NBSIR 81-2282 (R) Issued May 1981

Technical Training for Measurement Practitioners

Conference Report
January 12 and 13, 1981

Edited by
Lee J. Phillips
Albert D. Tholen

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Acknowledgments

The editors express their gratitude to all who assisted in the preparation of this conference report. Those who presented papers and led and participated in the workshop discussions were especially cooperative in responding to the requests of the editors.

Contents

Introduction

On January 12 and 13, 1981, more than 80 persons--State and local weights and measures officials, representatives from Federal agencies, university and educational staff members, and industry and business leaders and staff--assembled on the campus of Texas A&M University for a Conference on "Technical Training for Measurement Practitioners." The Conference provided an opportunity for the exchange of ideas, beliefs, and positions regarding the needs for technical training by practitioners of weights and measures activities in government agencies and associated private sector organizations. These discussions and exchanges took place in five concurrent workshops:

Government Regulatory Officials;
Measurement Laboratories;
The Weighing Industry;
The Measuring Industry; and
The Food Processing and Packaging Industry.

The opening session featured a keynote address by Commissioner Reagan V. Brown plus presentations by: James R. Bradley, Director of the Texas Engineering Extension Service; Albert D. Tholen, Chief of the Office of Weights and Measures, National Bureau of Standards; and Edward H. Stadolnik, Chairman of the National Conference on Weights and Measures. A second plenary session on January 13 featured presentations by: John Armstrong, Chief of the Weights and Measures Division from Canada; and William Nicol, President of Nicol Scale.

The five workshops were moderated by: Charles Forrester, Supervisor of Weights and Measures, Texas; Henry Oppermann, Office of Weights and Measures, National Bureau of Standards; Thomas Stabler, Manager of Weights and Measures, Toledo Scale Co.; Walter F. Gerdom, Manager of Technical Services, Tokheim Corporation; and Chip Kloos, Hunt-Wesson Foods, Inc. Overall planning for and support of the Conference were coordinated by Lee Phillips, Assistant Director of the Texas Engineering Extension Service (TEEX).

Included in these proceedings are the texts of several of the presentations, workshop reports, and evaluation of the Conference.

The Conference (and this report) was organized and conducted under the joint sponsorship of the Office of Weights and Measures, National Bureau of Standards, and the Texas Engineering Extension Service. Cooperating in support of the Conference were the National Conference on Weights and Measures, the National Conference of Standards Laboratories, and the National Scale Men's Association-Texas Division. It is the hope that results of the Conference will add to the effective development and establishment of permanent, educational training programs for measurement practitioners both in and out of government.

February 1981

Lee J. Phillips
Albert D. Tholen

Agenda for the Conference

Sunday, January 11

1:00 p.m.-5:00 p.m.
Registration
2nd Floor, Rudder Tower

6:00 p.m.-9:00 p.m.
Reception
Ballroom B, Ramada Inn
(Transportation provided between Aggieland Inn, Holiday Inn South, Memorial Student Center, and Ramada Inn)

Monday, January 12

7:30 a.m.-12:00 noon
Registration
2nd Floor, Rudder Tower

8:30 a.m. Room 701, Rudder Tower
Welcome to Texas A&M and the Texas Engineering Extension Service
James R. Bradley, Director
Texas Engineering Extension Service

9:30 a.m. "Training Needs: Fact or Fiction?"
Albert D. Tholen, Chief
Office of Weights and Measures
National Bureau of Standards

10:00 a.m. Break

10:30 a.m. "Training the Weights and Official--A Priority of Weights and Measures Administration"
Edward H. Stadolnik, Chairman
National Conference on Weights and Measures

11:00 a.m. The Workshop Objectives
Lee J. Phillips, Assistant Director
Texas Engineering Extension Service

11:30 a.m. Lunch

1:00 p.m. Concurrent Workshops

GOVERNMENT REGULATORY OFFICIALS
Room 301
Moderator: Charles Forester
Speakers: Stan Darsey
Joe Swanson

MEASUREMENT LABORATORIES
Room 401
Moderator: Henry V. Oppermann
Speakers: Gerald Berman
Herb Eskew

THE WEIGHING INDUSTRY
Room 308
Moderator: Walter F. Gerdom

THE FOOD PROCESSING AND PACKAGING INDUSTRY
Room 404
Moderator: Chip Kloos
Speaker: Ed E. Wolski

7:00 p.m. Conference Buffet
Room 201, Memorial Student Center
(Transportation provided between
Aggieland Inn, Holiday Inn South,
Ramada Inn, and Memorial Student Center)

Tuesday, January 13

8:30 a.m. Room 701, Rudder Tower
"The Canadian Experience"
John Armstrong, Chief
Weights and Measures Division
Legal Metrology Branch
Consumer Standards Directorate
Ottawa, Canada

9:30 a.m.	"N.S.M.A. Believes Consumers Need and Demand Professionalism and Professionalism is Obtained by Education and Training" - Ray C. Canfield Presented by William F. Nicol, President, Nicol Scales, Inc.
10:00a.m.	Workshops Continue through the Morning (same rooms as Monday)
11:30a.m.	Lunch
1:00 p.m.	Workshop Moderators Begin Summary of Discussion
2:30 p.m.	Conference Wrap-up Room 701
3:00 p.m.	Summaries to Stenographers Room 305A

Conference Objectives

Lee J. Phillips

Assistant Director, TEEX

It is hoped that this Conference will be a unique and profitable experience for everyone in attendance. Unique in that the staff of the Texas Engineering Extension Service will be listening to the participants and learning of the needs of your profession; profitable in that the information coming from this meeting should lead to the design of an education and training program that will directly benefit weights and measures officials, manufacturers and service personnel, and users.

Most of us would expect to return to an educational institution to be brought up to date on the latest developments in our field or to learn a new aspect of our profession. However, for the next two days, the administration and staffs of the Texas Engineering Extension Service and the Office of Weights and Measures, National Bureau of Standards will be learning from you. In each of the five concurrent workshops, there will be a representative from both staffs. They will be responsible for recording the proceedings of your meeting. They will be interested in what you say is needed in the field, in the lab, and in the office. They will be interested in past and current efforts regarding training and education--what has made it successful as well as what has not been successful. To support your deliberations we have a full administrative support staff in the form of student assistants in each workshop, a conference coordinator, and stenographic and copy service.

At the conclusion of the conference, a written summary will be prepared by each moderator. From that summary, the Texas Engineering Extension Service and the Office of Weights and Measures staffs will (1) attempt to determine the general acceptance or rejection of the concept of a national training program, (2) develop a matrix of needs based on the report of each workshop, (3) consolidate the needs into proposed training modules, and (4) report to you, through a conference report.

For the next two days, it is our purpose to provide you an environment in which you can create an outline for an educational service that would be a credit to your profession. The resource people you may need are available--call on them. If problems arise--call on me. We look forward to working with each of you.

GENERAL SESSIONS

Chairman:
Lee J. Phillips (*Assistant Director, Texas Engineering Extension Service*)

Speakers:
James R. Bradley (*Director, Texas Engineering Extension Service*)

Reagan V. Brown (*Commissioner of Agriculture, Texas Department of Agriculture*)

Albert D. Tholen (*Chief, Office of Weights and Measures, National Bureau of Standards*)

Edward H. Stadolnik (*Chairman, National Conference on Weights and Measures*)

William Nicol (*President, Nicol Scale Co.*)

John Armstrong (*Chief, Weights and Measures Division, Consumer Affairs Directorate, Canada*)

Staff Support (Texas Engineering Extension Service):

Sandy Clothier
Jeanette Hennigan
Joni Hennigan

Student Workers (Corps of Cadets, Texas A&M University):

Sam Haives
Bill Jones
Wes Klett
Wes Osburn

Opening Remarks and Welcome

James A. Bradley

It is a real pleasure for me to have the opportunity to welcome you to the State of Texas, the Bryan-College Station community, and to Texas A&M University. We have individuals representing many States and Canada, and we hope you will take time to tour our campus and get acquainted with some of our people who have a vital interest in your program.

Texas A&M University is the land-grant university for the State of Texas. Being the land-grant university, we have mandates that we must follow from both the State and Federal Government. A land-grant university has the responsibility to provide academic programs, conduct research, and provide public service programs to the citizens of the State.

In Texas, the Texas A&M University System is composed of four academic universities, the Agricultural and Engineering Experiment Stations, the Agricultural and Engineering Extension Services, and the Texas Forest Service. Texas A&M University, the major university in the System, has a full-time enrollment of more than 33,000 students. This student body is composed of approximately 3,000 in the Corps of Cadets, 24,000 civilian students, and 16,000 graduate students. There are ten colleges representing many academic areas.

In the 1979-1980 fiscal year, through Texas A&M University and the Experiment Stations, more than $65,000,000 worth of research and $55,000,000 worth of public service were conducted.

The date of this conference was set one year ago when Mr. Al Tholen returned to our campus convinced that the Texas Engineering Extension Service was the type of organization that could develop and deliver practical technical training for those individuals involved in measurement practices.

As in all scientific and technical undertakings, change is an important challenge--and metrologists are seeing rapid change with the introduction of electronics into so many instruments in measurements. What Mr. Tholen was looking for--and what we think we have to offer--is an organization and a philosophy dedicated to keeping individuals up-to-date with changes in their area of specialization through the use of formal training of a practical nature that stresses hands-on experience and programs that can be taken to the user.

At this time, I invite your attention to a slide presentation which will explain the nature of our organization and show you the many areas of training we undertake. (Appendix B)

That is the Texas Engineering Extension Service as it exists today. It is a constantly changing organization--changing to meet the needs of people. We hope through the long hours of effort we have expended, in cooperation with the National Bureau of Standards, that we will soon add a dimension to our training for measurement practitioners. What we do with regard to the development of a program will be largely in your hands because this is a rather unique conference. After hearing leaders from throughout your area of interests, you will be attending workshops where the professional staff of our organization will be listening to you telling them what should and should not be incorporated into a training program to meet your needs. We are asking for input from Government regulatory officials, measurement laboratory specialists, the weighing and measuring industry, and the food processing and packaging industry. From what you say you want, our specialists will develop a program with guidance from the National Bureau of Standards and a Metrology Advisory Committee.

So I challenge you to work hard, let your feelings be known, and feel free to call on any of us during the conference or afterwards. We think our facilities will serve you well. Some of our outstanding students will be in your workshops to see that you have what you need to develop a meaningful report and to gain the experience of being involved in the "real world" process of planning. I wish you every success.

Introduction of Commissioner Reagan Brown

It is my pleasure to introduce the keynote speaker who is a real friend of the Texas A&M University System and a gentleman who is well known throughout Texas and the United States.

Our speaker this morning is Reagan V. Brown, Texas Commissioner of Agriculture. Commissioner Brown is known to be one of Texas's most popular speakers. He has spoken in all 254 Texas counties and in 31 States. Commissioner Brown is one of the eight top elected officials in Texas. His distinguished career includes more than 25 years with the Texas A&M University System.

As Commissioner of Agriculture, he heads up one of the State's most vital agencies. The Texas Department of Agriculture is responsible for 47 laws affecting weights and measures, environmental quality, marketing, seed certification, pesticide and nursery regulations, and consumer information and protection. The famous Texas Agricultural Products (TAP) marketing program is one of the department's outstanding projects. Commissioner Brown's goal is to make Texas agriculture No. 1 in the Nation.

An articulate and vigorous advocate for the family farmer and rancher, he has been honored many times as one of America's most forceful ambassadors for agriculture.

He was picked as Texas Man of the Year in Texas Agriculture by the Progressive Farmer Magazine in 1968. He is one of the few who have been honored twice by the Freedom Foundation of Valley Forge, Pennsylvania.

He is married and has two children and one grandson.

I am happy to present Reagan V. Brown--farm boy, writer, poet, county agent, teacher, Special Assistant to the Governor, and now the elected Texas Commissioner of Agriculture.

"Give Me a Dime's Worth"

Reagan V. Brown

Thank you, Doctor Bradley, for that kind introduction. It is a pleasure and an honor to be a part of this important, and timely, project. As many of you know, Texas A&M is my alma mater. I have been associated with this great university, and its many vital extension activities, for over a quarter of a century.

I also am especially proud that you have called upon two of the Texas Department of Agriculture's most knowledgeable and experienced weights and measures professionals to head up workshops during this conference. For those of you who have not met them, I'd like to introduce Charles Forester, Supervisor of our Weights and Measures Section, and Herb Eskew, Chief Metrologist at our Austin Laboratory. I am confident that they will make an important contribution to this conference, as we identify current and future training needs for metrology personnel.

As many of you know, the Texas Department of Agriculture is this State's primary enforcement agency in the area of weights and measures. As such, we play an increasingly important, and increasingly complex, role in guaranteeing equity in the marketplace. In this capacity, our field personnel inspect and certify commercial devices ranging from hopper scales in grain warehouses to motor fuel pumps. Last fiscal year, TDA field inspectors performed over 504,000 weights and measures inspections for the people of Texas.

The Texas Department of Agriculture also is responsible for maintaining the State's standards of mass, length, and volume, as well as registering scale and pump servicemen. We currently have some 1,398 registered servicemen in the State.

Since our involvement in the field of weights and measures is so great, we are particularly interested in the program being undertaken here. Few would disagree that there has been an explosion of technology over the past two decades, leading to increasingly complex equipment. I can remember when the concept of electronics was just a dream. Today, even the most common weighing and measuring devices are utilizing digital readouts, printed circuits, microprocessors and minicomputers...supermarket scales, gasoline pumps, and even bathroom scales are included.

I also feel there is a great need today for a means to keep metrology professionals abreast of the rapid technological change that is affecting the field of weights and measures. And, at the same time, I feel that such programs should be standardized from State to State.

I feel that the realistic, common sense approach being taken here to develop this type of program will go far toward meeting our needs for the future. I commend the close cooperation of the Texas Engineering Extension Service and the National Bureau of Standards. I endorse their efforts fully, and pledge the continued cooperation and assistance of the Texas Department of Agriculture.

"Training Needs: Fact or Fiction"

Albert D. Tholen

HISTORY AS PROLOGUE

Just a few months over twenty years ago, September 27, Dr. Martin Mason, Dean of the George Washington School of Engineering, made an announcement in New York at the annual meeting of the Instrument Society of America. He said that the Martin Company (now Martin Marietta Corporation) and the National Bureau of Standards will establish the Nation's first Institute of Measurement Science at George Washington University. The University program was developed to award three degrees, B.S., M.S., and doctorate in the science of metrology (measurements).

> Dr. McNish, then Chief of the NBS Metrology Division said:
> "There has been nothing like it before in the field of scientific measurement. The very security of our Nation and the future vigor of science, industry, and commerce in America all depend on it."

The importance of precision measurement was highlighted at that time by the space program; by the apparent successes of the Russian program vis-a-vis the halting progress of the United States program. The Russians were perceived to be ahead of us in both measurement science research and development; this perception was evidenced by Sputnik.

> Dr. Martin said:
> "In 1956 the Soviets claimed they could make calibrations of temperature measuring devices up to 6,000 degrees Centigrade, and the five-year plan called for extending this competence to 12,000 degrees by 1960. By contrast, in 1956, the U.S. Bureau of Standards had reasonably satisfactory means for providing temperature calibrations of up to only 2,800 degrees."

He added that "today (1960), the NBS calibrations can go up to 4,200 degrees Centigrade, but that is still only about one-third of Russian capabilities."

A great concern about lack of adequate progress in research and development was highlighted in the media twenty years ago. General agreement in the need to strengthen and reinvigorate our research institutions was shared by our national leadership (including the President and Congress) and supported by the public.

That education program, established with much fanfare and acceptance twenty years ago, functioned successfully for nearly ten years. The space program and the deep involvement of the Martin Company in that program provided most of the motivation in terms of funding and students.

Many other major changes were taking place in our national research and development programs. One of particular importance to the National Bureau of Standards was the acquisition of property for our new campus in Gaithersburg, Maryland, and the subsequent construction of new facilities. We moved from our old campus in Washington, D.C., in the mid-sixties.

NBS ROLE[1] AND THE NATIONAL SCENE

The National Bureau of Standards is a national physical science and engineering laboratory. Our mission is to provide for the Nation's measurement and standards needs by supporting such national goals as:

- economic growth
- equity in commerce
- reasonable and equitable regulatory decision making
- accuracy and compatability in scientific communication and technology transfer.

The Bureau of Standards may be unique as a Federal agency in having an extremely broad mission that is relevant to nearly every national problem area and economic sector. It has a diverse and dispersed user community that includes nearly every user of scientific and technical information in both the industrial and governmental sectors.

The Bureau's basic measurements and standards work will continue to be the area of first priority in funding and staffing because this advanced work in fundamental measurement is the unique NBS mission and it provides the knowledge and capabilities that are the foundations of the more applied, problem solving efforts. To meet the needs of modern technology, NBS is developing new measurement standards and measurement protocols that can be maintained in the user's laboratory or on the factory floor to calibrate instrumentation. Above all, NBS

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[1]Paraphrased from NBS LRP pp I-VII

must continue to explore new ways to use the immutable laws of physics to define the base units to even higher levels of accuracy to meet the continually advancing needs of U.S. science and high technology.

Rapidly increasing applications of advanced electronics create major demands for the improvement of measurement devices and measurement methods through the incorporation of microprocessors. Internal and external pressures will increase for development of capabilities to deal with these developments.

Programs that contribute to the enhancement of U.S. industrial productivity and innovation will experience significant growth in the mid- to long-term future. Increasing recognition of the central role of technology to our national economic well-being will mandate increasing efforts to provide the measurement tools, materials understanding, and underlying technological information needed by U.S. industry and commerce.

The amount and complexity of government regulation are putting increasing pressure on the scientific and applied measurement capabilities that are the heart of much of our collective responsibilities.

NBS is deeply involved, as you will recognize, in researching and developing new measurement technology. But our interest does not stop at the laboratory door or with the published research paper. The value of our efforts is really magnified as they are usefully and productively applied by commercial, industrial, and government organizations. This brings me to our meeting today and the present environment relating to measurement science and practice.

MEASUREMENT NEEDS TODAY

I have taken this time to recount the past for several reasons. First, we are meeting here today because we also are motivated to strengthen and reinvigorate our national measurement science capabilities. Second, we believe that one basic way to do that is through establishment of formal educational programs in measurement science at a leading university. Third, there is a national concern about the industrial health of the United States; about our ability to compete within our own borders with the industrial successes of the Japanese and western European countries. Much is said about declines in productivity and quality of products. We read about the decline of our steel, auto, textile, television, and other industries.

Our political leaders are proposing programs for "reindustrialization" or "revitalization." Again, twenty years after we were making plans to meet the challenge of Russian technical achievements, we now are trying to meet the new challenges confronting us within our own marketplace.

Your program states that:
"Measurement technology has changed in the last generation from simple mechanical and electrical devices to sophisticated computerized systems."

Again, today, there is the widely held opinion that our "system" is somehow falling behind; that something dramatic needs to be done. I share that opinion and I believe most of you do also. Others not here today are trying to do something about it. Texas Congressman Phil Gramm, in a letter to Congressman George Brown, Chairman of the House Subcommittee on Science, Research, and Technology stated:

"The gap between the state of new electronic measurement technologies and the ability of State and Federal officials to monitor the accuracy of the new devices is widening and will present major problems unless action is taken swiftly. With the introduction of electronic devices to check out groceries, compute gasoline and utility bills, and weigh bulk goods, many new possibilities for costly errors and consumer fraud have evolved."

In my opinion, there is at least one major difference between the situation described by Dean Mason in 1960 and the situation today. He depicted the basic problem then as being a lack of advancement in basic measurement research; the Russian's calibration capability far exceeded that of the United States. Without arguing that claim here, I do not believe that the same problem exists today. Rather, our basic measurement research has been healthy and successful. The high quality and productivity in other countries are partly a result of their adoption of U.S. measurement technology.

In the United States, we seem to have been less successful in transferring and adapting this technology into practice by our industry and commerce. At least two areas must be strengthened:

1. Technology transfer mechanisms, and
2. Educational programs.

EDUCATIONAL PROGRAMS

Naturally, I am going to talk about the second, educational programs, today. Throughout our industrial, university, and government organizations, skills are needed for the transfer, adaption, and implementation of the latest measurement science. My thesis is that there are too few well educated measurement scientists, engineers, and technicians working in our society today.

In these two days, you are going to assess the educational needs in measurement science as you understand them. We at NBS are very much interested in what you conclude. Assuming a generally positive outcome tomorrow evening, we plan to work very closely with the university to develop needed programs.

Let me comment on the prerequisites for success as I view them. These views are somewhat influenced by the results of the earlier George Washington University experience. You will recall that the earlier program was:

1. sponsored by the university,
2. staffed largely by NBS professional staff,
3. funded by the Martin Company.

The program was successful for nearly ten years. However, when the Martin Company became Martin Marietta and moved to Atlanta (which somewhat coincided with the Martin Company having put their candidates through the program), the student body and financial support were no longer adequate.

Therefore, we have concluded that:

1. The program must be university based, operated, and staffed (and therefore will have been established only after the school is convinced of an adequate source of students, long term need, and funding), and

2. The study body must come from a large number of sources.

I'd like to suggest some criteria to be used to determine a need for such a program.

PREREQUISITES

The development of a Measurement Science Educational Program should have the following prerequisites:

1. Establish that there is a need for a quality education program and a sufficient number of potential students to support the program.

2. There should be a sincere desire on the part of decision makers to provide a continuing program of education and training that will offer career development opportunities for all personnel interested in measurement science and related fields.

3. Industry and government must provide leadership for the development of the program.

4. Technical societies and associations must be actively involved in articulating need and promoting development and support.

PROCEDURE TO ESTABLISH A COLLEGE PROGRAM

After the prerequisites have been satisfied, the following specific procedures will help to assure a well established educational program (cooperative effort):

1. Conduct surveys to obtain data on local and national requirements for specific measurement science educational needs.

2. Prepare educational program package papers for presentation to potential officials in government and industry. Ensure that these presentations demonstrate the following:

    a) The expected annual student enrollment.
    b) Student sources.
    c) Industry and government management support.
    d) Source of qualified instructors.
    e) Program compatibility with college standards, facilities, and current programs.
    f) The present and future scope of the educational program.

3. Conduct meetings with top government and industry officials such as the heads of departments for the presentations of the educational program package. Sell the idea at the top. Obtain approval to make follow up presentations to the department staff. Staff approval is necessary.

4. Make department staff presentations. Thoroughly explain program goals and technical requirements.

5. Arrange and conduct field trips for the school staff. Show them just what people do in measurement science, and how industry will support the program.

6. Prepare course proposals using college proposal forms and procedures. Ensure the backing of specific college staff members appointed by the department head.

7. Utilize local college vocational coordinators in assisting qualified instructors in credential applications and establishment of course schedules.

8. Concurrent with the above, conduct exhaustive survey and identify textbook(s) and other reference material and develop course outlines.

9. Establish schedule for initiation of classes. Promote program with all potential sources of students.

10. Initially monitor each class with guidance from the school coordinator to ensure effective course material, instruction, and acceptance.

11. Periodically review and update course requirements to ensure current measurement science needs are being fulfilled.

SUMMARY

FACT OR FICTION

The questions you and I are here to explore are: Can needs for training in the weights and measures arena (including officials, industry, business, and associated activities) be clearly defined? Are these perceived needs fact or fiction? Are the perceived needs extensive enough to justify development by education and training institutions? Will potential users of training programs have the fiscal backing to utilize the developed programs?

Or, is the entire exercise based on fiction? Are we gathered here in some false sense of needing to do something - which might turn out to be other than training?

I am convinced that what we seek is based on demonstrable facts. Measurement practice today must become a recognized professional occupation: recognized by ourselves first, then by our bosses, by our peers, by our constituencies, by our personnel departments, by the youth growing up through high school. Such professionalism must have a base in the qualifications we bring to the job. Quality training is essential to acquiring and maintaining the specialized skills of those hired into and engaged in this profession.

Our challenge is to clearly articulate the facts and plot a course to proceed with the planning and promotional efforts.

Our efforts in these two days are very significant and, perhaps, more vital today than those plans made twenty years ago by George Washington University, the Martin Company, and NBS.

Researching and developing new measurement technology is progressive and healthy. Today, transfer and application of that technology are obstructed because of many factors, one of which is inadequate numbers of educated measurement practitioners.

This must be corrected. Your interest is very encouraging. Let's really tackle the challenge, learn from the past, and lay the foundation for permanent university based education programs in measurement science.

Thank you.

"Training the Weights and Measures Official--A Priority of Weights and Measures Administration"

Edward H. Stadolnik

As Chairman of the National Conference on Weights and Measures, I welcome the opportunity to present the support of the National Conference in the concepts being explored at this meeting to develop a technical training program for measurement practitioners. I am quite confident that all weights and measures administrators, metrology laboratory personnel, field inspectors, manufacturers representatives, installers and repairmen, packaging industry personnel, and all others who have a stake in measurement processes applaud the activity that is going on here today and tomorrow. I would also like to take a moment to commend Texas A&M University, the National Bureau of Standards, the National Conference of Standards Laboratories, and the National Scale Men's Association, Texas Division, in recognizing the broad based need for technical training for measurement practitioners at all levels.

First, a few comments about the National Conference on Weights and Measures. "The National Conference on Weights and Measures had its beginning in 1905, when the Director of the National Bureau of Standards called a meeting of representatives from the various States to bring about uniformity in State laws referring to weights and measures, and also to effect a close cooperation between the State measurement services and the National Bureau of Standards. Since its establishment, the Conference has grown steadily in size and importance and now brings together at its meetings a total of approximately 500 persons comprising State, county, and municipal weights and measures regulatory officers, other officials of Federal, State, and local governments, and representatives of manufacturers, industry, business, and consumer organizations. The Conference develops many technical, legal, and general recommendations in the field of weights and measures administration and technology, and its programs explore the entire area of this economically important segment of governmental measurement services".

I also think it would be appropriate to place into the record, the National Conference on Weights and Measures definition of measurement operations, which appears on page 4 of the NCWM publication outlining its membership plan.

"Measurement operations is the total process of assuring compliance with those codes and other duly enacted regulatory measures that seek uniformity and equity based on measurement in commerce, general public health, welfare, and safety. The practitioners of measurement operations are employed at all levels of government, and in the private sector, and they perform a wide variety of functions ranging from highly specialized laboratory calibration, field inspections, manufacturing, packaging, and maintenance operations. They deal with a highly diversified body of technical knowledge - yet they find common causes and interests in their basic objectives and work approaches within a distinct sector of the public service".

So again, it is refreshing to note that both the National Conference on Weights and Measures and the other co-sponsors of this Conference recognize the commonality of interests between public and private sector organizations in establishing a much needed training concept.

The development and implementation of a comprehensive training program for weights and measures officials at the State, county, and municipal level is a priority issue for weights and measures administration. It is an issue of national concern which has been expressed at many of the regional and State weights and measures meetings that I have had an opportunity to attend in the past several months. We live in an era of rapid technological change, a period of economic change, and a period of cultural change. The need to develop a training mechanism may very well be one of the most significant challenges that we will be facing in the 80's, as it will be one of the tools that we have to utilize in managing our changing times. We have a priority need to marshal all of the resources available to provide the necessary training for some 3,800 weights and measures officials representing approximately 700 jurisdictions throughout these United States. Without a well trained weights and measures officer, all of our laws, rules, regulations, and specifications and tolerances will have little value if they are not implemented in an effective and meaningful way.

The lawmakers of this Nation at both the State and national level have long recognized that effective weights and measures administration is vital to the economic welfare of our country. It is a service of government that provides all parties involved in commercial transaction with a confidence relating to quantity determinations for charges of goods and services. I do not have a statistic that relates to the total annual dollar volume that changes hands in this country in the purchase or sale of commodities or charges based on measurement services, but I am quite sure that it would measure in trillions of dollars. Perhaps a few statistics will give us some idea of the financial impact in the purchase and sale of goods that are measured by devices that are regulated by weights and measures officials. A 1979 statistic indicates that there are some 196 billion dollars spent annually in this country in the retail sale of food. 1979 sales of gasoline at retail amounted to close to some 112 billion gallons and if an average price of $1.20 per gallon were used, we could extend this to an annual retail gasoline sales figure of approximately $134 billion dollars. Latest figures acquired from the Energy Department indicate the use of close to 102 billion gallons of fuel oil and kerosine on an annual basis, which again would translate to close to 102 billion dollars of product, all of which is measured by devices that are tested and monitored by weights and measures officials. This figure includes 20 billion gallons of distillate heating oils. We use close to 7 billion gallons of liquefied petroleum gas for residential and commercial use on an annual basis. Weights and measures inspectors calibrate farm milk tanks which provide the basis of sale from the dairy farmer to the dealer and in 1979, the United States Department of Agriculture reported that close to 124 billion pounds of milk were produced in the United States with a dollar value to dairy farmers of close to 16 billion dollars. These statistics only touch the surface of the economic impact that is reflected through the regulatory activity of the weights and measures community in the United States. In the final analysis, we must recognize that the effects of measurement mean money. If a purchaser is short-weighted, it is money that is lost to him and likewise if a seller unwittingly gives product away due to inaccurate measurement, is is money lost from his pocket.

As noted previously, our concerns at this conference in developing a national training program for weights and measures practitioners will have an impact on every citizen in the United States - in much the same way as training programs for police officers or firefighters affect the level of services in the communities in which they serve.

There have been tremendous changes and advances in the technological design of weighing and measuring instruments used in commerce, much of it using some of the concepts of space age technology. There is every reason to believe that this development will continue to accelerate. Coupled with new product design are the different and changing methods of conducting trade practices. Witness the commonplace use of point-of-sales systems where scales are interfaced with electronic cash registers which in turn are tied in with computer based operations. There is a reawakening of interest in price scanning laser technology at the supermarket checkout counter. New concepts in specifications and regulatory activities in an ever increasing degree of sophistication will continue to face the weights and measures official in the future. As electronic and microprocessor technology continues to expand, with it comes a whole new vocabulary of terminology which must be understood. However, it must still be recognized that we do not live in a world totally controlled by electronic systems. There are still many mechanical devices in use and that will continue to be manufactured for some time. Therefore, a training program for device terminology should address the needs of the field official who must face a wide variety of mechanical, electro-mechanical, and electronic systems in his daily activities.

It must also be kept in mind that besides being involved in the technical aspects and testing of weighing and measuring devices, weights and measures officials are also law enforcement officials. A weights and measures training program must recognize the need for development of criteria for training the official in the various aspects of State and Federal laws and the application of State and Federal rules and regulations. It is noted in the first page of your announcement booklet that programs relating to law enforcement and inspection training have already been developed. I am sure that there would be certain elements designed into your existing programs that could well be adapted to weights and measures training.

As we look inward to our current training needs and needs for the future, it is also apparent that we must seek the expertise of those in the teaching profession to ask their assistance in developing the appropriate types of audio-visual aids, training outlines, and other materials that would assist us in our individual States to supplement any formal training programs with an in-house training capability.

We often hear of the term "professional" and we as weights and measures officials like to consider ourselves as professional. However, the term professional generally implies a certain degree of preparation for one's profession; it implies that the professional has completed a program of basic study or training in his field. If we are truly willing to classify ourselves as professionals in the field of weights and measures administration, then we must be willing to set standards for training and education and subject ourselves to meeting those standards.

In conclusion, it is generally recognized that every modern work-force must have a clear set of objectives, a well constructed organization, and a means for recruiting, motivating, and upgrading talented personnel. It would appear that an effective measurement training program would be able to influence the ever expanding needs of weights and measures administration in a very constructive and dynamic manner.

"N.S.M.A. Believes Consumers Need and Demand Professionalism"

Ray Canfield (presented by William F. Nicol)

It is indeed a pleasure to appear before you and speak on behalf of and for the National Scale Men's Association. Some of the statements that I make will be personal opinions, which may not necessarily be the majority opinion of our Association. However, I offer these personal opinions with a firm conviction born of many years struggle in the battle for a professional approach to the many facets of our industry, starting with proper approval of manufactured units, correct installation procedures of these approved units, through Regulatory Officials approval of such units, so that the Consumer (and please do not think that the word Consumer is such a bad word because you and I too are Consumers) really receives equity in the Market Place.

I have several concerns with education or training as presently offered, in most instances. This education or training really is not getting down to the "Grass Roots" level where, in my opinion, it is most needed and where it could create good public relations with that ultimate consumer. Isn't it true that for every Director of Weights & Measures, who usually is well trained and well versed in his requirements, there are a multiple number of individuals down the line, under this Director, who are not as well trained, and these are the people who are out meeting the public. For every Industry Company Branch Manager or Independent Scale Dealer Owner there are many, many Salesmen and, or, Service Technicians and again these are the individuals who are meeting the public and setting the image for our industry. I contend that these are the "Grass Roots" individuals who really need education and training in all proper procedures, be they regulation or achievement of regulatory tolerances by correct and proper manufacturing, installation and repair of Weighing and Measuring units. Our challenge to this and other educational facilities is to determine the manner to get education and training to these "Grass Roots" individuals where, in my opinion, it is most needed.

Having achieved this goal, I sincerely believe that you will have taken a "Giant Step" forward in assuring that "Consumer", and you and me, that we have achieved Professionalism in the Weighing and Measuring Industry and there really is Equity in the Market Place assured by Knowledge.

Determine the manner to Educate and Train "these Root" members and you can be sure that you will have the eternal gratitude of all present and future generations of Consumers.

Be assured that our National Scale Men's Association will continue in our meager method of Education and Training and we will support any effort this University or any other Educational facility makes to further the education of our people.

WORKSHOP A: GOVERNMENT REGULATORY OFFICIALS

Moderator:
Charles Forester (*Supervisor of Weights and Measures, Texas Department of Agriculture*)

Speakers:
Stan Darsey (*Chief, Bureau of Weights and Measures, Florida Department of Agriculture and Consumer Services*)

Joseph L. Swanson (*Chief, Weights and Measures Section, Alaska*)

Observer:

Gerald Becker (*Electronics Training Division, Texas Engineering Extension Service*)

Richard Smith (*Manager, Training Program, Office of Weights and Measures, NBS*)

Coordinator:
Betsy Nussbaum (*Omega Phi Alpha, Texas A&M University*)

Workshop A Report:

"Technical Training for Measurement Practitioners in a Government Regulatory Career"

Three career fields were identified:

Field Inspector;
Supervisors/Managers/Administrators; and
Standards Laboratory Personnel.

Nationwide, approximately 3,000 employees are in these career fields in the city, county, and State jurisdictions (Federal Employees not included). A 10% turnover rate is expected or approximately 300 annually. Qualified candidates are not readily available in any of the career fields and therefore most are usually obtained thru field promotions. Possibly 15% come from the measurement industry. Typical entry level educational background for a field inspector varies from High School Graduate to College Graduate depending on the State. A large majority of today's supervisors and managers were promoted from the ranks of the field inspector.

Training is typically ad hoc or at device manufacturer's schools for the field inspector. There is no formal nationally adopted training program available. Each jurisdiction has provided its own means of basic, upgrading, and updating training.

It was unanimously agreed that at other than job entry, formal training programs for updating and upgrading should be held yearly at a minimum.

The following subjects are considered a must-know for a person to be competent in his job:

I. <u>Inspector Trainee & Standards Laboratory Personnel</u>

The history of weights and measures
Regulatory law
Units of measure
Interpretation of laws and regulations (Intent of law)
Test procedures
1. Devices
    Handbook 44 & Codes
2. Packaging
    Basic math review (Tolerances, Units, Conversion)
3. Method-of-Sale Investigation

Basic physics
Basic electronics
Human relations - How to deal with public

Communications - Oral & written
Ethics - Conflict of interest
Job safety
Inter-governmental relations, jurisdictions (who tests what)
Jurisdictional rules of organization

II. <u>Intermediate Field Inspector</u>

Review of basic material
Investigative training (Court Trial Requirements)
Referral of violations
Basic training techniques
Special applications of technology
Advanced inter-government relations and liaison
State of the art developments
Work planning & time management

III. <u>Supervisors/Managers/Administrators</u>

Budget
Program evaluation
Performance evaluation
Performance development
Scheduling/Planning
Personnel management
State and Federal rulemaking procedure
Soliciting input from advisory councils & consumer groups

Entry level training should be held in one to five day segments at intervals of approximately three months. Some of this training could be by correspondence. The majority should be obtained from regional or local courses conducted by a training specialist with field experience and expertise in the subject. Hands-on practical experience for the trainee during the course is a must.

Many of the training materials/aids are currently available but need to be gathered and evaluated (i.e. each jurisdiction has invested time and effort in training and has developed useful material), then instituted into a modular training program and made available as a nationally accepted means of training.

It was generally agreed that everyone in each jurisdiction should and would be made available for training if it is offered on a regional basis and that the organization would underwrite training tuition, materials, and moderate travel.

Certification of competence on the national level is desired but at present is not required. Legislation for certification in the western States is now in progress. California has adopted State certification in six levels of competence and is utilizing it for job promotion standards. It was agreed that the National Conference on Weights and Measures should be the certifying authority.

Adoption of the Modular Training Concept presented by John Armstrong, Chief, Weights & Measures Division, Legal Metrology Branch, Consumer Standards Directorate, Ottawa, Canada, was placed high on the list of training material sources. A serious effort should be made to share the work load with Canada to complete the remaining training modules. Following is a list of the training modules and a description of each.

LIST OF TRAINING MODULES

Page Code	Section Code	Module Description	Training Days
	INT-1.0	Introduction to Weights & Measures	1
INT-1.1 (first page)		Organization of Government Objectives and Organizational Structure of Consumer and Corporate Affairs Canada Objectives and Organizational Structure of Weights & Measures	1
INT-1.35 (last page)			
INT-2.1		History of Weights & Measures Legislative Process Acts & Regulations	1
INT-3.1		Socio-Economic Impact of W&M Service Traders/Consumers/W&M Inspection General W&M Devices Used in Trade The Inspectors' Duties & Responsibilities Role of the W&M Inspector	1
	ADM-1.0	Administration	
ADM-1.1		Reports Fees WMIS Treasury Board Regulations Terms and Conditions of Work	1
ADM-2.1		Field Operating Service Organizational Structure Work Planning (Itinerary) Program Forecast and Work Plans Categories of Work	1
	THE-1.0	Basic Theory	
THE-1.1		Fundamentals of Mechanics Elementary Machines Applications of the lever Center of Gravity Moment of Inertia Velocity and Acceleration Force, Work and Energy	1

Page Code	Section Code	Module Description	Training Days
		Pendulum Principle	
THE-2.1		Principles of Levers	
		Vectors	
		Beam and Lever Formulas	1
		Lever Systems	
		Roberval Principle	
		Applications	
THE-3.1		Fundamental Properties of Fluids	
		Definition of a Fluid	
		Force, Weight & Mass	
		Viscosity	1
		Density & Specific Volume	
		Specific Weight, Specific Gravity	
		Pressure	
		Vapour Pressure	
		Surface Tension	
THE-4.1		Applications of Fluid Mechanics	
		Pressure Measurement	
		Velocity Measurement	1
		Flow Measurement	
		Positive Displacement Meters	
		Pumps	
		Air Eliminators	
THE-5.1		Fundamental Electrical Concepts	
		Current	
		Resistance	1
		Voltage	
		Ohm's Low	
		Direct Current	
		Alternating Current	
THE-6.1		Electric Circuits	
		Series Circuits	
		Resistance of a Series Circuit	1
		Parallel Circuits	
		Resistance of a Parallel Circuit	
		Series -Parallel Circuits	

Page Code	Section Code	Module Description	Training Days
THE-7.1		Measurement of Electrical Quantities	
		Ammeters	
		Voltmeters	1
		Resistance by voltmeter-ammeter	
		Digital Voltmeters method	
THE-8.1		Magnetic Circuits and Electromagnetic Devices	
		B-H Curves	1
		Magnetic circuits	
		Electric Meters	
THE-9.1		Capacitance and Inductance	
		Capacitors	
		Capacitors in AC Circuits	
		Application of Capacitance Circuits	1
		Inductors	
		Inductors in A.C. Circuits	
		Applications of Inductive Circuits	
THE-10.1 to THE-19.1		Electronics	10
		Applied Electronics	
		Load Cells	
		Applications of Load Cells	
THE-20.1		Metals and Metallurgy	
		Hardening Process	
		Pivots	
		Bearings	1
		Stresses	
		Metal Fatigue	

Page Code	Section Code	Module Description	Training Days
	GRV-1.0	Gravimetric Devices	
GRV-1.1		Static Devices - Small Capacity Equal Arm Balances Unequal Arm Balances Single Lever Non-computing Multiple Lever-Non computing Computing	1
GRV-2.1		Static Devices - Medium Capacity Dormant Hopper OH Track	1
GRV-3.1		Static Devices - Large Capacity Dormant Truck, Portable and Permanent Railway Track Tank	1
GRV-4.1		Applied Electronics Digital Indicators Weighing/Counting Devices Batching Printers	1
GRV-5.1		Electronic Devices - Small Capacity Single Lever Multiple Lever Computing	1
GRV-6.1		Electronic Devices - Medium Capacity Dormant Hopper OH Track Automated Systems Tank	1
GRV-7.1		Electronic Devices - Large Capacity Dormant Truck Railway Tank Automated Systems	1

Page Code	Section Code	Module Description	Training Days
GRV-8.1		Dynamic Devices	
		Railway Track	
		Coupled	1
		Uncoupled	
		Mono Rail	
		Dormant	
GRV-9.1		Conveyor Scales	
		Weight Feeders	
		Pellet Loaders	1
		Off-loading Systems	
		Batching systems	
		Industrial Uses	
		-steel industry	
		-mining	
		-cement	
		-sand & gravel	
		-limestone	
		-coal	
		-mineral processing	
GRV-10.1		Point of Sale Devices	1
		Types of Devices	
		Mode of Operation	
		Discriminators	
GRV-11.1		Automatic Tare	
		AXT, PBZ	1
		Computer-Invoicing	
		Double Bridge Cell	
		lb-kg switch	
		Selectors	
	VOL-1.0	Volumetric Devices	
VOL-1.1		Static Measures	
		Provers	1
VOL-2.1		Mobile Tanks	1
		General Design	
		Piping Network	
VOL-3.1		Applied Fluid Mechanics	1
VOL-4.1		Liquid Measuring Meters	1
		Petroleum Dispensers	
		Inspection Procedure	

Page Code	Section Code	Module Descirption	Training Days
VOL-5.1		Bulk Meter Loading Rack Truck Bunker	1
VOL-6.1		Gravity Meters Truck Bulk Plant	1
VOL-7.1		LPG Meters Slow flow	1
VOL-8.1		Milk Cattle Feed Liquid Fertilizer Chemical Aircraft fuelers (fixed mobile)	1
VOL-9.1		Master Meter Provers Pipeline Provers	1
VOL-10.1		Piping Systems Bulk Mobile Marine	1
VOL-11.1		Pumping Systems Loading Arms Deaerators Flow Control Valves	1
VOL-12.1		Automatic Temperature Control Remote Registers Computers-Including Invoice Systems	1
	COM-10.0	Commodities	
COM-1.1		Consumer Products Labelling Act & Regulations Prepared Commodities Procedures - Scale Testing Forms - CCA 777 - Work Sheet - Hand calculator	1
COM-2.1		Clerk Served Commodities Test Procedure - CCA 906 Disposal Procedure	1

Page Code	Section Code	Module Description	Training Days
	OTH-1.0	<u>Other Devices</u>	
OTH-1.1		General Review of Other Devices	
		Area	1
		Length	
		Volume	
		Time	
		Odometer	
		Temperature	
		Coin-operated	
	ENF-1.0	<u>Enforcement</u>	
ENF-1.1 to ENF-5.1		F.O.S. Enforcement Course	5
	MET-1.0	<u>Metrication</u>	
MET-1.1		Introduction to S.I.	1
		Common Metric Units	
		Length	
		Area	
		Volume	
		Mass	
		Temperature	
		Time	
MET-2.1		Implementation	
		Volumetric Conversion	
		Mass Conversion	1
		Length Conversion	
		Equipment	
		Timetable for - Grain	
		Petroleum	
		Retail	
		Transportation	
		Mining	
		Construction	
		Beverage	

WORKSHOP B: MEASUREMENT LABORATORIES

Moderator:
Henry Oppermann (*Physical Scientist, Office of Weights and Measures, NBS*)

Speakers:
Gerald Berman (*National Voluntary Laboratory Accreditation Program*)

Herb Eskew (*Chief Metrologist, Texas Department of Agriculture*)

Observer:
Basil Collins (*Electronics Training Division, Texas Engineering Extension Service*)

Coordinator:
Glenette Lowrie (*Omega Phi Alpha, Texas A&M University*)

Workshop B. Report:

"Measurement Laboratories"

PRIVATE LABORATORY

Career opportunities are primarily at the technician level. Engineers are usually obtained by hiring a graduate from a four year college. Ninety percent of laboratory staff are hired as technicians. Qualified entry level technicians are hired from high school or associate degree (two year) programs; others are obtained from the public work force. More highly skilled technicians are obtained from the military. College graduates are also a source of personnel, but they are usually hired as engineers.

Sandia classifications for technicians are considered relevant and are those who have:

a. high school education and interest in technical area, and perhaps have some specialized training;
b. completed on-the-job training;
c. technical institute degree;
d. matured on the job and thereby gained judgment and integrity (that is, work results are consistently valid); and
e. a knowledge equivalent to an engineer in the particular field of specialization, but is limited to this field.

Other companies have two basic classifications: technicians and supervisors. The supervisors may be engineers or technicians who have been promoted to the supervisory level. Generally, there is a low attrition rate.

The desired qualifications for an entry level technician vary with the company. The profile and background desired for an entry level technician at the lowest level consists of:

<u>Profile</u>

Quality oriented
Technically inclined
Perfectionist attitude
Mechanical ability

Persistent
Communication skills with good human relations qualities, and ability to read and interpret technical papers, and good writing ability.

Background

One year lab experience (on-the-job training)
Algebra
Basic physics
Statistics and ability to document results
Basic electricity
Introduction to data processing
Knowledge of how to perform measurements

To gain an entry level knowledge in electronics, the individual must also have:

- An electronics background
- Experience in troubleshooting and repair
- Knowledge of microprocessors
- Experience in the calibration of test equipment
- Knowledge of digital/analog circuitry

The next higher level of qualification above that of the entry level technician requires more experience or course work in the areas listed under the background for the entry level technician. Advancement training should include instruction in "how to teach" because quality technicians progress to a supervisory level and train other technicians. This training is available through other commercial businesses, but is desirable for supervisors.

STATE LABORATORY

Entry level requirements for a State metrologist in the weights and measures laboratory are a college education in a technical field, e.g. physical sciences, engineering, mathematics, etc. Specialized training is then needed in the measurement procedures used in the laboratory operation. The training needed is currently provided in the NBS basic and intermediate laboratory metrology seminars.

PHYSICAL STANDARDS MEASUREMENT

Measurements include gauge blocks, standard cells, mass, length, volume, flow, pressure, temperature, acceleration, lasers, optics, surface characterizations, force, and torque. The last two areas require a knowledge of geometry, mechanics, and statistics. Temperature measurements involve more mathematics than the others.

The basic training in these measurement areas should include:

An overview of measurement science including familiarization with the terminology used in each branch of measurement;

Precision and accuracy;

Instruction in the procedures used to perform the various measurements;

Hands-on experience of using the equipment that is involved in performing the various measurements in the measurement areas given above; and

Training and experience in how to handle standards, laboratory environment considerations, and sources of errors in measurements.

In the past, one source of candidates for positions in the physical standards areas has been people who worked in the inspection areas of machine shops.

Reference material that could be used as textbooks for training in the physical standards measurements area are:

Textbooks by Metron for the Navy;

ASQC Introduction to Metrology;

ASQC Advanced Metrology;

NBS 300 Series and other publications; and the

CORE Course at Lowry Air Force Base.

An outstanding text for electrical measurements is Electrical Calibration developed by John Fluke Manufacturing Co., Inc.

Basic Laboratory Metrology Seminar Outline

Mass

I. Introduction

II. Topics

A. Sensitivity test

B. Standard deviation calculation

C. Pooling standard deviations

D. Standard deviation control charts

E. Precision tests

F. Theory of tolerances and application

G. Weighing designs

1. X-S = d sign convention

2. Deviation of equations

3. Single substitution

4. Modified substitution

5. Double substitution

6. Transposition

H. Uncertainty statements

III. Laboratory Auditing Program

A. Standards traceability

B. Measurement traceability

C. Measurement surveillance

D. OWM certification of laboratory

1. Basic laboratory metrology seminar

2. Completion of basic LAP problems

3. Adequate laboratory facilities

4. Maintenance of laboratory

5. Maintain inventory of standards

IV. Weight testing concepts

A. Proper application of weighing designs

1. Tolerance testing

a. Direct reading

b. Single substitution

c. Modified substitution

2. Calibration

a. Double substitution

b. Transposition weighing

c. 3-1 weighing design

d. More advanced intercomparison weighing designs

B. Tolerance testing

1. Proper application of tolerances

2. Class F tolerances (revised 1975)

3. Theory of tolerances

C. Calibration

1. Correction values

2. Uncertainty statements

V. Single pan balances

A. Design

B. Operation

VI. Sensitivity tests and standard deviation calculation

A. Purpose of sensitivity test

B. Sensitivity test as part of calibration weighing designs

C. Sensitivity test exercise

D. Standard deviation calculation

1. Test to check standard deviation calculation

2. Conversion of standard deviation to mass units

VII. Direct reading exercise

A. Test of ability to read balance

B. Tolerance application and weight errors

VIII. Modified substitution

A. Procedure

B. Methods to offset optical scale

C. Tolerance considerations

IX. Calibration procedures

A. X-S = d sign convention

B. Derivation of equations for the single substitution weighing design

1. Different weighing sequences

2. Sensitivity test as part of the weighing design

3. Requirements of the sensitivity weight

C. Double substitution weighing design

1. Different weighing sequences

2. Derivation of equations

3. Advantages of the double substitution weighing design

D. Double substitution exercises

X. Pooling standard deviations

A. Table method

B. General equation

XI. Calculation of correction values

- A. General equation when tare weights are used
- B. Simplified equations for special cases
- C. Computing and reporting uncertainties
- D. Computation of corrections from double substitution exercises

XII. Control charts

XIII. Double substitution -- Russell balance and 30 kg balance

- A. Procedure on 30 kg balance
- B. Procedure on Russell balance
- C. General equations for the double substitution
- D. Modified substitution on the Russell balance

XIV. Transposition weighing design

- A. Purpose
- B. Advantages
- C. Procedure
- D. General equation using X-S sign convention

XV. Exercises on the Russell balance and 30 kg balance

XVI. Error checking methods

XVII. Measurement control

- A. Theory
- B. Methods

XVIII. Air buoyancy correction

- A. True mass
- B. Apparent mass versus any reference density

Intermediate Laboratory Metrology Seminar Outline

(Tentative)

I. Weighing design calculations
   A. X-S sign convention
   B. Sensitivity weight notation
   C. Standard deviation calculations

II. Air Buoyancy correction
   A. Explanation of effect
   B. When to make a buoyancy correction
   C. Calculation of the magnitude of the buoyancy effect

III. True mass
   A. Definition of true mass
   B. Derivation of equation using volumes
   C. Estimating volumes of large and small weights
   D. Derivation of equations using densities only

IV. Apparent mass vs reference density
   A. Definition of apparent mass
   B. Change of reference density base to 8.0 g/cm^3 from brass
      1. Effect on laboratory operations
      2. Calculation of apparent mass vs 8.0 g/cm^3 corrections for the mass standards
   C. Apparent mass vs 8.0 g/cm^3
   D. Apparent mass vs any reference density

V. Buoyancy correction for tolerance testing
   A. Carry a weight with X or S to correct for air buoyancy
   B. Equation: $AM_{X \text{ vs REF}} = X_{NOM}\left(1 + \frac{\rho - \rho_n}{\rho_X} - \frac{\rho}{\rho_S} + \frac{\rho_n}{\rho_{REF}}\right)$

VI. Measurement Assurance
   A. Standards traceability
   B. Measurement traceability
      1. Short term standard deviation
      2. Long term standard deviation
   C. LAP 26 results
      1. Comparison of standard deviations
      2. Values obtained for standards vs NBS calibration values
   D. Documentation of laboratory measurements
      1. Measurement of same item over time
      2. Measurements "in-control"
   E. Measurement assurance program
      1. Intercomparison of standards
      2. Calibration of standards sent out by NBS
         a. Systematic error
         b. Analysis of uncertainties

F. Application to tolerance testing
    1. LAP problem
    2. Documentation for legal purposes

VII. 3-1 weighing design
  A. Procedure
  B. Sign convention - calculations
  C. Short term standard deviation
  D. Buoyancy correction
  E. Sample calculations

VIII. 4-1 weighing design
  A. Procedure
  B. One weight restraint
  C. Two weight restraint
  D. Sign convention - calculations
  E. Sample calculations

IX. Uncertainties
  A. Computing uncertainties
  B. Pooling standard deviations
  C. Reporting uncertainties

X. Calibrating built-in weights
  A. Procedure
  B. Calculations
  C. Alternate standard deviation method
  D. Balances calibrated to 8.0 g/cm^3 and 8.4 g/cm^3

XI. Gravimetric calibration of glassware
  A. Explanation of gravimetric calibration
  B. When to calibrate gravimetrically
  C. Water supply considerations
    1. Water density tables
    2. Adequate purity of water
  D. Glassware calibration
    1. Cleaning procedures
    2. Weighing flask preparation
    3. Gravimetric calibration
    4. Calculations

XII. Large volume test measure calibration
  A. Gravimetric
    1. Cleaning procedures
    2. Procedure
    3. Equations
  B. Volume transfer and temperature correction

XIII. Tape to tape calibration

General Needs Identified

In order to build professionalism and augment training, other related needs must be addressed concurrently:

Job titles and job descriptions need to be written and standardized;

Technicians (and therefore technician training) are in more demand than engineers, especially in electronics/electrical job classifications;

Training for both prospective new hires or up-grading incumbents must be a mixture of theory and practical hands-on curriculum with current state of the art equipment;

Most new technicians are either from the military or must be trained by the employer on the job; and

Training literature and training programs should be consolidated at a single source and be available for use by the using industry/governmental bodies.

Specific Training Needs Identified

Specific training program development should be based on the following perceived needs:

Estimated need for 12,000 new employees per year;

Training on how to write good calibration procedures;

Training for new employees in the areas of
- philosophy of testing and measurements,
- quality control and assurance,
- statistics used in testing laboratories,
- orientation--terminology, safety practices, etc.,
- human relations, and
- introduction to data processing;

Up-grading training must emcompass
- environmental control,
- sources of errors,
- more accurate measurements and data, and
- use of more complex procedures and equipment.

MEASUREMENT LABORATORIES REPORT
AMENDIUM FOR STATE LABS

The NBS training in their Basic and Intermediate Courses is most adequate in subject matter. The problem is in the availability of space in these courses and more locations to minimize travel time and expenses. Consideration should be given to regional courses on a more timely basis. These courses could easily be held in a state lab, on a regional basis, with NBS trained local instructors.

The added need for basic level courses in Pressure, Temperature, Time, and Frequency, to get the new employees ready to take the NBS Courses, is advisable and required.

The States now have employees with several years of service and more advanced state-of-the-art lab problems and technology study courses, for their use, would further add to their skills.

With more complex measurements and calculations here, as well as on the horizon, a course in programmable calculators as applied to these solutions would assist in meeting this need.

The State metrology directors would support a school in management and supervision. This would assist them in employee evaluations, promotions, and better usage of their employees.

The metrologists have expressed a desire and need to share in person and in a written document, technical information, equipment usage, testing solutions, etc. on a periodic and continuing basis.

WORKSHOP C: THE WEIGHING INDUSTRY

Moderator:
Thomas M. Stabler (*Manager, Weights and Measures, Toledo Scale Co.*)

Speakers:
Richard Hurley (*Advertising Manager, Fairbanks Scale Co.*)

"Woody" Woodruff (*Vice President and General Manager, Nichol Scale Company*)

Observers:
Lloyd E. Fite (*Division Head, Texas Engineering Extension Service*)

Otto Warnlof (*Manager, Technical Services, Office of Weights and Measures, NBS*)

Coordinator:
Rita Brown (*Omega Phi Alpha, Texas A&M University*)

Prepared Presentation

Richard Hurley

EQUITY

Equity is that situation where buyer and seller are convinced that they both received and sold the proper weight. We know that although the perfect weight was not transmitted, both parties were satisfied. The transaction was equitable or fair as perceived by both parties.

If we take the weight involved in the transaction and weigh it again on a highly accurate scale, we could call this the ACTUAL weight. If the highly accurate scale has sufficient resolution, then this number representing the ACTUAL weight will usually be different from the transaction DISPLAYED weight number. THE DISPLAYED WEIGHT IS THAT WEIGHT WHICH IS INDICATED ON THE ANALOG OR DIGITAL READOUT, WEIGHBEAM, TICKET, ETC. OF THE SCALE USED IN THE TRANSACTION. THE DISPLAYED WEIGHT IS THAT WEIGHT WHICH BOTH BUYER AND SELLER THOUGHT, TO THE BEST OF THEIR KNOWLEDGE, WAS EXCHANGED.

Since we have defined two numbers, let's establish a ratio of the ACTUAL weight over the DISPLAYED weight and call this the EQUITY RATIO, (ER). We would like the equity ratio to be 1.0000000 for equity to prevail for both parties. The ER can be plotted on a graph where the X-axis depicts the ER, and the Y-axis the number of occurrences (F_{ER}) in which a given ER was actually determined. Figure 1 depicts this curve. We assume in this curve that the distribution of ER with respect to F_{ER} is normal.

The line through the ER = 1.0 divides the Seller Advantage Region from the Buyer Advantage Region.

Looking at Figure 1, our interest lies in the location of the mean and the width of the curve (or the standard deviation) and its implication with respect to several interest groups. Several groups come to mind. They are:

Buyer	Scale Owner
Seller	Scale Manufacturer
Law Enforcement Official	Me, a Consumer

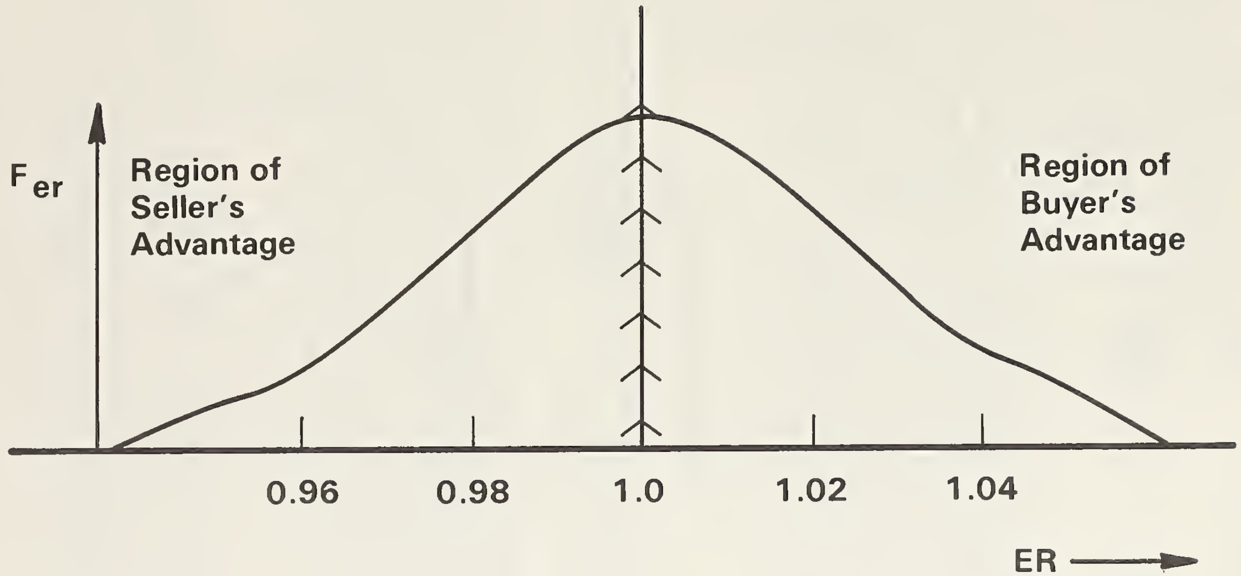

Figure 1 - Normal Distribution of the Equity Ratio

The best location of the mean is most easily defined with respect to the self-interest of the different groups; I will assume they are as follows:

Buyer	Mean > 1
Seller	Mean < 1
Law Enforcement Official	Mean = 1
Scale Owner	? (Dependent on whether he or she is buyer or seller)
Scale Manufacturer	Mean = 1
Me, a Consumer	Mean >> 1 (I am most often a buyer.)

It should be noted that the local sealer, when sealing a scale, takes a measurement, usually believes this to be the mean of all the possible random variations and, therefore, unknowingly will permit the scale to bias itself. The same person seals many scales and so we assume that he does not consciously favor either the seller or the buyer; on the average buyer and seller will both obtain the correct amount. I, a consumer, might get a raw deal, since it is possible that I always go to the store which has the wrong "seller" scale.

STANDARD DEVIATION

The standard deviation, a means of expressing the dispersion of a set of data points or "the width of the skirt" might tell us more concerning the behavior of a scale.

A scale or weighing device which has an EQUITY RATIO with a large standard deviation could generate problems in a pattern approval situation with a fixed error interval (tolerance band). A scale with this type of behavior would sometimes be found to be operating outside of the fixed tolerance band (and should, therefore, be placed out of commission). This scale also would place a burden on the manufacturer and the sealer since the scale mean would seem to have to be continuously adjusted.

A scale or weighing device with a very narrow standard deviation could be used to knowingly defraud, if ER could be set different from 1.0, although within the limits of the law or tolerance band. This scale might be an attractive product for a scale owner since if sufficient numbers of transactions were made, the scale owner could obtain a fast return on his investment. See Figure 2.

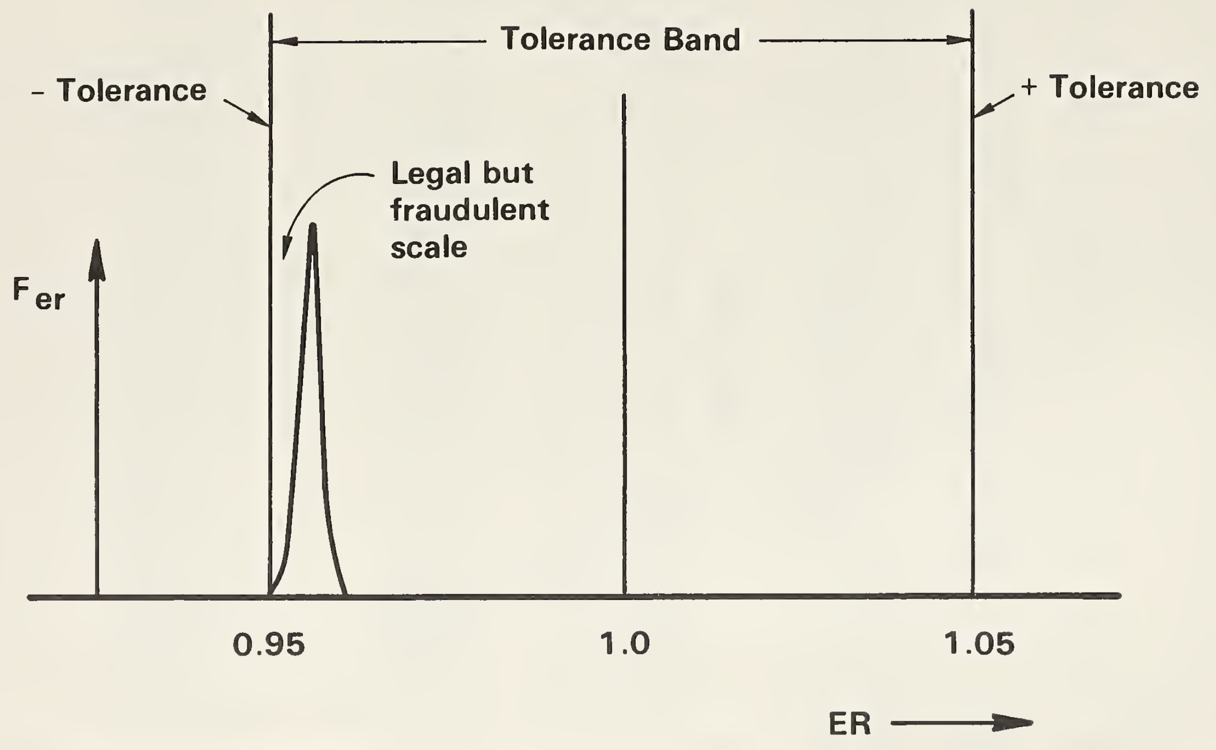

Figure 2 - Fixed Tolerance

A MEANS TO DETERMINE ACCEPTABLE ERROR BAND WIDTH

The acceptable error band for a weighing device, consistent with equity, should:

-- be no wider than $\pm$0.1% of the actual weight measured

-- encompass the random weighing of 95% of all transactions (about the width of 4 standard deviations) See Figure 3.

- be controlled, in the case of a narrow standard deviation, to permit no fewer than 40% of all random weighments to appear $>$ 1.0(ER) or $<$ 1.0(ER) depending on the scale's bias. The purpose is to reduce "legal" bias of the scale very close to ER = 1.0. See Figure 4.

CONCLUSIONS

1. Fairness (equity) requires that limits be set on the number (%) of random weighments allowed which are out of tolerance.

2. Highly accurate scales can be used to defraud.

3. The tolerance band and distribution of random weighments $\pm$ true weight, imposed by the government agency, should have the intention to force the equity ratio mean back to one (1.0), and minimize legal bias.

[Following his presentation on equity, Mr. Hurley addressed training needs by presenting a series of slides. The content of the slides is outlined on pages 57 to 61.]

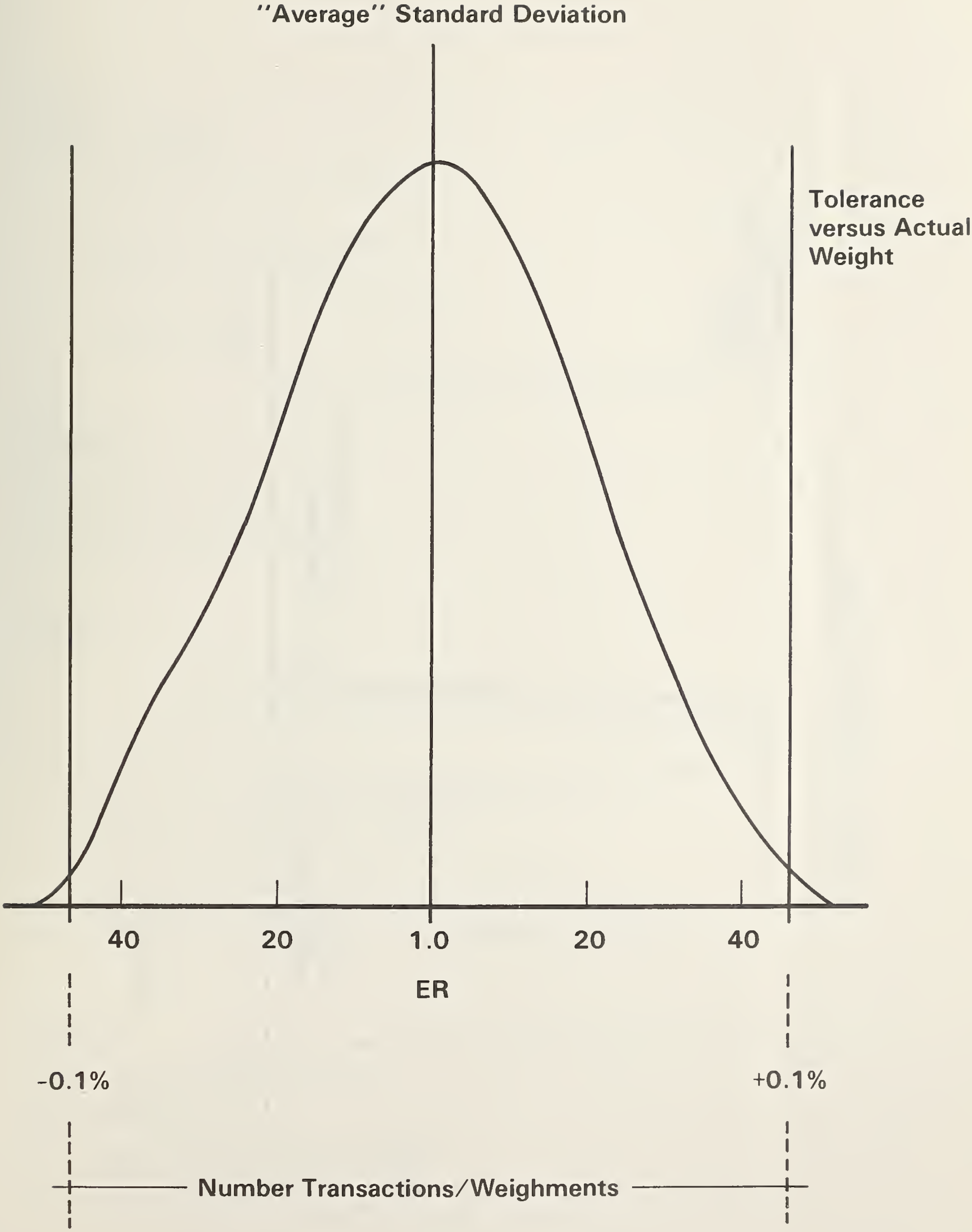
"Average" Standard Deviation
Tolerance
versus Actual
Weight
40
20
1.0
20
40
ER
-0.1%
+0.1%
Number Transactions/Weighments

Figure 3

Narrow Standard Deviation

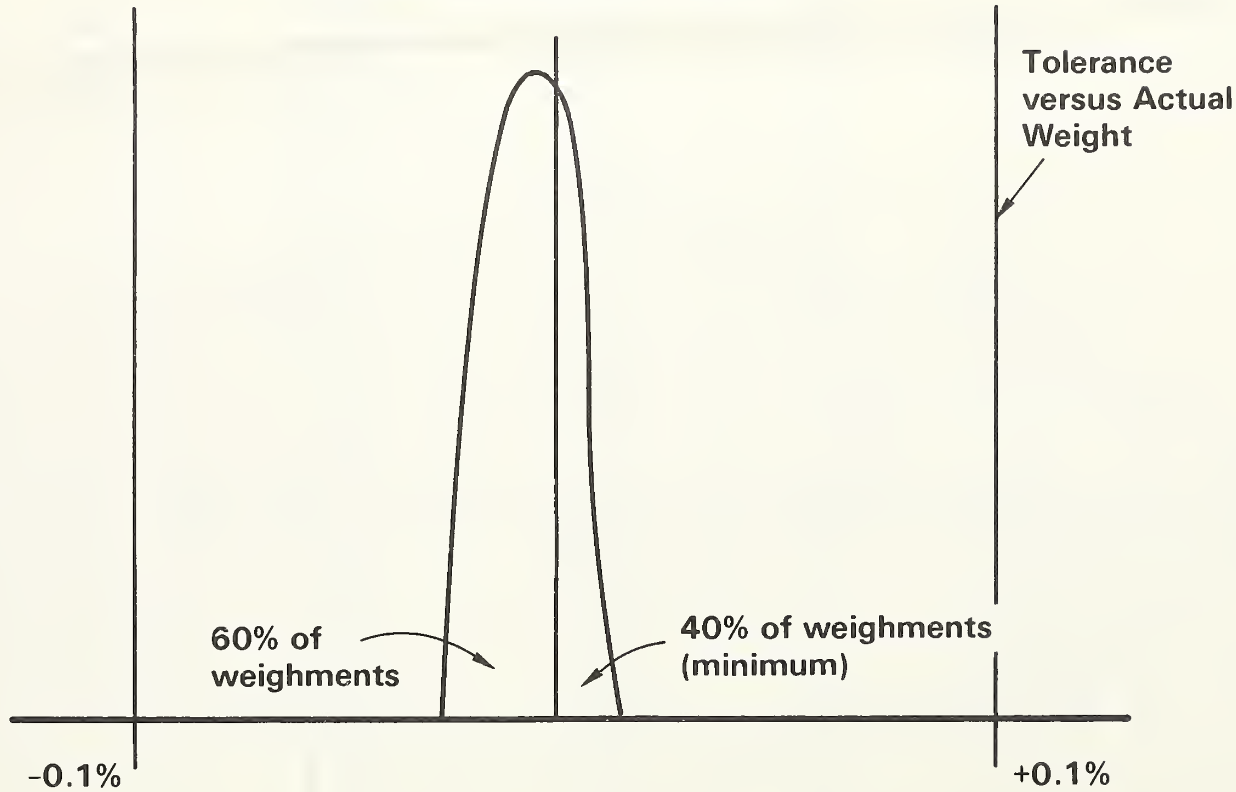

Figure 4

SLIDE #1

DURING 1981-1990:

- WHAT TECHNOLOGICAL CHANGES?

- WHAT NEW/DIFFERENT DEMANDS UPON W & M REGULATORS?

- HOW ADAPT W & M REGULATORS TO NEW CONDITIONS?

SLIDE #2

o CHANGE THROUGH FORCE

o CHANGE THROUGH CHOICE

SLIDE #3

TECHNOLGICAL ADVANCES/CHANGES

- MICROPROCESSOR EXPANSION

- GAUGED PLATFORMS OR WEIGHBRIDGES

- INTERNAL APPEARANCE OF DEVICES: SIMPLE, CLEAN, NO HINT OF TRUE COMPLEXITY

- BASIC DEVICE CAN BE EXTENDED EASILY IN FUNCTION THROUGH COMPLEX CIRCUITRY SUPPLEMENTS (90-88XX)

SLIDE #4

BASIC CHANGE IN W & M "MENTAL SET" REQUIRED.

- FIRST CONCERN MUST BE "WHAT ARE DEVICES SUPPOSED TO DO?"

SLIDE #5

W & M "MENTAL SET"

- NEVER MIND HOW EVERYTHING WORKS OR WHY

(TECHNOLOGY & FINITE TRAINING WON'T PERMIT BROAD/DEEP COMPREHENSION)

SLIDE #6

W & M "MENTAL SET"

- NEVER MIND OVER-RIDING OR DISABLING STANDARD IN-USE FEATURES

SLIDE #7

W & M "MENTAL SET"

- BECAUSE OF (SLIDES 3-6) ACCEPTANCE OF 1-STOP PATTERN APPROVAL BY ALL IS A MUST.

SLIDE #8

CHANGE THROUGH FORCE

- FORCE OF TECHNOLOGY

- FORCE OF LITTLE W&M TIME AVAILABLE FOR DUPLICATION OF EFFORT

- FORCE OF GROWING DEVICE PROLIFERATION

SLIDE #9

CHANGE THROUGH CHOICE?

SLIDE #10

NEW/DIFFERNET DEMANDS
ON REGULATORS

- BECOME ENFORCERS OF PROCESS CONTROL
- ENSURE THAT A DEVICE IS BEING USED PROPERLY
- ENSURE THAT THE CONDITION OF EQUITY IS MET (NOT JUST THAT DEVICE IS WITHIN TOLERANCE)

SLIDE #11

NEW DEMANDS ON REGULATORS

- COMPREHENSION OF EQUITY EVALUATION & ASSESSMENT IN PLACE OF DEVICE TECHNOLOGY
- DETERMINE EQUITY RATIO (ER) OF A DEVICE.
- SET STANDARDS FOR IN-USE PROCESS CONTROL EQUITY.

SLIDE #12

TRAIN REGULATORS FOR NEW DEMANDS

- REQUIRE COMPETENCE IN BASIC MATH.
- UNDERSTAND RANDOM ERROR THEORY
- UNDERSTAND STEP TOLERANCE AND INITIAL/SUBSEQUENT VERIFICATION CALCULATIONS

SLIDE #13

TRAINING PROBLEM TODAY IS OF MANY PARTS.

ONE OF THE BIGGEST: HOW DO YOU READ/UNDERSTAND (i.e. "INTERPRET") H-44 PROVISIONS.

SLIDE #14

TRAINING TOMORROW CAN BE SIMPLER, EASIER, MORE PRODUCTIVE IF THE NEED IS OBLITERATED FOR CONSTANT REPETITIVE, "INTERPRETATIONS" OF MANY OF THE REGULATORY PROVISIONS.

SLIDE # 15

- THEN THE REGULATOR CAN REGULATE FROM A CLEAR UNDERSTANDING OF THE RULES.

- THEN EQUITY FOR BUYER/SELLER USER/OWNER WILL HAVE A FIGHTING CHANCE.

SLIDE #16

TRAINING OPPORTUNITIES 1981-1990

MAKE AVAILABLE TO ALL FIELD & ADMINISTRATIVE OFFICIALS:

1. MANUFACTURER'S OPERATING MANUALS (WHAT'S IT SUPPOSED TO DO?) -CANADA
2. EXPAND USE OF SMALL REGIONAL A & M SEMINARS (2-3 STATES) "BICYCLE" AUDIO/VISUAL MATERIAL (BASIC PRINCIPLES, DEVICE OPERATIONS.)
3. MFR/W & M/OWM CONSORTIUM TO DEVELOP STANDARD, EASILY-REVISED A/V MATERIALS FOR BROADCAST.
   - PBS-TV
   - SATELLITE TO SPECIFIC LOCATIONS
   - CLOSED CIRCUIT FOR GROUPS

SLIDE # 17

THE 2-3 STATE SEMINARS AND BROADCAST ARRANGEMENTS SHOULD BE ON A REGULAR TIMED BASIS WITH JURISDICTIONAL ATTENDANCE REQUIRED.

SLIDE #18

END RESULT TO SEEK:
- REGULATORS MORE KNOWLEDGEABLE OF REGULATIONS, OF EQUIPMENT
- REGULATORS BECOME ENFORCERS OF PROCESS CONTROL
- REGULATORS CAN BE MEASURED AGAINST UNIFORM STANDARDS (EDUCATIONAL REQUIREMENTS) TO HELP INSURE CERTIFIED COMPETENCY

Workshop C Report:

"The Weighing Industry"

Upon convening, the twenty-three persons in attendance introduced themselves and identified their affiliations. Participants included representatives from the scale industry, State and Federal governments, and Texas A&M University. (Attendance list is attached.)

The first order of business, following interesting and provocative presentations by Richard Hurley and Woody Woodruff, was to decide upon the objectives of the workshop. The objectives are listed in Item 1 of the attached outline.

The second item concerned the identification of clients to enroll in technical courses. Estimates were made of total populations in each client group. (See Item 2.)

Third, we listed the general qualifications for new hires--technicians to attend technical training courses beginning at the "basic" level. (See Item 3.)

Fourth, the courses were identified that were deemed appropriate for scale industry personnel. (See Item 4.)

Fifth, we listed Prerequisites, Basic, Intermediate, and Advanced training needs. (See Item 5.)

Sixth, the question of location for technical training was discussed and the alternatives are set forth in Item 6.

The seventh question concerned the faculty resource for technical training. (See Item 7.)

Finally, two fundamental questions were asked:

"Will you support technical training?"

"If so, to what extent in time and money?"

Answers to the above reflected full support of technical training programs by the scale industry. The answers to the question of time and cost, however, reflected concern by individual companies of the cost/benefit of technical training.

The group concluded that 5-10 days annually was a feasible term for formal training of weighing industry personnel.

The workshop participants expressed their appreciation to the Texas A&M University, Dr. Fite, and Ms. Brown for their friendly assistance in assuring success of the workshop.

Weighing Industry

Workshop Report
Outline

1. Objectives

   Identify the need for Technical Training
   Identify the Clients for Training Courses
   Identify the Qualifications for Participants
   Identify the Training Courses
   Identify the Training Institutions
   Identify the Training Faculty

2. Population--Who and how many.

   Scale technicians: 15-20,000
   Salesmen: 5-10,000
   Development and Systems Engineers: 500-5,000
   Users: 1,000,000 or more

3. Qualifications of participants.

   Mechanically inclined
   Mature
   High School and/or technical school education
   In good health

4. Courses of Study

   A. Mechanics/Physics
      1. Principles of levers (classes, multiples, design)
      2. Force
      3. Dials and beams
      4. Devices: installation and maintenance
      5. Friction and lubrication (damping means)
      6. Laboratory practice
      7. Mechanical scale elements
      8. Suspension system
      9. Schematics
      10. Terminology

   B. Electronics and Microprocessor Technology

      1. Analog technology
      2. Digital technology
      3. A/D Conversion
      4. Output (serial and parallel)
      5. Test instruments
      6. Load cells (includes single and multiple applications)

7. Schematics
8. Power supply/lines
9. RFI/EMI
10. Devices: Installation and maintenance
11. Grounding Systems
12. Terminology
13. Relay logic systems
14. Programmable controller

C. Laws and Regulations

1. State laws and regulations (W/M, safety, building codes, EPA, etc.)
2. NCWM/NBS Handbooks
   a) H-44
   b) H-112
   c) Registration of Servicepersons
   d) H-130
   e) H-105-1
   f) ASTM
3. Terminology

D. Inspection and Test Procedures

1. NBS H-112 (Updated annually)
2. FGIS/CA/NBS exam procedures
3. USDA-P&S Procedures
4. AREA procedures
5. Terminology

E. Measurement Units/Measurement Systems/Terminology

1. NBS H-44 Fundamental considerations
2. NBS H-44 Units/Systems
3. SMA Terms and Definitions
4. U.S. Customary Systems (Avoir, Apoth, Troy, etc.)
5. Metric system
6. Conversions

F. Computer Terminology (Basic)

5. Levels of Instruction for A through F above:

Prerequisite	Basic	Intermediate	Advanced
(A) Math, OJT	x	x	---
(B) Basic Electronics	x	x	x
(C) None	x	x	Periodic Update
(D) None	x	x	Periodic Update
(E) None	x	x	---
(F) A&B above	x	---	---

6. Location of Institutions

   Universities
   Industry facilities
   Company facilities

7. Teaching Faculty

   University instructors
   Industry training instructors
   Weights and Measures training instructors

8. Fundamental Questions:

   "Will you support technical training?"
   "If so, to what extent in time and money?"
   "What time (days) can your technician devote to training courses?"

NAME	AFFILIATION
Richard H. Abbott	Texas State Dept of Highways
G. T. Anderson	Electroscale Corp
James R. Bird	NJ Office W/M
Rita Brown	Texas A&M University
Bob Callahan	Fairbanks Weighing Division
L. H. Degrange	MD Dept of Agriculture
Randy Divin	Houston Scale Co
Iris Estes	Estes Scale Co
Lloyd E. Fite	Texas A&M University
Tom Geiler	W/M Hyannis MA
Richard Gray	Aabbott Scales, Inc
Charles W. Harman	Burlington Northern RR
Dick Hurley	Fairbanks Weighing Division
Terry James	Cardinal Mfg Co
Fred Katterheinrich	Hobart Corporation
Tony Ladd	Technical Consultant W/M
Donald C. Leonhardt	Martin-Decker
Warren Rankin	Burlington Northern RR
Tom Stabler	Institute for W/M
O. K. Warnlof	NBS/OWM
Thomas J. White	Federal Grain Inspection Service
Woody Woodruff	Nicol Scales Inc
Harley Yerkes	PA Scale Co

Workshop D: The Measuring Indsutry

Moderator:
Walter F. Gerdom (*Manager, Technical Services, Tokheim Corporation*)

Observers:
Cyrol Smith (*Electronics Training Division, Texas Engineering Extension Service*)

Stephen Hasko (*Manager, Liquid Measurement Program, Office of Weights and Measures, NBS*)

Coordinator:
Ellen Pendergrass (*Omega Phi Alpha, Texas A & M University*)

Workshop D Report:
"The Measuring Industry"

The consensus of opinion in the Measuring Industry Workshop was that additional training is needed in all areas of measurement. Much of the training now being accomplished by individual companies through in-house training could be done by having a source to establish basic courses such as hydraulics, electricity, electronics, metering, etc. The most important subject today would be electronics--both basic and advanced.

Members of our group indicated cooperation in working toward supplying information on their products which could be organized and used as a basis for preparing training manuals.

The group further expressed an interest in cooperating with an established training program on a sampling type basis to determine if the courses offered provide the training desired in their industry.

The primary area of training required is in the area of technicians and servicepersons.

Our group felt that in addition to the subjects listed (Principles of Metering, System Design) Safety should include product safety, device safety, and testing safety, as well as testing procedures. These should all be included in any training course.

Our group felt that 300-400 new servicepersons enter this field each year with basic mechanical aptitude and this number could support a training program.

Industry would lend its support to assisting in the preparation of manuals; textbooks are available in very limited numbers.

The financial support would depend upon the courses offered and, as stated above, would also depend upon the results obtained. All courses should be "hands on" type, of 3 day duration, with cost to be approximately $500.00 plus travel expenses.

Certification was not considered acceptable.

The workshop group attempted to answer questions posed as follows:

1. What are the career opportunities in your field?
   Technicians need--most important
   Engineers need
   Managers evolve from engineers, sales, etc.
   Sales best evolve from engineers & technicians plus personality
   Other (Specify) servicepersons--accountants--lack of technicians can be attributed to farming out of work load. Biggest need is electronics technicians.

2. In each of the above career fields, how many new employees are recruited annually? 300-400

3. Where are such qualified people found? Principal source--other service areas. Formal education at university and other technical trade schools.

4. Does the career program in your field have definite, identifiable steps? If not, should there be such a definition of the career program? not generally, but should

5. What is minimum level of formal education required? In what field?
   BS--Engineering
   Associate or 4 year college or trade school--technicians
   Either or both for sales or managers

6. What minimum experience is required? In what skill areas?
   all--can do the job

7. In terms of specific subjects such as: (see key on next page)

Fundamentals

da Basic Math
a Advanced Math
a Base and Derived Units
b Basic Metrology
c Statistics, Sampling
c Quality Assurance
a Metric/SI System
Other Mechanical Aptitude, a-Theory of Testing

Inspection

a Basics, Accuracy, Precision
a Specifications, Codes
a Requirements
a Devices
Commodities
c Variable Frequency
Other

Laws and Regulations

Equity
Uniformity
Fraud
a Enforcement
a Prosecution
Other

Organization

Goals, Objectives
Program Evaluation (justification)
Budgeting, Financial Management
c Records
Other

Technical

b Mass and Density
a Volume and capacity
Length, Angle, Form
a Electrical Concepts
a Mechanical
a Electronics
Strain Gages/Transducers
a Solid State Components
a Microprocessor Basics
Time and Frequency
a Temperature
a Pressure
Radiation
a Environmental Testing
Automatic Testing
Weighing Devices
a Measuring Devices
a Measuring-Weighing Systems
Other d-Mechanical Aptitude

A

1. Principles of Metering
2. System Design
3. Safety
4. Testing Procedure

B

1. Problem Analysis
2. Mass and Density
3. Basic Metrology

KEY: a) In what subject must a person be competent in order to do the job?
b) What information needs to be known to enhance or support the basic knowledge?
c) What information would be nice to know in support of the basic requirements? statistics--quality assurance
d) What qualifications are required from a prospective employee at the present time?

What training is required to meet these qualifications?

Other than at job entry, at what points or how frequently should there be formal training programs for updating or upgrading?

new technology available--minimum 1 year

8. In terms of type of training programs such as:

a. Internal Training Programs 1,2,3
b. On-the-job Training 1,2,3
c. National Bureau of Standards 2,3
d. Professional Society Short Courses 2,3
e. Books/Magazines, Literature 2,3
f. Professional Society Conferences 2
g. University/colleges 2,3
h. Government Seminars 2
i. Self-study Courses 1,2,3
j. Manufacturer Training 1,2,3
k. Technical schools 2,3
l. Consultants 2

Key for above:

What would be the desired training program for (1) job entry, (2) updating, (3) upgrading?

Can the type of training you are recommending be taken "to the field"? If not, where should it be offered? yes

What qualifications should training specialists have to teach in your area of expertise? Knowledge of equipment and systems; Knowledge of teaching techniques.

Where do your trained people come from? Industry
NBS

Identify training efforts that have not been effective and should not be tried? movie films, video tape

Identify training efforts that have been effective and should be supported? reinstituted? expanded?
in house
on the job
seminars
technology schools
manufacturing schools

9. What type of training materials/aids are needed? a
Are currently available? b

   a. Textbooks a,b
   b. Handoooks a,b
   c. Films b
   d. Slides a,b
   e. Audio - with slides a,b
   f. Equipment-tools a,b
   g. Devices a,b
   h. Other

10. If, in the next eighteen months, a course (or courses) were offered in the area(s) of your need(s), how many people would your organization send? unanswerable at this time

    During the past two years, what courses have you (or people in your organization) attended (by type, duration, cost)? seminars

    What length of a training course would your organization support?

    None?
    One day?
    Two days?
    Three days? $500.00
    Up to one week?
    Two weeks?
    Up to one month?
    One semester?
    Night school?
    One academic year?

    At what cost level would your organization underwrite training course(s) answered in the affirmative above? (tuition, materials, travel). $500.00 plus travel expenses

11. Is certification of competence really desired by the profession? no. Is such certification now required? no. If it is presently required, who does the certification? If it is not presently required, but desired, who should be the certifying authority.

WORKSHOP E: THE FOOD PROCESSING AND PACKAGING INDUSTRY

Moderator:
Chip Kloos (*Section Head, Research and Development, Hunt-Wesson Foods, Inc.*)

Speaker:
Edward E. Wolski (*Manager, Quality Control, Colgate-Palmolive Company*)

Observers:
Harold Lawton (*Electronics Training Division, Texas Engineering Extension Service*)
Carroll Brickenkamp (*Manager, Research and Development, Office of Weights and Measures, NBS*)

Coordinator:
Mary Slaby (*Omega Phi Alpha, Texas A&M University*)

Workshop E Report:

"The Food Processing and Packaging Industry"

The participants in this workshop were:

Carroll Brickenkamp (NBS)	Kathy Weber (Coors)
Chip Kloos (Hunt-Wesson)	Tony Ladd (Pkg & Weighing Systems)
Ed Wolski (Colgate Palmolive)	Bob Peterson (ANMC)
Jim Bird (State of New Jersey)	Mary Slaby (TEEX)
Joe Bow (Single Service Institute)	Harold E. Lanton (TEEX)

The group, using the questionnaire outline provided to all participants, discussed needs and attempted to answer the questions by annotating the questionnaire as follows:

1. What are the career opportunities in your field?

Technicians - quality and quantity requiring skilled training --

Hunt-Wesson: 400; we are 5% of food industry--8000 in U.S.
Colgate: 150 in soap & detergents alone
Bow: 1,000 in paper/container industry
ASQC: has 20,000 managers in QC--this gives you an idea of the number of people involved.

Engineers - chemical, electrical, mechanical, packaging, QC same number -- (C/P even more because we hire engineers mainly)

Managers - Quality Assurance, plant manager, all levels
C/P -- promoted from within

Sales - the training in measurement intensive areas for sales is novel but not necessary

2. Where are such qualified people found?
Many times from other companies rather than from schools.

3. Would industry ever pay attention to a certification program?
Yes--in data processing, QC, etc. But "just another short course"; No, this would have no weight in hiring, etc.

4. Does the career program in your field have definite steps? If not, should there be such a definition of the career program?

Professional promotion based on 1) promotability, 2) availability of opening. Technician promotion based on ability (promotability)

5. What is minimum level of formal education required? In what field?

Technicians: High school diploma or equivalent
Professional: college degree except for computer programmers.

6. What minimum experience is required? In what skill areas?

Technician: little to none - 5-10 years to progress
Levels of non-managerial/non-supervisory (4 years to progress) vs. managerial/supervisory (10-15 years to progress)
In some companies, it is management's prerogative.

7. In terms of specific subjects as follows, what is level of need?

Key:
1--must have
2--needs
3--nice (but drop for now)

	Tech.	Engr.	Mgr.
Fundamentals			
Basic Math	1	1	1
Advanced Math (calculus, algebra)	2,3	1	2
Base and Derived Units	3,2	1	1,2
Basic Metrology (how to measure)	1	1	3
Statistics, Sampling	3	2*	2*
Quality Assurance (philosophy & oversights of QC)	3	3,2	1
Metric/SI System	3	1	3
Inspection (managing or doing)			
Basics, Accuracy, Precision	1,2	1	1
Specifications, Codes	3,2	1	1
Requirements	3,2	1	1
Devices	2	1	3
Product	2	1	3
Variable Frequency	3	1	1
Laws and Regulations			
Equity	3	2	1
Uniformity	3	2	1
Fraud	3	2	1
Enforcement	3	2	1
Prosecution	3	2	1

*In some areas this is a "1"

	Tech.	Engr.	Mgr.
Organization			
Goals, Objectives	3	2	1
Program Evaluation (justification)	3	2	1
Budgeting, Financial Management	3	2	1
Records	3	2	1
Technical -- Weber	2	1	2.5
Ladd	2	1	3
Wolski	3	1	1
Bow	3	1	2
Kloos	2	1	2
Lanton	2	1	3
Slaby	2	1	2

8. In terms of type of training programs, what would be the desired length (days) of a formal training program for:
(1) job entry (2) updating (3) upgrading?

		(1)	(2)	(3)
a.	Internal Training Programs	0	1/2	1
b.	On-the-job Training	5	1	1
c.	What NBS presently provides	0	0	0
d.	Professional Soc. Short Courses	0	2	2
e.	Books/Magazines, Literature	0	0	0
f.	Professional Soc. Conferences	0	2	2
g.	University/Colleges	0	3	5
h.	Government Seminars	0	1	0
i.	Self-study Courses	0	2	6
j.	Manufacturer Training--function of complexity of device or system			
k.	Technical schools/vocational/ manual	0	0	0
l.	By consultants	0	1/2	1

What qualifications should training specialists have to teach in your area of expertise?

Recognized; state-of-art; able to teach; experience in area being taught.

Where do your trained people come from?
Schools; other industries; within own company; government.

Identify training efforts that have not been effective and should not be tried?
Too much too fast -- shouldn't be too.much theory, or general purpose; must be hands-on, specific. Shouldn't exceed needs of job or capability of students.

Identify training efforts that have been effective and should be supported? reinstituted? expanded?
100% job related -- hands on -- finite answer to problems -- include a pleasant atmosphere -- effective visual aids

9. What type of training materials/aids are needed? Are currently available?
Depending on what you're going to do, they're all needed.

a. Textbooks -- to meas. practitioners, limited need
b. Handbooks -- most needed, are available
c. Films -- poor, not as useful to industry workers.
d. Slides
e. Audio-video
f. Equipment--tools
g. Devices
h. Other

10. If, in the next eighteen months, a course (or courses) were offered in the area(s) of your need(s), how many people would your organization send?

If it applies to my people and it were available where I needed it,
C/P -- 3 people from 4 diff. places = 12
H/W -- same + 1 or 2 from corporate level
3,000 measurement related associations -- 1 apiece.

During the past two years, what courses have you (or people in your organization) attended (by type, duration, cost)?

Not sent across country--
1 to 2 people per year per plant -- QC-like course.
C/P week duration, $1,500 total costs apiece
H/W week $500 apiece

What length of a training course would your organization support?
Up to one week.

At what cost level would your organization underwrite training course(s) answered in the affirmative above? (tuition, materials, travel).
$500-$1,500 total costs

11. Is certification of competence really desired by the profession? For student, yes.

Is such certification now required? No.

If it is presently required, who does the certfication? If it is not presently required, but desired, who should be the certifying authority? NCWM.

Lloyd Fite

The individual workshop reports have been studied and summarized to identify the training needs from the following five areas:

Government Regulatory Officials
Measurement Laboratories
The Weighing Industry
The Measuring Industry
The Food Processing and Packaging Industry

The five workshops identified their specific training requirements which have been consolidated into the Training Matrix for Measurement Practitioners as illustrated in Table I. A topic outline is provided in Table II which identifies the courses to meet the training requirements identified at the Conference. It is proposed that each course be a complete training module with student reference material and training aids to provide hands-on experience. It is the consensus of the workshops that hands-on experience is a must for the training to be successful. The modular courses must be designed and developed such that the training can be conducted in any region of the United States and provide maximum laboratory and measurement experience to the participants. The length of each module will depend upon the technical nature of the material.

The modular concept of the training program will allow for the selection of individual courses or groups of courses depending upon the requirements of the student and his employer. This flexibility is required as the training requirements vary not only between regulatory officials and industry, but also between industries and between individual students.

In-Plant training programs are currently used by most industries attending the conference. Government Regulatory Officials utilize manufacturer schools in an attempt to stay abreast with technological changes and participate in the training programs provided by the National Bureau of Standards. Measurement Laboratory personnel attend the NBS Basic and Intermediate Laboratory Metrology Seminars on a routine basis.

The number of potential students requiring training were identified as follows:

Government Regulatory Officials - 3,000 plus 300/year
Measurement Laboratories - 1,000 to 1,200
The Weighing Industry - 15,000 to 20,000
The Measuring Industry - 300 to 400/year
The Food Processing & Packaging Industry - 1,500 to 2,000

The certification of technicians and industrial personnel is not considered acceptable although representatives from The Food Processing and Packaging Industry felt that Certification of Quality Control personnel would be acceptable. The Regulatory Officials indicated that certification of Field Inspectors was desired but not required.

The following key points for Measurement Practitioners in Metrology were identified:

1. Severe need for Industrial Service Technicians and short course update of present Technicians.

2. Industry obtains Technicians from other companies and the military.

3. Approximately 15% of new Field Inspectors are obtained from industry.

4. Educational requirements for Service Technicians is High School and/or Technical School Graduates.

5. Educational requirements for Field Inspectors is High School or College Graduates, depending upon State laws, etc.

6. Educational requirements for Engineers is a College Degree.

7. Supervisors and Managers are promoted from Technician and Engineering positions within the organization.

It is the consensus of the workshops that formal training would be of benefit to all new employees. In addition, short courses should be conducted as technology changes with a minimum of one course per year to keep personnel abreast of technical developments.

The workshop reports suggest short courses varying from 1 to 5 days (2 weeks maximum) at a suggested cost of $650 per student plus travel for a 5-day training program.

The next step in developing the curriculum for Measurement Practitioners will be the preparation of a course syllabus for each training module. The course syllabus will identify the objectives of the module, course length, prerequisites, topics to be covered, including related hands-on experience, and associated cost for the module. With a well defined course syllabus, student reference material and laboratory experiments can be written and training aids developed to provide meaningful measurement experience.

TABLE I

TRAINING MATRIX FOR MEASUREMENT PRACTITIONERS

TOPICS	REGULATORY OFFICIALS			INDUSTRY	
	TRAINEE	INSPECTOR	SUPERVISOR	MAINTENANCE	REPAIR
Metrology	Basic	Basic Intermediate	Basic Intermediate Advanced	Basic	Basic
Laws and Regulations	Basic	Basic Intermediate Advanced	Basic Intermediate Advanced	Basic Update	Basic Update
Organization	Basic	Basic Intermediate	Basic Intermediate Advanced	Basic	Basic
Units and Systems	Basic	Basic	Basic	Basic Update	Basic Update
Inspection and Test Procedures	Basic Intermediate	Basic Intermediate Advanced	Basic Intermediate Advanced	Basic Update	Basic Update
Applications of Devices	Basic	Basic	Basic	Basic Intermediate	Basic Intermediate Advanced
Statistics and Sampling	Basic	Basic Intermediate	Basic Intermediate	Basic	Basic
Mechanical	Basic	Basic	Basic	Basic Intermediate	Basic Intermediate Advanced
Physical Measurements	Basic	Basic Intermediate	Basic Intermediate	Basic	Basic Intermediate
Electronics	Basic	Basic Intermediate	Basic Intermediate	Basic Intermediate	Basic Intermediate Advanced
Electrical Measurements	Basic	Basic Intermediate	Basic Intermediate	Basic Intermediate	Basic Intermediate Advanced
Computer Terminology	Basic	Basic	Basic	Basic	Basic Intermediate

TABLE II
TOPIC OUTLINE

for

Measurement Practitioners

METROLOGY
- History of Measurements
- Basic Metrology
- Masic Math
- Basic and Derived Units
- Quality Assurance
- Traceability

LAWS AND REGULATIONS
- Equity
- Uniformity
- Fraud
- Enforcement
- Prosecution
- History

ORGANIZATION
- Goals and Objectives
- Program Evaluation
- Records
- Financial Management
- Supervisory Skills Development

MEASUREMENT UNITS AND SYSTEMS
- Metric/SI System
- NBS H-44 Unit/Systems
- SMA Terms and Definitions
- Conversions
- U.S. Customary Systems (Avoir, Apoth, Troy, etc.)
- Measurement Assurance

INSPECTION AND TEST PROCEDURES
- Theory of Testing
- NCWM/NBS Handbooks
- Terminology
- Specifications and Codes
- Requirements
- Care of Standards
- Precision and Accuracy
- Standard Test Procedures
- Area Test Procedures
- Environmental Testing
- Automatic Calibration and Test Procedures

APPLICATIONS OF DEVICES

- Survey of Existing and New Electronic Weighing Devices
- Survey of Existing and New Electronic Measuring Devices
- Study of Existing and New Measuring-Weighing Systems
- Programmable Controllers
- Maintenance of Devices
- Device Safety

STATISTICS AND SAMPLING

- Basic Statistical Analysis
- Sampling Techniques and Procedures
- Systematic and Random Errors

MECHANICAL

- Principles of Levers
- Friction and Lubrication
- Dials and Beams
- Length, Angle, and Form
- Suspension System
- Terminology
- Elements of Mechanical Measuring Devices
- Device Safety

PHYSICAL MEASUREMENTS

- Mass and Density
- Volume and Capacity
- Force
- Pressure
- Temperature
- Radiation
- Optics
- Vacuum
- Flow
- Strain Gages and Transducers
- Vibration and Acceleration
- Acoustics and Sound
- Safety

ELECTRONICS

- Analog Technology
    - D.C. Circuits
    - A.C. Circuits
- Digital Technology
    - Numbering Systems
    - Digital Circuits
- Solid State Circuits and Applications
- Analog-to-Digital Conversion
- Use of Null Detectors
- Test Equipment
- Load Cells

- Time and Frequency
- RF and Microwave
- Electrical Standards
- Calibration Techniques and Procedures
- Interference Busing
- Ground Loops
- Relay Logic Systems
- Schematics
- Troubleshooting Procedures and Techniques
- Electrical Safety

ELECTRICAL MEASUREMENTS

- Instrument Noise
- Ground Loops
- Installation and Maintenance of Devices
- Terminology
- Analog Control Loops
- Digital Control Loops
- Device Safety

COMPUTER TERMINOLOGY

- Input/Output Characteristics
  - Serial
  - Parallel
- Microprocessor Based Systems
- Automatic Control Systems
- Terminology

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Appendix B

The Texas Engineering Extension Service

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The Texas Engineering Extension Service

The Texas A&M University System has provided job-related training on an extension basis for more than half a century. By 1948, these activities had reached such proportions that the Texas Engineering Extension Service was established to carry out statewide extension responsibilities of the land-grant institution of Texas.

Training programs are conducted for public service employees; for employees in business, industry, and engineering-related fields; and for teachers of vocational subjects. Over 50,000 persons attended the 2,100 classes conducted during the past year by the training divisions of the Texas Engineering Extension Service.

In addition to providing vocational training, the Texas Engineering Extension Service disseminates information on public works, fire protection, teacher training, energy conservation, and electric power utilities.

Headquartered on the campus of Texas A&M University in College Station, the Texas Engineering Extension Service accommodates the training needs of the citizens of Texas through a network of regional training centers located at Arlington, Floydada, Corpus Christi, and San Antonio.

The concept of taking its programs to the people rather than bringing the people to the programs is an integral part of the Texas Engineering Extension Service philosophy.

The largest of the training divisions is the Fire Protection Training Division--dedicated to training firefighters in all aspects of fire prevention and control. With courses ranging from basic, entry level training for recruit firefighters to specialized courses in liquefied natural gas fire control and safety, the Fire Protection Training Division is recognized worldwide for its unique training programs and facilities. On-campus courses are conducted year round at Brayton Firemen Training Field, a 60-acre facility adjacent to the Texas A&M University campus.

The Oil and Hazardous Material Control Training Division was established to train industry and government personnel in the prevention and control of oil and hazardous material incidents. The 40-hour

Oil Spill Control Course is a major function of the division. Classroom instruction is combined with field exercises to provide an optimum balance of technical information and practical application.

Courses offered by the Building Codes Inspection Training Division are designed to encourage and train people in the code inspection field. Students are familiarized with the development, administration, application, and enforcement of codes.

Area extension courses cover new methods of effective code enforcement and techniques of field inspection and management.

The Law Enforcement and Security Training Division provides certification training for basic law enforcement, private security, and polygraph licensing. In addition, courses in traffic law enforcement, advanced accident investigation, and intermediate and advanced law enforcement are offered.

The Public Works Training Division provides city, county, and State public works personnel with training designed to shorten the time period between the development and the implementation of public works technology.

Sanitation, street and roadway construction, engineering, transportation, and energy conservation are key training subjects. The division's Technology Resource Center serves as a focal point for the dissemination of information to cities and State agencies regarding public works technology.

The Water and Wastewater Training Division provides certification training courses which are required for water and wastewater operators employed by municipalities, privately owned utilities, and rural water supply corporations. Advanced courses supplement the basic training programs. The division's training facilities in Bryan include a modern laboratory for the complete bacteriological and chemical analysis of water and wastewater.

Persons employed in the heavy construction equipment industry receive training from the Construction Equipment Training Division. The division's specially designed facility at the Texas A&M University Research and Extension Center at Bryan enables students to perform full-scale construction operations and exercises on a 50-acre training field.

A Heavy Equipment Operator Program provides basic courses in four equipment areas: crawler tractors, motor graders, motor scrapers, and draglines.

The Equipment Maintenance and Safety Program includes a study of equipment mechanisms which require specific maintenance care as well as safety techniques of maintenance.

The Electric Power Utilities Training Division provides onsite training in the construction, maintenance, and operation of modern power distribution and transmission systems.

Short schools held at the division's headquarters in Bryan utilize indoor and outdoor laboratories, classrooms, and facilities built to operational specifications.

The Electronics Training Division conducts the Institute of Electronic Science, an 18-month preemployment training program designed to develop high-level electronic technicians for industry.

Short courses which have been developed for industry include Industrial Motor Controls, Basic Electronics, Industrial Soldering Techniques, Oscilloscope Measurements, Electronic Motor Controls, Transistor Circuits and Applications, Digital Electronics, Linear Integrated Circuits, Troubleshooting Electronic Circuitry, and Microprocessor Control Technology.

Supervisory and management personnel learn effective supervision and management through courses offered by the Supervisory Training Division. Effective communication, improved job methods, supervisory problems, and employee safety are among the topics included in the basic training program. Courses for middle and top management include financial management, personnel selection and appraisal, and time management.

The Telecommunications Training Division provides basic training for individuals newly employed in the telephone industry and advanced training for more experienced personnel.

Courses are divided into two broad areas: outside plant operations (which include telephone line installation and repair) and inside plant operations (which cover switching equipment installation and maintenance). Courses conducted regularly include station installation, basic electricity, cable splicing, cable pressurization, key systems, fault location, test boards, and logic fundamentals.

The Special Programs Training Division was established to meet specific training needs which are not covered through programs of the other training divisions. Training is offered for women in construction crafts and highway construction and for persons involved in food management. Career and personal growth seminars are conducted for persons interested in developing their lifelong goals. Other areas of interest and of program development include the coordination of vocational training for trade and professional organizations, counseling, and job training for handicapped persons.

The Vocational Industrial Teacher Education Division provides supplemental training for teachers and coordinators in vocational fields of study. Courses are available for teachers at the secondary, post secondary, and adult levels.

The program for secondary educators includes an orientation course and six college level, credit courses.

The adult level program is tailored to meet the needs of instructors of apprentices, trade extension instructors, and instructors in industrial training departments. The post secondary program provides certification training for teachers and coordinators of health occupations programs.

The San Antonio Training Division offers skills training in six subject areas--auto mechanics, business technology, refrigeration and air conditioning, production machine operation, radio-television repair, and combination welding.

The International Training Division provides general support and coordination within the Texas Engineering Extension Service for the training of international students. Support ranges from intensive, nontraditional English to completion of training programs. The division provides cultural and social activities designed to ensure a comfortable transition into American society.

Recognizing the need for information concerning energy technology, the Energy Technical Assistance Division has been implemented to assist public institutions, business, and industry in effectively and efficiently utilizing energy resources.

The Energy Technical Assistance Division provides direct assistance through workshops, energy audits, responses to requests for assistance, newsletters, and energy management programs.

By riding the crest of changing technology and staying attuned to the needs of those it serves, the Texas Engineering Extension Service continues to fulfill its responsibility of providing occupational and technical training.

The measurement technology program will be developed and instruction conducted by the Electronics Training Division.

The Electronics Training Division provides Basic, Advanced, and Specialized Training for employment and advancement opportunities in the field of electronics. Basic and Advanced Training is provided in the Electronic Technology Training Program including Microprocessors and Minicomputers through the Institute of Electronic Science.

The Electronic Technology Program is a non-degreed, non-accredited program which emphasizes practical hands-on experience. This unique training program was started in 1963 and the objective of the program is to provide basic and advanced training to meet the industrial requirements for non-degreed electronic technicians. This objective is accomplished through an optimum blending of classroom and hands-on experience. The students receive 30 hours of instruction per week for 18-months. The program is divided into three (3) six month terms and each term consists of twenty-two (22) weeks. All instruction is directly related to the subject of electronics, and approximately sixty (60) percent of the total training is devoted to hands-on laboratory experience. The curriculum, textbooks, and laboratory experiments are revised as required to stay abreast with the state-of-the-art.

The graduates of this program receive 1980 hours of supervised classroom and laboratory instruction. The continuing demand for these graduates is a result of the high level of instruction and practical experience that the students receive at the Institute of Electronic Science. More than 580 electronic technicians have graduated from this program over the past 17 years.

Specialized Training is provided to meet the requirements of individuals employed by industry. These training programs are designed to upgrade the skills and efficiency of employed personnel through the use of hands-on laboratory experiments, demonstrations, and lecture material. These comprehensive programs are composed of instruction in electronic fundamentals, troubleshooting, and repair of electronic equipment and systems with emphasis placed on proper troubleshooting procedures and techniques.

The Electronics Training Division is experienced in developing specialized Training Programs for Industry. For example, the Marine Electronic Technology Program was developed for the Maritime Industry and is designed to teach the student the latest state-of-the-art troubleshooting techniques and procedures for electronic equipment similar to that found on their vessels. In this way, the student can apply the principles and techniques gained through this training program to practical applications aboard his vessel.

The Marine Electronic Technology Training Program is divided into three sections:

1. Basic Electronics - 4 Weeks
2. Correspondence Lessons - 20 Lessons
3. Advanced Electronics - 6 Weeks

The four-week course in Basic Electronics is designed to provide the student with a comprehensive review of basic electronic circuits and to discuss in detail the latest solid-state and integrated circuit techniques. The laboratory experiments illustrate the theoretical concepts presented in the lecture material and provide hands-on experience with the test equipment required to troubleshoot electronic circuits and systems.

The Correspondence Section of the Marine Electronics Program is designed to investigate and apply the principles learned in the Basic Electronics Section and to prepare the student for the Advanced portion of the training program. Simple Laboratory experiments utilize the supplied test equipment and components to extend the student's confidence and experience and to demonstrate the ideas presented in the Twenty Lessons.

The emphasis of the Advanced portion of the program is placed on troubleshooting techniques and procedures. The application of these troubleshooting techniques is discussed and demonstrated on actual equipment similar to the electronic equipment aboard the vessels. During the Advanced Phase, hands-on experience is acquired and the theory of operation is discussed for X and S Band Radar, AM-FM-SSB Communication Equipment, Loran, Lorain, Recording Fathometer, and Anti-Collision Devices.

The success of this program has led to the development of an Electrical Training Program for Marine Engineers and we have been asked to develop a continuation course for the Marine Electronic Technology Program by the Texaco Marine Department.

The Electronics Training Division is headquartered at the University Research and Extension Center at Bryan, Texas and has Regional Training Programs located in San Antonio and Arlington, Texas.

I hope that this quick review tells you something of our expertise and our experience in developing and conducting technical training programs.

On January 12-13, 1981 a Conference on Technical Training for Measurement Practitioners was held at College Station, Texas to determine the training needs for Metrology personnel. The training needs from the following five areas were identified:

Government Regulatory Officials (State & National)
The Measuring Industry
The Weighing Industry
Measurement Laboratories
The Food Processing and Packaging Industry

The objective of this conference was to identify:

The background (experience and education) of the individual attending the training programs;
The must know information for satisfactory job performance;
The should know information for satisfactory job performance;
The expected technical level of the graduate of the program;
The requirements for certification.

Once the common elements of these different areas have been identified, the curriculum for the Measurement Technology Training Programs will be developed. The strength of the proposed training program is that it will be modular in concept; i.e., a series of short courses which may range from a few days to a few weeks in length, and that it would be a national program which could be conducted in any region of the United States. The length of each short course will depend upon the technical nature of the material as well as the background of the students attending the class.

The training program will be designed to be a complete course to obtain the objectives established at the January Conference. The modules may be selected individually or in groups depending upon the requirements of the students and their employers. The course content of each module will be complete in itself and all modules will be related and compatible. This modular concept will allow for the addition of new subject areas as technology changes. To serve a national as well as international audience and because of the special training requirements of different organizations, the programs will be designed to be appropriate for a wide spectrum of technical personnel and others working in Metrology.

There will be uniformity and consistency of the lecture material and of the laboratory experiments. Training aids will be developed and used throughout the courses to provide hands-on experience. A complete set of reference material and workbooks will be retained by the student. Overnight problem assignments will be given and reviewed at the beginning of the following class day to monitor the students progress through the training program. The progression of the training program will utilize the results and experience of previous lessons to cover an extensive amount of material through practical and repetitive use. Therefore, the students continue to gain additional experience, understanding, and confidence with each lesson and experiment.

The emphasis of the training program will be placed on hands-on practical experience. The objective of the training program will be to train measurement personnel and regulatory officials in the state-of-the-art of measurement technology and to emphasize traceability and assurance of measurement practices.

The programs will be structured such that the courses can be presented anywhere in the United States or Foreign Countries. Arrangements for International Training would be administered through the International Training Division of the Texas Engineering Extension Service.

Possible curriculum structures of the Measurement Technology Program may include but are not limited to such areas as:

Weighing and Measuring Technology
Measuring Instruments
Weights and Measures Law
Practical Statistics and Sampling
Principles of Construction, Operation, and Testing
  of Weighing and Measuring Equipment
Enforcement
Packaging and Labeling

or

Metrology Theory - history of measurements, quality assurance
  and traceability
Standards Laboratory Practice - precision, accuracy, statistics,
  and sampling procedures
General Concepts - length, mass, density, volume, and temperature
Electronics - basic electronics, standard cells, low and high
  frequency measurements, digital concepts, optical electronics,
  and microprocessor applications
Transducers - pressure, temperature, flow meters, and strain gages

Because of the amount and complexity of the material, it is anticipated that each class will be limited to 10 to 16 students. Although this will increase the cost of the program, it will provide for maximum student-instructor interaction.

A certificate of completion will be awarded to the students who successfully complete the training program. Satisfactory completion will be determined by the results of the overnight assignments, laboratory experiments and a final examination.

Several Training Programs are in existence or have been proposed for Metrology Personnel. These existing programs in Canada, Great Britain, and West Germany will serve as a guideline and the difficulties and successes of their experience will be considered in the development of the program to be offered by the Texas Engineering Extension Service. The other existing or proposed programs are primarily conducted at only one location or based on the self-study concept. My personal experience with the self-study or correspondence concept has not been satisfactory. The success of the Correspondence Phase of the Marine Electronic

Technology Program results from the fact that the students attend supervised classroom lecture and laboratory classes and that they must complete the Correspondence Lessons to be eligible to return for the Advanced Phase and complete the program. For maximum benefit to the student and his employer, the Texas A&M program will be based on supervised classroom and laboratory instruction.

How to stay abreast of changes in technology is a constant challenge. Additional short courses would be developed as technical advances dictate to meet this challenge. For example, if a Measurement Technology program were in existence today, short courses in Laser Technology (grocery store checkout) and microprocessor controlled gasoline pumps would be developed.

The development of course material, reference material to be retained by the students, and training aids to provide hands-on experience is very expensive. The Federal Government has seen fit to consider the development of the Training Program on a one time basis. The training would be on a fee basis or contract basis for industry. The registration fee will be based on the expenses associated with the training program as well as with future course development to maintain a current program as Technology changes.

The January Conference at College Station was to give the attendees and others involved in Measurement Technology an opportunity to identify their training needs, the background of the personnel attending the short courses, and the establishment of the end product. Without this information, the curriculum for the Measurement Technology Courses may not satisfy their requirements for training nor increase the practical skills and knowledge of their personnel.

Appendix C

Workshop Guide

Appendix C

Workshop Guide

The objective of the conference is to outline a training program that would (1) prepare a person for a career, (2) update a person who has fallen behind in technological developments, or (3) upgrade a person from one job level to a higher level. Five career "areas" have been identified:

Government Regulatory
Measuring Laboratories
The Weighing Industry
The Measuring Industry
The Food Processing and Packaging Industry

Each of the five workshops was asked to identify the training needs which should be established for the career area represented by that workshop. Each workshop group was asked to concentrate on recording answers to the following questions for each category noted above:

1. What are the career opportunities in your field for:

   Technicians;
   Engineers;
   Managers;
   Sales; or
   Other.

2. In each of the above career fields, how many new employees are recruited annually?

3. Where are such qualified people found?

4. Does the career program in your field have definite, identifiable steps? If not, should there be such a definition of the career program?

5. What is the minimum level of formal education required? In what field?

6. What minimum experience is required? In what skill areas?

7. What are specific subjects required? Of the subjects identified (a through e below), address the following questions:

   In what subjects <u>must</u> a person be competent in order to do the job?

   What information <u>needs</u> to be known to enhance or support the basic knowledge?

   What information would be <u>nice</u> to know in support of the basic requirements?

   What qualifications are required from a prospective employee at the present time?

   What training is required to meet these qualifications?

   Other than at job entry, at what points or how frequently should there be formal training programs for updating or upgrading?

   a. Fundamentals

      Basic Math
      Advanced Math
      Base and Derived Units
      Basic Metrology
      Statistics, Sampling
      Quality Assurance
      Metric/SI System
      Other

   b. Inspection

      Basics, Accuracy, Precision
      Specifications, Codes
      Requirements
      Devices
      Commodities
      Variable Frequency
      Other

   c. Laws and Regulations

      Equity
      Uniformity
      Fraud
      Enforcement
      Prosecution
      Other

d. Organization

Goals, Objectives
Program Evaluation (justification)
Budgeting, Financial Management
Records
Other

e. Technical

Mass and Density
Volume and Capacity
Length, Angle, Form
Electrical Concepts
Mechanical
Electronics
Strain Gages/Transducers
Solid State Components
Microprocessor Basics
Time and Frequency
Temperature
Pressure
Radiation
Environmental Testing
Automatic Testing
Weighing Devices
Measuring Devices
Measuring-Weighing Systems
Other

8. In terms of type of training programs such as:

a. Internal Training Programs
b. On-the-job Training
c. National Bureau of Standards
d. Professional Society Short Courses
e. Books/Magazines, Literature
f. Professional Society Conferences
g. University/Colleges
h. Government Seminars
i. Self-study Courses
j. Manufacturer Training
k. Technical Schools
l. Consultants

What would be the desired length of a formal training program for (1) job entry, (2) updating, (3) upgrading?

9. Can the type of training you are recommending be taken "to the field"? If not, where should it be offered?

10. What qualifications should training specialists have to teach in your area of expertise?

11. Where do your trained people come from?

12. Identify training efforts that have not been effective and should not be tried?

13. Identify training efforts that have been effective and should be supported? reinstituted? expanded?

14. What types of training materials/aids are needed--are currently available?

    a. Textbooks
    b. Handbooks
    c. Films
    d. Slides
    e. Audio-video
    f. Equipment-tools
    g. Devices
    h. Other

15. If, in the next eighteen months, a course (or courses) were offered in the area(s) of your need(s), how many people would your organization send?

16. During the past two years, what courses have you (or people in your organization) attended (by type, duration, cost)?

17. What length of a training course would your organization support?

    None?
    One day?
    Two days?
    Three days?
    Up to one week?
    Two weeks?
    Up to one month?
    One semester?
    Night school?
    One academic year?

18. At what cost level would your organization underwrite training course(s) answered in the affirmative above? (tuition, materials, travel).

19. Is certification of competence really desired by the profession? Is such certification now required? If it is presently required, who does the certification? If it is not presently required, but desired, who should be the certifying authority.

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☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This is a report of the proceedings (edited) of a Symposium sponsored by the Office of Weights and Measures of the National Bureau of Standards and conducted by the Texas Engineering Extension Service on January 12-13, 1981. The central matter discussed was the identification of training needs of Federal, State, and local weights and measures officials and metrologists to perform their jobs in view of the rapid technological developments being realized in the field of metrology.

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