Metrology Education: Opening the Door to the Next Century of Competitiveness

Tom Kimbrell
Director of Metrology
Community College of Aurora
Higher Education and Advanced Technology Center

Dr. Peter Heydemann, Director of Technology Services at the National Institute of Standards and Technology (NIST) stated recently, "The next 25 years will see dramatic changes in international trade patterns. New trade blocks will emerge; economies that now seem strong will falter. Metrology and standards will play an increasing role. We all need extensive training and education, and must study new approaches to provide our industry with the best possible support."

We are now in the midst of a major paradigm shift in the way the world does business. The common denominator that will allow the United States to compete in a global economy is the ability to become innovative in our thinking and creative with the methods we use to address these changes. Business as usual will not suffice. One of the major players in this success will be the education community.

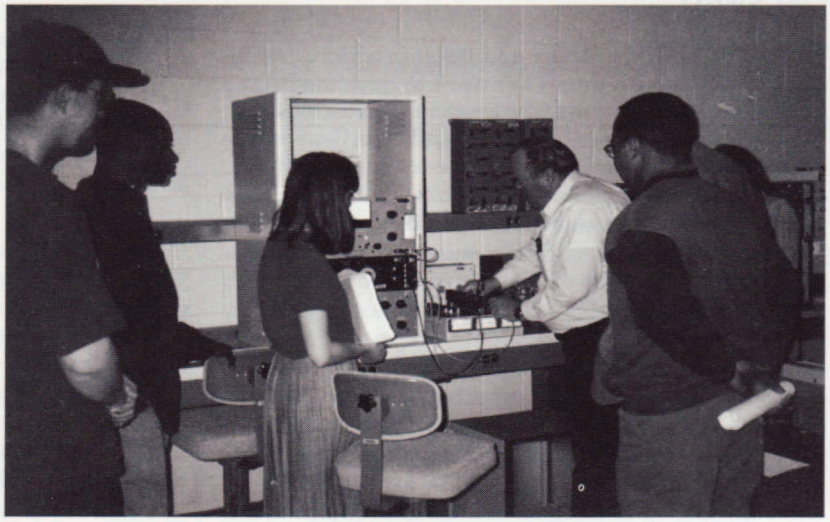
International trade is enabled by and dependent upon technology. In transferring known standards of measurement to the workplace, metrologists have created a global standardization network used daily throughout the world.

Without shared measurements, nations of the world would be technically and economically isolated. Although standards have always been used to control trade between nations, increasingly, competition in rapidly expanding export markets is causing many countries to establish barriers to trade based on normative standards or conformity assessment.

The design of tests and procedures to ensure proper accuracies and precision along with supporting data, as well as calibration of manual and automated instrumentation, are necessary in every aspect of industry including manufacturing, transportation, medicine, pharmaceuticals and others. Education and training must meet the challenge of this need to enable engineers and technicians to accomplish this in an exemplary manner.

Metrology is the constant in national defense, space exploration and atmospheric research. All depend upon the metrologist's ability to find new and better methods of standardization. Using these standards, industry sectors establish statistical process control to ensure quality process, products and services. In the absence of quality measurements, decisions made where accuracies, precision and traceability are unknown are suspect and may be disastrous to individuals, firms and governments.

In the light of the need to remain



Students in the lab at the HEAT Center at Aurora Community College

competitive in a global economy and in the midst of major changes taking place within the United States, technical education in general and metrology education specifically faces its greatest challenge since the late 1950's. There are a number of factors that have had a significant impact creating the situation we now face.

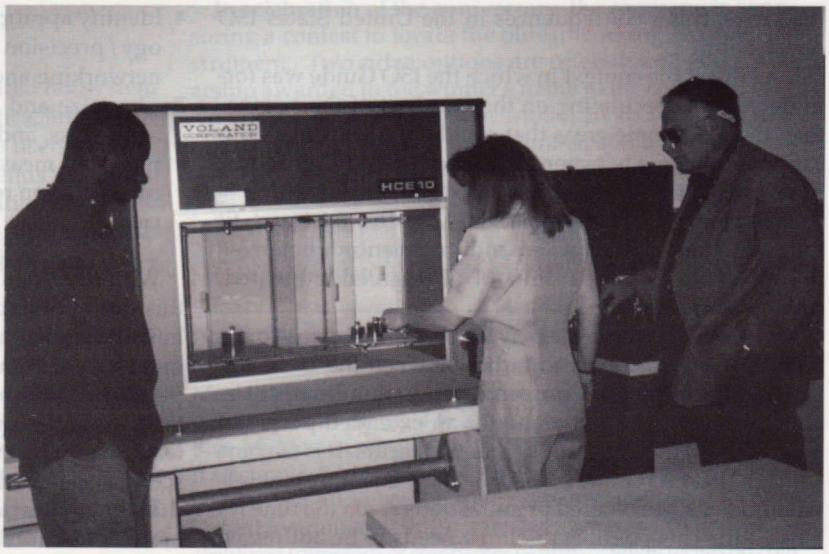
The Impact of Military Downsizing

The greatest impact on metrology training has been the downsizing of the military. During the past half century, significant numbers of American metrologists and standards experts were prepared in great numbers by the military. Throughout the country, industry leaders have said the best qualified, most experienced and most easily integrated technicians came from military programs.

As military training programs are either completely stopped, watered down in content, or curtailed by reductions, fewer people are now being prepared to conduct precision measurements. Yet, as measurement challenges become more complex, the need increases for highly-trained personnel. The number of experienced metrologists has also been in decline in recent years due to both military and private sector downsizing. Replacing these knowledgeable people, who, in the past provided on-the-job training of entry-level metrologists, will be extremely difficult and time consuming.

The Impact of Attrition

The number of graduates from educational institutions is another area of concern to many individuals having questions about the future availability of qualified measurement personnel. A large percentage of the original graduates of the military schools, many of whom have moved on through further education and training, are quickly becoming fatalities of a time war. Within the next five years, large numbers of the "greybeards" with 30 to 45 years of experience will exit the boardrooms, middle management positions and metrology laboratories to exchange measurements in the labs with golf courses. Of special significance to me and many of you has been the loss of fellow metrologists and friends who have passed away over the last few years.



The HEAT Center maintains a $1.5 million laboratory facility for training.

The greatest loss to metrology may well not be the individuals themselves as much as the knowledge and experience this group will take with them. A major shortcoming of the metrology community has been the inability to capture this knowledge gained by a half century of experience. In short, we have tended to concentrate on today's measurement with little thought to the future. An awareness of this, hopefully, will prompt action. Quoting a friend, "Today we are too busy doing our jobs to think."

Requirements for Training and Education

ISO 9000 has created a challenge that *must* be addressed satisfactorily and in a cost effective manner for the private sector if we are to remain competitive. Section 6.1 of the ISO Guide 25 states, "The testing laboratory shall have sufficient personnel having the necessary education, training, technical knowledge and experience for their assigned function." Section 6.2 states, "The testing laboratory shall ensure that the training of its personnel is kept up to date."

ANSI/NCSL Z540-1-1994 makes the same statements in its Section 6.0 Personnel. ISO/IEC Guide 25 draft 4-3.13 states "personnel performing specific tasks shall be qualified on the basics of appropriate education, training and/or experience as required."

The National Council of Standards Laboratories (NCSL) *Glossary of Related Terms* states the following:

Education — "disciplining the mind through instruction or study. Education is general and prepares the mind to react to a variety of situations." (Ref. *NIST Publication 260-100 Handbook for SRM Users*)

Training — "formal or informal instruction designed to provide competence of a specific nature." (Ref. *NIST pub. 260-100-1 Handbook for SRM Users.*)

As one begins to analyze the meaning of education, training, and experience, the questions arise, at least in my mind: what is the real purpose for all three requirements and what are

the far reaching consequences in the United States ISO registration?

Looking at the context in which the ISO Guide was formulated and speculating on the mind set of the originators, there are some areas that stand out: the formal education differences between the European and U. S. model of practicing metrologists have vast differences. The U.S. utilizes practicing metrologists that, for the most part, fit the definition of the trained and experienced, however, few meet the European model of degreed/educated, trained, and experienced.

With GATT in place, the playing field has become somewhat leveled in respect to tariffs between the U. S. and Europe. There are few European corporations that will be able to compete in that arena for an extended period of time without the aid of higher import tariffs. It is of some concern that ISO Guide 25, 6.1 may play an important role when U.S. ISO-registered organizations reach the time for a re-audit. This possible dilemma needs to be addressed by education and training providers as one of the top priorities.

Education and training must meet the challenge of education — not for it's own sake, but meaningful, directed, quality-oriented, world class education to meet the requirements of the century before us. To accomplish this, educational institutions must partner with both the government and the private sector to maintain current facilities and equipment. Distant learning must be made available to those outside the normal delivery areas of colleges and universities, and all this must be delivered at a world class level and be cost effective.

Identifying National Standards and Needs in Education

First and foremost before training and education can be adequately addressed, the requirements must be identified. The NCSL has begun to compile national training needs for metrology measurement technicians through their Personnel Training Requirements Committee. The National Science Foundation has awarded a grant to the Higher Education and Advanced Technology (HEAT) Center in Metrology at the site that was formerly Lowry Air Force Base to accomplish the following:

1. Identify industry skill standards for curriculum development in metrology/precision measurement as a foundation of advanced technology education;
2. Establish a national advisory council;
3. Develop a competency-based articulation model to enable rapid entry from community and technical colleges to the workforce and expeditious acceptance to university programs of engineering and engineering technology;
4. Identify appropriate instructional strategies for metrology/precision measurement that include electronic networking and distant learning, and;
5. Organize and distribute appropriate information for awareness, and increase understanding of metrology/precision measurement and the advanced technological education required to achieve necessary competencies.

With the existing number of educational institutions, this does not appear difficult on the surface. There are, however, inherent problems in the education system that must be overcome. Educational institutions for the most part are entities — competitive and traditionally behind the curve in emerging technologies and laboratories. Problems that exist in academia originate from a number of scenarios; many think of themselves as the "experts" and think that knowledge originates in the classroom. Many are isolated from the very industries and customers they serve. Many simply compare themselves against other academic institutions and judge themselves on that outcome alone. The result is that change is slow, often misdirected, and generally accomplished to accommodate the education process rather than industry.

Solutions

Acknowledging its responsibility to provide laboratory-based, world class learning opportunities for increased applications of advanced technology, the Colorado Community College and Occupational Education System (CCCOES) acquired 156 acres and 1,000,000 square feet of classroom, laboratory and auxiliary space from the closed Lowry Air Force Base in 1994. This was possible through a public benefit conveyance offered by the Air Force and the United States Office of Education. To maximize this extraordinary opportunity, CCCOES created the HEAT Center, which is now working in concert with the Community College of Aurora and a number of other institutions to solve the recognized needs and challenges set forth in this article. Progress realized during the past year includes acquisition of:

1. A precision metrology laboratory valued at $1.5 million,
2. Thirteen million dollars of advanced machining and joining equipment, and
3. A $1 million biotechnology laboratory.

The major advantage CCCOES has is that it is not one college or university, it is a state-owned educational system with many colleges and universities. This provides a central location for laboratories that can be used by all participating campuses, allowing the tax dollar to be spent more effectively on capital expenditures. This enables

laboratories to remain as current as possible. As important as current equipment is, however, the synergy that a center dedicated to higher education and advanced technology dispels the ownership mentality; and competitive energy gives way to a cooperative spirit that utilizes the best methods and personnel available.

The Advanced Technology Center at Lowry has recognized that all disciplines are closely tied to and dependent upon measurements, therefore, all technical degrees offered at the center will have in the curriculum a measurement component. Metrology has been designated as the centerpiece for all technologies taught at the HEAT Center.

At the present time commitments have been made for advanced machining technology through the Rocky Mountain Manufacturing Academy. This includes plastics manufacturing, advanced machining, biotechnology, semiconductor manufacturing and information/telecommunication technology. The HEAT Center at Lowry will provide an advanced technology learning environment for development and upgrades of technicians, technologists, engineers and supporting business personnel who are capable of providing leadership in the high performance, technology-based workplace.

How do we resolve the education/training question sufficiently to maintain the industrial competitiveness? Educational institutions must adapt to the changing environment. The HEAT Center at Lowry will be the cornerstone of an innovative approach to the training and education areas leading the way through a number of methods. Adding value to existing higher education programming, the HEAT Center will serve this function by

1. Effecting aggressive interagency public/private partnerships to obtain maximum resources for education and training;
2. Providing world class, high performance, technology-intensive systems and application-based learning environments;
3. Creating interdisciplinary capstone "teaming" experiences for technicians, engineering and business students;
4. Providing a high-performance technology-intensive learning environment with strategies to accommodate the increasing retraining/upgrading/restructuring processes within the private sector;
5. Providing a support environment for technology access, transfer, and application to improve the market position for manufacturing and service firms; and
6. Providing a technology vendor showcase within the learning environment for demonstration of technology-based innovation and application.

To enable this education to be delivered at a university level, the University of Colorado at Denver is moving their engineering programs to the Lowry center. Plans are underway to provide an M.S. degree in measurement science and possibly a B.S. degree at a later time.

Colorado has created an "electronic college" that awards degrees with no requirement for onsite classes. The metrology program was recently given authorization to offer college level credit classes nationally that can be applied toward an Associates of Applied Science Degree in Metrology and Advanced Precision Measurements.

To expedite the goals of metrology and measurements education, a proposal has been submitted by the HEAT Center to the National Science Foundation NSF seeking to become the national center for measurements. If this award is granted, the HEAT Center will form a consortium with seven community colleges and three universities as alpha sites to develop and test curriculum and distant learning materials. Distant learning classes available electronically may begin as early as fall, 1997.

The HEAT Center also plans to introduce measurements instruction at the high school level beginning this fall to establish an understanding and appreciation of its importance.

The vision and ability to bring resources and talents to a single location, each adding to the overall, has created an educational institution capable of making a difference in the technological future of the United States. The challenge for the future is before us; however, as in the past, metrologists have risen to the challenge in a cooperative effort and accomplished or exceeded the goals before them. Once again we shall meet the challenges of today and the next century.

Editor's note: Currently an Associate of Applied Science Degree in Metrology is offered through the Community College of Aurora with coursework in measurement science, traceability standards, statistical quality control, metrology electronics (2 courses), physical metrology (3 courses), dimensional metrology, electrical metrology (3 courses), and automated metrology.

Tom Kimbrell is Director of Metrology at the Higher Education and Advanced Technology Center at Lowry. 9125 East 10th Drive, Aurora, CO 80010, (303) 340-7073, fax (303) 340-7080.