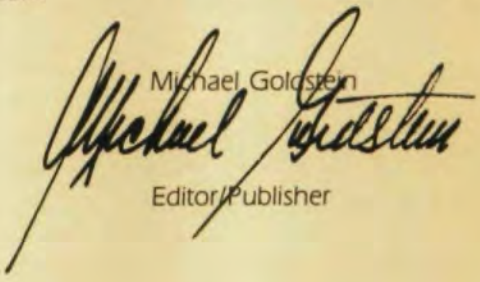
The 19th century American writer, Henry Adams, wrote long before the development of the computer, but his comments about education and technology are still relevant. He suggested that a university education was beneficial, not because it could anticipate and solve all the problems of new technology, but that it provided the foundation for the lifetime of learning and study necessary to do so. Likewise, the new computer technology cannot eliminate and solve all our engineering problems. Only our own engineering education and experience will enable us to use the new technology to solve problems, to build and to create.

That, after all, is the real fun of engineering. Engineering, for all its emphasis on logic and mathematics and verifiable data, is a creative, inventive science. It would be indeed a tragic irony if we allowed one of the most innovative engineering developments of the 20th century to limit our ability to create and invent in the future.

So where does all this speculation about the computer in the work place lead us? Are we worse off than we were before? Has the invention been more trouble to us than it was worth? Of course not. No one wants to limit us to the possibilities of the days before the advent of the silicon chip, but we must look to the complex future that computers promise us with clear-eyed realism. They are neither the salvation nor the doom of our industry.

The ancient Greeks had a saying that seems appropriate. "The gods demand of us toil as the price of all good things." The computer as a design and manufacturing tool is certainly a good thing, but we are going to have to work to make it as useful and helpful to us as it can be. We will have to exercise thought, care and self-discipline to use it responsibly. We must look at it as a tool, not as an end in itself.

Ralph Waldo Emerson said, "Invention breeds invention." The computer and its implications for the gear industry—both the promises and the challenges—are nothing more than an opportunity to continue the basic functions of the engineer: to raise questions, to solve problems and, finally, to invent and create.



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