

Journal of

INDUSTRIAL TECHNOLOGY

Volume 20, Number 1 - November 2003 to January 2004

Preparing to Meet Industry's Demand for Dimensional Metrology Trained Industrial Technologists

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Peer-Refereed Article

KEYWORD SEARCH

*Curriculum
Higher Education
Materials Testing
Quality
Quality Control*



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Preparing to Meet Industry's Demand for Dimensional Metrology Trained Industrial Technologists

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Introduction

As Industrial Technology (IT) educators, we are tasked with the responsibility of providing our students with the education and training that will best prepare them to become an employer's leading asset. To meet this challenge, National Association of Industrial Technology (NAIT) IT programs are mandated to assemble an Industrial Advisory Council (IAC) to solicit the council's input for curriculum changes that will meet the continuously changing demands and expectations of our graduates' employers. One of Southern Illinois University Carbondale's IAC members, Chuck Kuhn, has expressed a sense of urgency to make the Industrial Dimensional Metrology course a requirement within the IT curriculum. According to Kuhn (personal communications, May 2, 2002), "10 percent of the Technology and Engineering applicants he interviews do not know how to read a micrometer or caliper, and about 80 percent do not have any concept of what Geometric Dimensioning and Tolerancing is." Similar concerns were expressed by an audience of IT professionals attending a NAIT conference presentation by DeRuntz & Liu (2001) on the perceived need for developing a dimensional metrology course and lab within IT programs.

In a survey conducted by Bagley (2000), dimensional metrology professionals representing a cross-section of experienced metrology managers, engineers, technicians, ISO assessors, and other metrology personnel from

government, industry, and the military were asked if there was a need in America's institutions of higher learning for formal comprehensive metrology education; 90 percent answered yes. The respondents were also asked to rank different subject areas of dimensional metrology educational curriculum by their importance. The top subject areas indicated were calibration techniques, ISO accreditation, and dimensional metrology quality assurance.

One challenge faced by education is having the resources to respond to industry's demands. Historically, one of industry's and education's primary sources for formally trained metrologists was the U.S. military. Industry leaders throughout the country have agreed that the best qualified, most experienced, and most easily integrated technicians came from the military programs (Krause, 1996). From World War II to the end of the Cold War, a significant number of American metrologists and calibration technicians were prepared by the military. Since that time, the military has undergone significant downsizing of many of its metrology training centers and has instead turned to outsourcing much of its calibration work. However, the need and importance of these trained personnel has continued to rise as evidenced by the increased requirements of ISO 9000 and ISO 17025 (formerly ISO Guide 25), the creation of a Calibration Technician certification by the American Society for

Quality, and the symposiums to develop dimensional metrology curriculum (Krause, 1996).

Dimensional Metrology Requirements Placed on Industry

Perhaps there is no greater demand being placed on industry today than to become ISO certified. ISO 9000 continues to evolve and advance the requirements of an internationally accepted quality management system (QMS) that is the foundation for global trade. According to the International Organization for Standardization (2002), 2001 statistics show that at least 510,616 ISO 9000 certificates had been awarded in 161 countries and economies, an increase of 101,985 certificates (+24.96 percent) over 2000. The U.S. alone has experienced a 76 percent growth in companies gaining certification over the past seven years.

The acceptance and growth of the ISO 9000 QMS coupled with the growth of international competition has led to an increasing number of IT graduates gaining employment with companies possessing or seeking this certification. While probably most IT programs provide their students with a good overview or perhaps an elective course on the ISO 9000 standard; the emphasis will be on learning the structure of this prevalent QMS and not on mastering the specific skills outlined within. However, contained within these standards are elements of fundamental dimensional metrology skills, which an employer may expect a graduate of a technology-based degree to possess. The ISO 9001 QMS requires the use of competent personnel as defined in Section 6.2 and the establishment of an effective system for the control of inspection and measuring equipment covered in Section 7.6.

Industrial Technology graduates who will work in manufacturing and in an increasing number of service industries, may need to possess the following competencies of this standard: the knowledge and skills for identifying the elements of an effective calibration system, the ability to interpret the

requirements for those supplying calibration services, and the knowledge on how to prepare for a compliance audit. More specifically, manufacturers want technologists and engineers to have the following basic dimensional metrology skills: (Bagley, 2000)

- Ability to effectively communicate using the language of measurements
- Understand the basic measurement principles and practices
- Understand the definitions of traceability, capability, reliability, uncertainty, repeatability, and reproducibility
- Learn the roles of calibration, standards, and traceability
- Calibration system documentation structure
- Calibration methods/procedures and records
- Calibration intervals, calibration status, and recall
- Dimensional metrology Quality Assurance
- Required environmental controls
- Geometric Dimensioning and Tolerancing

Purpose

The purpose of this research is to speculate on the need for a basic dimensional metrology course within the curriculum of IT programs. It is not to imply that IT programs need to begin educating students to become Metrologists; who require a separate specialized education on their own. According to Painchaud (2001), "A true Metrologist must first be rigorously educated in those sciences fundamental to all measurement concepts and processes (sometime referred to as the Measurement Sciences) and then trained in those specific technologies and processes in which he is expected to endeavor." To further clarify this point, the analogy can be made that while most IT programs require one or more courses in physics; our intentions are not to produce physicists, just good technologists and engineers who can apply the basic laws of physics to solving problems in their company. The same holds true for the need to require a

dimensional metrology course in an IT curriculum. The intention is not to produce metrologists, but to train these future technologists and engineers in good measurement and calibration practices.

Methodology

To collect data on the state of dimensional metrology education within NAIT, the author conducted a survey via the internet of IT degree granting institutions. The target population of the study was the department chairs of NAIT IT institutions. The chair position was selected for their macro understanding of a department's resources and future plans. The survey population consisted of a census of the sixty-six 2001 NAIT IT institutions. An internet medium was chosen to minimize the costs, increase speed of returns, reduce the data entry time and errors, and reduce the chance of bias. In January 2001, the email addresses of 66 NAIT department chairs were obtained from the NAIT directory and then emailed the survey and a cover letter explaining the purpose of the research. They were asked to fill out the on-line survey by following a URL to <http://www.engr.siu.edu/staff2/deruntz/survey1.htm>.

The questionnaire was designed to be a single page document, consisting of five multiple choice questions, two rank-order questions (limited to 4 items), and one inventory question. Each question was formulated to obtain critical information and analyzed using descriptive statistics. Questions were sequenced in a logical progression to accommodate all participants, regardless of whether they offered a dimensional metrology course. The data was tabulated into averages to normalize the results for any missing data. The survey was pre-tested with colleagues, a dimensional metrology educator, and a department chair. Recommendations from the pre-test participants were incorporated into the final instrument.

The request to participate in the survey was made only once, and performed through a mass emailing. A return of

27 out of 66 surveys produced a return rate of 41 percent. According to Alreck and Settle (1985), "Mail surveys with response rates over 30 percent are rare." Additional data supporting the validity of this sample population is present in its 95 percent confidence interval of +/-13.73 percent. In other words, there is a 95 percent probability that repeated sampling would produce a response rate between 26 and 62 percent. This would be the confidence interval for the population proportion when the sample size is sufficiently large. According to Cochran (1977), "the minimum sample size needed to insure validity is about 30 if the population proportion is about 0.50". Given this information and the total sample of the survey, the author would classify the inferences made from this research as cautiously valid.

Results

The data collected from the survey was used to draw conclusions on the perceived need for a dimensional metrology course, availability of trained faculty, availability of equipment, and plans for implementing a dimensional metrology course. The demographics and proportional distribution of the sample population is listed in Table 1 as percentages.

To measure the pervasiveness of dimensional metrology curriculum in IT programs, the first question asked was, "Does a dimensional metrology course exist in your industrial technology program?" The data shows that only 11 (41 percent) of the IT departments offered a course on dimensional metrology; indicating that a majority of IT programs do not offer dimensional metrology as part of their curriculum.

The second question was designed to collect data on the age of existing dimensional metrology courses to determine if any type of positive or negative growth pattern is occurring. The data showed that among the 11 colleges or universities offering dimensional metrology courses, six of them (55 percent) have had dimensional metrology courses for less than

Table 1. Highest Degree Offered by Responding Schools

Degree	Percentage of Respondents
Associate of Science	11%
Bachelor of Science	55%
Master of Science	19%
Doctor (Ph D or DIT)	11%
Other	4%

Note. The values represent the demographic distribution of the sample population expressed in percentages.

Table 2. Reasons why a Dimensional Metrology Course is not offered.

Reason	Mean score
Lack of trained personnel	2.9
Lack of funding	2.5
Lack of faculty interests	2.3
Lack of need	2.2

Note. A higher mean score implies a more important or relevant reason.

five years; five of them (45 percent) have had dimensional metrology courses between five and 10 years, and none of the departments had dimensional metrology courses older than 10 years. These results show that of the 11 respondents indicating that they have a dimensional metrology course, 100 percent of them have been started in the last 10 years. This would suggest a positive growth trend; however the question was not able to determine how many courses were dropped from programs. The intent of the third question was to understand the most prevalent reasons for not offering a dimensional metrology course in an IT program. Respondents were provided with four possible choices (see Table 2) and asked to rank the reason with a scale of 1 to 4, with 4 being the most important and 1 being least important. It should be understood that a higher total score implies a more important or relevant reason. The respondents to this question would have been from the 16 department chairs that indicated that they did not have a dimensional metrology lab. Table 2 summarizes in rank order, the

responses with their respective mean scores for the question.

Lack of trained personnel was identified as a leading factor for not offering a dimensional metrology course, which may suggest that more IT programs should offer a dimensional metrology course if they had qualified personnel to teach it. The reason ranked last was lack of need for a dimensional metrology course, suggesting that a dimensional metrology course may not apply to their program (e.g. graphic communications) or that the program's IAC and alumni have not expressed a need. The fourth question of the survey was designed to determine the proportion programs that possess a dimensional metrology laboratory. Among the 26 respondents, 15 had designated dimensional metrology labs, and 12 programs did not. Interestingly, the number of schools with dimensional metrology laboratories (15) exceeded the number of schools with dimensional metrology courses (11). There are two possible explanations for this situation: 1) there are laboratories without supporting courses, or 2) these laboratories could

be used as part of another class (e.g. manufacturing processes). The presence of a dimensional metrology lab without a dimensional metrology course in the curriculum reflects the importance placed on these skills in the past and present, as well as the possible effects of faculty attrition.

The fifth question found that among the 12 universities or colleges that do not presently have a dimensional metrology lab, six of them have plans to establish a dimensional metrology lab, whereas the other six did not have immediate plans to do so. This statistic shows that half of the 12 programs without labs recognize the importance of dimensional metrology in their specific IT curriculum and have plans to establish a laboratory.

The purpose of the sixth question was to identify hurdles in developing a dimensional metrology lab. This question was specifically designated at the 12 respondents who did not have a lab; however, 3 department chairs chose not to respond to this question. These 3 department chairs were among the 6 colleges that currently do not have plans to establish a dimensional metrology course. Respondents were provided with the same four previous choices (See Table 3)

According to their response, lack of trained personnel was identified again as the dominating hurdle for establishing a dimensional metrology lab. This reinforces the belief that there is a possible shortage of trained faculty to conduct this course.

Summary and Implications

The purpose of this paper was to speculate on the need for a basic dimensional metrology course within the IT curriculum. The results of this research indicated both a perceived need for a course, but also identified the primary constraint or challenge from the choices provided. According to the limited sample of IT department chairs responding, the research findings suggest the following:

Table 3. Hurdles in Developing a Dimensional Metrology Lab.

Hurdle	Mean score
Lack of trained personnel	2.7
Lack of faculty interests	2.3
Lack of need	2.2
Lack of funding	1.8

Note. A higher mean score implies a more important or relevant reason.

1. Only a minority of IT programs offer a dimensional metrology course.
2. The dimensional metrology courses being offered are relatively new.
3. The reason cited most often for not offering a dimensional metrology course is a lack of trained faculty, while the reason cited least often is a lack of needing a dimensional metrology course.
4. The number of schools with dimensional metrology labs exceeds the number of schools offering a course in dimensional metrology.
5. A large portion of programs without a dimensional metrology lab, plan on establishing one in the future.
6. Based on the choices provided, a lack of trained faculty is the primary reason for not establishing a dimensional metrology lab.

These research findings offer an account of the state of dimensional metrology curriculum in IT programs and also suggest a shortage of dimensional metrology trained faculty as a reason for not being able to conduct a dimensional metrology course or starting a new one. While this research specifically targeted dimensional metrology faculty, the IT educator profession as a whole may be suffering a shortage. According to Zargari, Patrick, & Coddington (2000), an estimated 38 percent of IT faculty will retire between 1999 and 2009.

The implications of this dimensional metrology shortage are realized by both education and industry. As industry's demand for metrology skilled IT graduates increases, so does the demand for dimensional metrology trained IT professors. However, industry is not going to allow this need to go unnoticed. Employers, alumni, and Industrial Advisory Councils will emphasize that the failure to provide manufacturing students with good measurement and calibration practices has ill-prepared them to meet the new demands of ISO 9000 and industry. It is up to IT faculty and administrators to listen to the voice of the customer and implement new and creative ways to fill these educational gaps.

Creative solutions abound for educators at the start of the 21st century. Metrology education is being delivered by a host of providers (NCSL, 2002) through a variety of formats from distance learning to on-line self study. Industrial Technology programs can partner with these specialized trainers to provide their students with a high quality metrology education without the burdens of finding a metrology educator, funding the possible addition of a course, or the funding and maintenance of a laboratory. If an institution is adverse to outside partnerships, another possible recommendation would be to teach individual modules of metrology within specific technical courses. Either way, the objective remains the same, provide our IT manufacturing students with the basic metrology education that industry needs.

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