

MEASURING THE IMPACT OF EDUCATION AND TRAINING

Georgia L. Harris
National Institute of Standards and Technology
100 Bureau Drive, MS 2600
Gaithersburg, MD 20899
301-975-4014
gharris@nist.gov

Abstract - As metrologists we are typically subject matter experts (SMEs) in a technical area of measurement. However, most of us are not experts in measuring the value or impact of education and training efforts using standard models for evaluation. This paper will cover background concepts for training evaluation by Kirkpatrick/Phillips and demonstrate how we can incorporate these concepts into our metrology conferences and training sessions to demonstrate learning, application, and the impact of our efforts rather than just to see if people are satisfied with the presentations when they leave a session. Specific case studies from NIST Seminars at MSC will be presented to demonstrate the concepts. (Note: this paper is an expansion of an article published in the NCSLI "Metrologist" called "Did They Learn? Who Cares?" and includes additional Level Four assessments with Case Studies.)

INTRODUCTION

As metrologists, we think we are good (even expert) at measurements. But, our subject matter expertise is most often in the world of science, and not necessarily in the world of education. There are a number of aspects of measuring training that we could consider in a study about measuring the effectiveness of training. What most often comes to mind in training evaluation is the course evaluation. However, instructors need to use assessment methods within the classroom environment to determine if and how well students are learning. Universities need to measure the effectiveness of instructors and course curricula. In the workplace, managers want to invest in courses that make their employees more productive and efficient. In laboratory accreditation according to ISO/IEC 17025, a laboratory must also have a way to measure the effectiveness of training efforts. As you can tell already, training evaluations need to include more than simple course evaluations. With all of these various aspects of measuring effectiveness, where do we start?

"If you cannot measure it, you cannot improve it."

Lord (William Thomson) Kelvin
(1824-1907)

REASONS FOR TRAINING

Why have training at all? Generally, employers who invest in training want to see results. If certain training can improve performance so that an organization can be more effective, sell more products, have a higher quality product, make better measurements, or achieve accreditation more easily, the investment can be justified. Trainers want to be able to demonstrate that they are helping students improve their knowledge, skills, and attitudes (because that is their business and they need to make the case for training!). Students want to be able to demonstrate their value to the organization by implementing new knowledge and skills on the job to contribute to the success of the organization and thus personal success. We all care!

Sometimes, the solution is not training. The real objective (think “root cause” for training) is usually performance improvement; that requires a three-way partnership among the organization, the trainer, and the student. Everyone plays a part in ensuring performance improvements. For example, if the employer doesn’t provide time or opportunities to implement what was learned in a training event, nothing will change and the training was a waste of everyone’s time and money. If the trainer doesn’t provide adequate instruction, learning activities, and opportunities to apply learning during the event, the student may not learn effectively. And if the student is going to class “because my manager said I needed to come to keep my job,” there isn’t a lot of motivation to learn and apply new concepts and skills later. For training to be worthwhile barriers to application of new ideas or good measurement practices must be removed and learning must be reinforced on the job.

As an aside note: improving performance in specific ways is a key reason to have well-written learning objectives. All three parties want to know what the employee will be able to know or do differently after the training event.

In addition to having effective partnerships among all parties, sometimes the performance improvement solution is the removal of a barrier to try new ideas or the use of a simple checklist to follow to apply a complex procedure. Formal training needs analysis is another form of evaluation and assessment that looks at performance improvement options, but is beyond the scope of this article. It’s a topic that we should come back to in the future. For the sake of this paper, let’s say that we’ve determined that a training event is the best solution and all three parties are fully engaged. Now, let’s talk more about assessing learning.

Who cares about training effectiveness?

Organizations who invest in training expect demonstrable performance improvement.

Trainers and training organizations want to be a part of improving student/employee knowledge, skills, and attitudes.

Students want to have essential knowledge that will enable them to be successful on the job.

MEASURING ORGANIZATIONAL PERFORMANCE AND EFFECTIVENESS

Much has been written on measuring training effectiveness by Kirkpatrick,¹ Phillips,² and Clark³. In fact, much of the training assessment literature builds on the works of Kirkpatrick. Both Phillips and Clark suggest modifications of the basic ideas presented by Donald Kirkpatrick in 1959. The bottom-line for these approaches is the ability to measure whether the training makes an impact and if employee performance improves over the longer term. Let’s look at their ideas.

Kirkpatrick’s Four Levels presents a series of evaluation levels as shown in Table 1. The table shows the levels and descriptions of what is to be measured.

Table 1. Kirkpatrick’s Four Levels of Evaluation (0th and 5th Levels added by Phillips)

Level		Considerations
0	Inputs	Organizational measures such as number of courses, number of participants, hours, costs, timing
1	Reaction	Measures how the learners react to the learning process
2	Learning	Assesses the extent to which the learners gain knowledge and skills (usually requires instructor assessments)

¹ See this title by Kirkpatrick in the NCSLI Training Aids Library: Evaluating Training Programs, The Four Levels.

² See these titles by Phillips in the NCSLI Training Aids Library: How to Measure Training Results, A Practical Guide to Tracking the Six Key Indicators; Return on Investment in Training & Performance Improvement; The Bottom Line on ROI.

³ Clark, D. (2008). Flipping Kirkpatrick. bdd.blogspot.com. Dec. 17, 2008. Retrieved from web April 27, 2009: <http://bdd.blogspot.com/2008/12/flipping-kirkpatrick.html> (November 6, 2010).

3	Behavior	Evaluates the capability to perform the learned skills while on the job (requires employer engagement and review)
4	Results	Considers the effects on the business or environment resulting from the learner's performance (assessing the impacts)
5	Return On Investment (ROI)	Calculates the benefit cost ratio and looks at payback periods

Level One

Level one seeks to answer: Did the participant “like the training”? Course evaluations are used at level one and are quick and relatively easy to collect and assess. They are also inexpensive and don’t take a lot of time or energy to evaluate. A good course evaluation will also uncover if there are problems or barriers to learning that need to be improved or corrected (such as poor audio quality, missing handouts). But, level one course evaluations are often called “smile sheets” because they assess whether students were happy when the course ended. Course evaluations are often written from the perspective of the training provider or instructor and may not address what concerns the student may want to address at the end of a training event. Reaction may also tell you how well the training experience (needs analysis, materials, instructor, and environment) met the student expectations.

Level Two

It is important to focus on whether learning objectives were presented and covered and whether the student feels like learning outcomes were achieved during the course (in addition to the administrative questions a provider wants answered). Level two seeks to answer: Did the participant “learn anything”? Assessments such as pre-tests and post-tests are often used to assess this; however a course evaluation can gather information from the participant about whether they were able to demonstrate that they learned new knowledge or skills during the event. Observations should also be used by the instructors to assess whether learning occurred and whether learning objectives were achieved. The instructional design process should consider how to assess whether learning happens during the training event. However, it is more challenging to capture and report on whether learning occurred.

Key questions to ask might be:

- What knowledge was acquired?
- What skills were developed or enhanced?
- What attitudes were changed?

One way to measure this is to make sure the learning objectives, activities, and assessments are aligned and then make sure that the course evaluation asks specific questions about whether objectives were achieved. Documenting the demonstration of skills, compiling test results, and reporting on case studies are all ways that can be used to assess whether learning occurred. Another measure that can be captured at level two is whether the training experience was effective in enabling learning.

Level Three

Level three requires an effective partnership between the employee/trainee and the employer/supervisor because it answers the question: does the participant “use the knowledge/skills/attitude on the job”? It requires observation and interviews over time to assess change, relevance of change, and sustainability of change in on-the-job performance. Sometimes, an employee already knows how to perform certain skills on the job and chooses not to do so. In this case, training is not likely the solution unless there is a component of attitude improvement designed into the learning event – so that the employee now *wants* to perform in a certain way on the job. This kind of measurement of behavior requires cooperation and skill of supervisors. Another output of level three is whether the training experience enables improved performance on the job. Level three helps assess whether the training was effective.

Level Four

Level four evaluations answer questions about: What impact does the training have on “the business result(s)?” One big challenge here is to demonstrate clear correlation between the training and the impact. Business measures need to be in place to assess before and after conditions and is often quite difficult. A key aspect to consider at level four is whether the training experience led to the impact or whether barriers were removed, incentives were provided, or even whether new employees implemented systems that were already in place and not being followed prior to the training. The dynamics of the working environment make it difficult to assess training at the fourth level. Assessments and follow-up surveys often yield results in the qualitative and quantitative realms, and depending on whether managers like to hear stories about impact (qualitative) or see the data and financial impact (quantitative), one can choose to focus next-step efforts. Survey responses shown in the appendices of this paper are primarily qualitative and tell the story about the impact of conferences and tutorials.

Measuring the Impact of Training

“Measuring ROI in the Public Sector” by Jack and Patricia Phillips⁴ provides a number of case studies and a lot of guidance on criteria that should be considered in developing ROI measures. But, what case studies do we have for metrology?

Measuring impact requires follow-up assessments to the organizations and trainees to determine what impact has been made through application of content learned at an event. Impact might include qualitative social, environmental, health and business impacts as well as traditional quantitative economic impacts (Return on Investment). For example, after training and implementation of new ideas/methods a non-profit association can now provide a health/welfare service to meet the needs of a target audience that perhaps it was unable to provide in the past. In simple terms, traditional Return on Investment measures consider the cost of a training program or event and measures the economic benefit to the organization as a result of applying training content. Some specific factors that also may be considered might be outcome related to the following four key (hard data) measures:

- Time: improved time for project completion, improved cycle time, amount of overtime, average response times.
- Output: output per person hour, items assembled, forms processed, units sold, tasks completed.
- Quality: percent of tasks completed properly (satisfying an auditor), lack of deviation from the standards, amount of shortage/waste, accuracy of employee data.
- Costs: operating expenses, fixed cost, unit costs, profit as percent of sales, turnover costs.

Soft data measures might include items such as quantifying customer satisfaction, employee engagement, and brand awareness. While customer satisfaction measures give us opportunities for corrective and improvement actions, as measurement professionals, we usually prefer to focus on hard data measures (as do many, but not all, of our managers).

Case Studies

When an organization is interested in whether their education programs are making a difference, and they want to know the impact of their efforts to share with future participants or even sponsoring management, conducting level three and level four assessments would be good to pursue. As noted earlier, 20 % to 30 % of our evaluations should target level three and level four assessments. Back in 2001, a participant at the annual National Conference of Standards Laboratories, International (NCSLI) Workshop and Symposium approached me with an interesting comment: “you have indicated that NCSLI is a learning/educational association, but none of your evaluation forms are assessing whether anyone has learned anything.” It was a very insightful comment that has since spurred much of my interest in this topic. You will also note that there has been increasing focus on establishing and measuring learning and learning objectives in metrology conferences, tutorials, and training events. So, what have we done and what might we consider for our metrology training efforts?

⁴ Measuring ROI in the Public Sector, Jack J. Phillips, Patricia Pulliam Phillips, ASTD Press, 2002.

Example 1 – NIST Training Efforts at Measurement Science Conference

Highlights from the 2008 Measurement Science Conference are included in Appendix A. The summary information was circulated to the Measurement Science Conference Committee and to National Institute of Standards and Technology (NIST) instructors. The data provided information about overall satisfaction, and self-declared levels of learning and intended applications. The course evaluation form is also included in Appendix A. You can see that the evaluation also gathers data about needs assessments (why conduct extra surveys?!). Overall, we get a lot of information that can be used in After Action Reviews to establish continual improvement efforts within a training program.

Beginning in 2009, NIST conducted several “45-day follow up assessments.” This idea was encountered during a workshop at the American Society for Training and Development (ASTD) workshop in Atlanta, GA in 2008. The course evaluations we use (See Appendix A) ask participants what they will apply in their laboratories after the seminar. The series of 45-day follow-up questions includes a preliminary note about what percentage of students indicated that they planned to apply concepts back in their laboratory.

Here are the questions we asked in 2010 following the NIST Seminars held at MSC:

- Thank you for attending a NIST Seminar at the 2010 Measurement Science Conference. Your responses will be handled anonymously unless you enter your name and contact information on the last question for us to conduct follow-up inquiries. Please select which class you attended: (List of Seminars)
- We asked participants in your class evaluation whether you would apply concepts from the seminar back on the job and asked for specific examples of what you would apply. We regularly hear that over 50 % of the participants in all of the NIST seminars plan to apply something on the job. Have you applied any of the concepts, principles, or procedures to your work? (Yes/No).
- If you have applied something, what did you apply and has there been an impact? Please describe.
- If you have not applied anything, but intended to do so, what were/are the barriers that have prevented your implementation? Please explain.
- Is there is anything else you would like to say? (e.g., if you have a specific story about impact that you would like to share, please provide some insight and information here. If you have specific financial impact or risk/safety impacts, please let us know that too.)
- Do you have any specific measurement training needs you would like to see NIST address in the future? (We include Needs Assessment in the survey, though it's not directly related to measuring impact, it does help address specific training needs in the community.)
- This section is completely optional. If you are willing to participate in follow up telephone or email surveys for us to be able to track and begin to measure "impact" and "return on investments" of NIST Training, please enter your contact information below. Thank you for participating!

So what were the results? Please see Appendix B for the response details. Note, some of the responses were edited for spelling, punctuation, and some minor editing was done.

- Response rate: 45 % (28/62).
- Percent of respondents indicating willingness to participate in follow-up evaluations: 32 % (9/28).
- Percent of respondents indicating that they applied concepts from the course: 82 % (23/28).

We got feedback from the follow-up survey that can be used to make immediate improvements and we obtained direct comments about what was important to students and that they have been able to implement. In fact, future instructors will all make sure printed handouts and/or CD resources are available and some of the NIST seminars were expanded to three-day sessions for 2011. We can see clearly that laboratories are now able to perform at a level that is better than before the seminar (providing better services). However, only one specific example was tied to a financial impact. Even so, that one alone was quite significant. Feedback on this survey has been shared with NIST staff who were involved in the seminars, but the instructors don't currently have an internal system or structure for sharing this information systematically at higher management levels to garner support for additional/expanded training efforts.

Example 2 – NCSLI Follow-Up Surveys

Several years ago, a Conference Visioning Session was coordinated by Terry Conder, the Vice President for Conferences, which resulted in specific Learning Objectives being developed for the Annual Workshop and

Symposium. In 2009, NCSLI held a Learning and Development working session to consider implementation of the International Association for Continuing Education and Training (IACET) standards for issuing continuing education units (CEUs). Conference team members were a part of the IACET working session and conducted post-conference surveys to measure and assess the impact of Conference participation.

NCSLI has been working on standardizing evaluation forms – especially those used for collecting CEU information. Those surveys provide primarily level one and level two assessments, feedback to instructors and coordinators, and again, needs assessment information that is used in subsequent event planning.

Here are the five evaluation statements that were presented. Responses used a 5-scale Likert Scale from Strongly Disagree to Strongly Agree.

1. These learning objectives helped me and my organization get the value for our investment in the 2010 Conference.
2. What were some of the new concepts, ideas or principles that you heard or learned?
3. I did apply these "lessons learned" on my job.
4. I did enlist my supervisor/manager/organization in accomplishing these objectives.
5. The implementation of the objectives and lessons learned did have a positive influence on our organization.

But what did the conference follow-up questions show? Please see Appendix C for detailed responses. Question two focuses on what was learned (e.g., did learning take place?). Given that this survey was conducted after the fact, a positive response with specific examples is more likely than what might have been retained during the conference itself. Questions three and four focus on application. Question five focuses on impact, though is paraphrased as a positive influence. The comments received for all of these questions are more interesting and powerful than the graphs showing the various responses. In fact, the graphs seem inconsistent with the comments provided.

As you can see, NCSLI also got qualitative feedback that we can use to make immediate improvements in the conference, sessions, and design of our training events, including the type and quality of papers and talks that are presented. We also got feedback that can be used to demonstrate intended application and a positive influence on the sponsoring organization. But, as with the first case study, we have limited quantitative data that can be used to demonstrate impact. When we look at the graphs of these five questions (not provided), about 30 % to 38 % of the respondents indicated a response to the question in the Agree or Strongly Agree category. In the neutral category were 14 % to 29 %. Overall, we have some work to do at “metrology conferences” in using learning objectives, setting expectations that information will be applied back on the job, setting up the infrastructure for the sponsoring organization to expect participants to come home with new ideas that can be applied on the job to make a positive influence, and even for the participant to attend with the expectation that he or she will gain new ideas to apply on the job. However, the comments demonstrate that learning is occurring, new ideas are being applied, and our organizations are benefitting.

Modifications and Criticisms

Since Kirkpatrick published his original model in 1959, other authors (e.g., Phillips) have suggested a possible fifth level, such as Return On Investment (ROI). Some authors believe that ROI can actually be incorporated into the Results level.

One of the criticisms of the Kirkpatrick model is that there is little direct correlation between Level 1 (Student Reaction) and Level 3 (Behavior – Application on the job). Students may leave a seminar and not enjoy a single part of it, thus providing negative feedback on the course evaluation. Yet, they may be fully successful in applying knowledge and skills on the job. Given that most course evaluations are only looking at Level 1 (recall: smile sheets), what can that tell us about how we need to measure training effectiveness?

Another criticism is that the model is upside-down! Clark suggests that we start with the end in mind and look at the required level of performance first. He suggests that we flip the model and work backwards by identifying:

- The desired impact (outcome or result) that will improve the performance of the business;
- The level of performance the learners must be able to do to create the impact;
- The knowledge and skills they need to learn in order to perform; and
- What they need to perceive in order to learn (the need to learn).

Phillips⁵ also presents a version of this approach called the V model. This approach fits well with the reasons for training we stated earlier: performance improvement. But, just because we have a model that fits our reasons for training, it doesn't make it any easier to measure the results! Two things are sure: we need to engage all parties in the learning process and Level 1 course evaluations don't measure it. That doesn't mean we should throw out Level 1 evaluations; they are still important to assess barriers and areas for corrective action and course improvements.

The International Association for Continuing Education and Training (IACET) references the Kirkpatrick levels of evaluation as a part of their ANSI/IACET standard. Here are a couple of interesting statistics I've noted. One is that Bassi⁶ and others discovered that 96 % of companies surveyed used some form of the Kirkpatrick framework to evaluate training and development programs. Another is that McMurrer⁷ and others at ASTD surveyed the American Society for Training and Development Benchmarking Forum to determine what percentage each of Kirkpatrick's four levels is used in organizations:

- Level 1: 95 % (target goal: 100 %)
- Level 2: 37 % (target goal: 70 %)
- Level 3: 13 % (target goal: 30 %)
- Level 4: 3 % (target goal: 20 %)

Phillips⁸ indicates that we probably shouldn't seek to assess each level at 100 % due to the cost and benefit required, but suggests target goals as those given in parenthesis above. Given that we are looking for training effectiveness in the laboratory working to meet the requirements of ISO/IEC 17025 and that only 13 % of organizations are using level three assessments, we probably don't have many good examples of best practices. In fact, failure to apply new concepts, or evidence of applying concepts, is generally used as a measure of training (in)effectiveness. For example, "my technical audit found non-conformities; therefore my audit training was effective." Given that we really want to measure impact, results, and performance improvement, and yet only 3 % of organizations have implemented level four assessments, we can conclude that we need to do a better job of measuring!

Measuring Student Learning

Student Assessments

Assessing student learning is generally a level two assessment. The October 2010 Train the Trainer article in *Metrologist* presented ideas about aligning learning objectives, activities, and assessments. Instructor assessments of student learning are a critical part of good instructional design concepts and are one way to assess whether students have learned. Assessments are a critical part of the training event, and they assess student learning *as demonstrated during the event*. This level of assessment may be incorporated into course evaluations, but generally only as "self declaration."

If we are looking for performance improvements, additional tools can aid the student and the employer in evaluating whether the learning was effective. For example, a checklist used by the instructor to assess whether a student has learned a topic can also be given to the student so they know how they will be assessed and self-assess. The same checklist can be shared with the employer so that they can review or observe the employee's work back on the job to make sure all items are implemented on the job. Job aids such as forms and checklists may even be more effective than a course notebook or set of slides to take home from a training event.

⁵ ROI Institute.

http://media.roiinstitute.net/tools/2010/01/29/Training_2010_Session_506_Beyond_Learning_Objectives.pdf

⁶ Bassi, L., Gallagher, A., & Schroer, E. (1996). *The ASTD Training Data Book*. Alexandria, VA: American Society for Training and Development.

⁷ McMurrer, D., Van Buren, M., & Woodwell, W., Jr. (2000). *The 2000 ASTD State of the Industry Report*. Alexandria, VA: American Society for Training & Development.

⁸ Phillips, Patricia Pulliam, *The Bottom Line on ROI, Basics, Benefits, and Barriers to Measuring Training & Performance Improvement*, 2002.

Course Evaluations

Course evaluations most often determine whether students were happy with the training experience (hence the phrase “smile sheets”) at level one. They can also provide an assessment of whether the learning event provided a good environment, resources, and opportunities to begin applying concepts and skills. Given the concepts presented in the previous section on the four levels of evaluation and return on investment for a training program, it is unlikely for course evaluations to effectively get to the heart of whether there will be performance improvement on the job. However, designing course evaluations to assess student learning is still a worthwhile goal. Students may self-declare their level of learning and intent to apply concepts back on the job, which is a start. Having questions such as “what concepts/skills will you apply back on the job?” reinforces the expectation that the reason for the training event is to improve the on the job performance of the student/employee. It also helps the instructors and training program managers identify the key concepts, skills, or knowledge that students found were valuable and can be applied back on the job.

Feedback from the course evaluations can help with further training needs analysis, identify topics for measuring impact, and provide details about what improvement actions may be needed in the environment, resources, and instruction. Assessing the course evaluation feedback is an important measure for continual training improvement. Additional resources on course evaluations can be found in the NCSLI Training Library.⁹

The Perfect Course Evaluation

I read an online a story recently about an instructor who always gets perfect evaluations! The gist of the story was that the instructor spends most of his time ensuring that his evaluations are perfect rather than whether students are learning anything. In fact, he really doesn't teach anything, just prepares the students to answer the course evaluations at 100 percent! Perhaps you've attended a training event with this instructor? I hope not. Teaching-to-the-test efforts are probably not much better. Please remember that the purposes of the course evaluation are to assess the learning experience, to have a continual improvement process, and eventually to measure the impact of our efforts.

RECOMMENDATIONS FOR METROLOGY ORGANIZATIONS

If education and training are truly important to our organizations, and we believe that with the retirement projections we are facing, getting new staff members up to speed quickly will become even more essential in coming years. We have several approaches we can use to assess satisfaction, learning, and impact. We must also measure the impact of our efforts and be able to demonstrate meaningful measures such as Application, Impact, and ROI to our sponsoring organizations and managers. In addition to demonstrating the value of networking and learning, we have to demonstrate the value of metrology as a whole, yet that is a much bigger issue. A key subject to address in planning for measuring impact is to identify what kind of measures are most useful to our metrology organizations and what kinds of measures are most important to the sponsoring organizations for the individual participants. We need to identify the most meaningful measures. Are the questions we have asked in the case studies the best ones to determine application and impact. We cannot wait until we have determined the best questions to begin measuring, but we need to look at the results and determine if the ways in which we collect, analyze, and present the data is benefitting all parties — and that will require collaboration efforts.

Therefore, we need to make a concerted effort to work together to gather case studies showing qualitative and anecdotal information (such as most of what has been shared here) about impact as well as a planned effort to gather application data and return on investment data. We know that stories about application and impact can be powerful; however, we need to have the data to support the stories.

⁹ See these additional titles in the NCSLI Training Library: *ASTD Evaluation Basics, A Complete, How-to Guide to Help You: Use Evaluation to Drive Performance, Develop a Comprehensive Evaluation Plan, Demonstrate Value and Communicate Results; ASTD Train the Trainer: Measurement and Evaluation.*

CONCLUSION

Measuring the impact and effectiveness of training from a system perspective requires a three-way partnership between the employer, the trainer/training organization, and the student/employee. Everyone has a vested interest in measuring effectiveness and improving training results and employee performance. There is a lot we can learn from professional trainers about measurement. Ensuring that our course, tutorial, and conference evaluations consider more than whether the students had an enjoyable time is essential.

APPENDIX A – NIST 2008 SURVEY HIGHLIGHTS

MSC 2008 NIST SEMINAR EVALUATIONS

G. Harris, March 16, 2008

Summary

We had over 105 participants¹⁰ in six NIST seminars this year (2008) with four divisions participating. Courses included:

N01	7	Pressure and Vacuum Measurement	Jay H. Hendricks	Process Measurements Division
N02	6	Fluid Flow Measurement	G. E. Mattingly (retired NIST) Mike Carter (Flow Systems, Inc.) Aron Johnson	Process Measurements Division
N03	25	Hands-on Workshop on Estimating and Reporting Measurement Uncertainty	Will Guthrie Hung-Kung Liu	Statistical Engineering Division
N04	32	Preparing Your Laboratory for 17025 Accreditation: A Step-By-Step Approach	Barbara Belzer Greg Strouse Tom Hettenhouser Sherrie Wentzel	Standards Services Division (NVLAP)
N05	31	Practical Measurement Assurance	Georgia Harris	Weights and Measures Division
N06	6	Selection, Calibration, and Use of Contact Thermometers	Greg Strouse Karen Garrity	Process Measurements Division

More than 95 percent of the students submitted a course evaluation.

Course Evaluation Methods

Course evaluation forms for the NIST Seminars were revised this year to apply formal principles from the learning field so that we can begin to measure learning, application, and return on investment (ROI)¹¹. Copies of course evaluations and compiled comments from each seminar have been distributed to each course instructor. A copy of the course evaluation form is included here as an appendix. Historically within NIST, “count” measures, or numbers of students have been captured by Divisions, but were not rolled up across NIST. Within NIST we have begun tracking training efforts on Measurements and Standards¹². We have also begun discussions on formal methods of training evaluation.

Levels of evaluation we are now using include:

- Level 1: Satisfaction
- Level 2: Learning
- Level 3: Application
- Level 4: Impact
- Level 5: Return on Investment

¹⁰ Numbers estimated until final count obtained from MSC database and instructors.

¹¹ Phillips. Kirkpatrick. References available.

¹² Contact G. Harris for more information on current data or to submit training course information.

gharris@nist.gov.

Note: We had one student who asked for a copy of the evaluation form so he could investigate applying some of the evaluation concepts in his metrology training efforts.

Measuring Satisfaction

Historically in training seminars we (NIST and MSC) have measured Satisfaction. Professionals in the learning field call these kinds of evaluations “smile sheets” because they only measure whether students leave with a smile on their face. Unfortunately, they don’t tell us anything about the impact of our training efforts. Another thing you’ll note is that we don’t have a mid-range score that students could select. (A copy of the student evaluation is attached as Appendix A.) Students wanting to select something in the middle (for average) must select from either a “3” or a “4” and either slightly below average or slightly above average; this approach forces a decision. Satisfaction questions and summaries are shown in Figure 1. Overall, every course was rated as “good” or above. Overall course satisfaction in five of six courses was very good or above. From our experience in the Weights and Measures Division (WMD), course logistics is often the lowest score and the most frustrating to coordinate when we aren’t directly in charge of logistics and implementation – we don’t have control as when in-house coordination is done. Even when it is in house, we have found over the past 15 years in WMD that course logistics tend to receive the lowest scores. For example, within NIST, we have little control over the student experience getting access through security or payment of fees to the Comptroller (their experience with the Conference Facilities program). In the case of MSC scores in 2008, some of the logistics comments were related to detractor items such as:

- Not knowing starting times and locations of the NIST seminars.
- Not getting an individual confirmation email.
- Noise from AC.
- Bigger tables to use laptops.
- Need more frequent and shorter breaks.

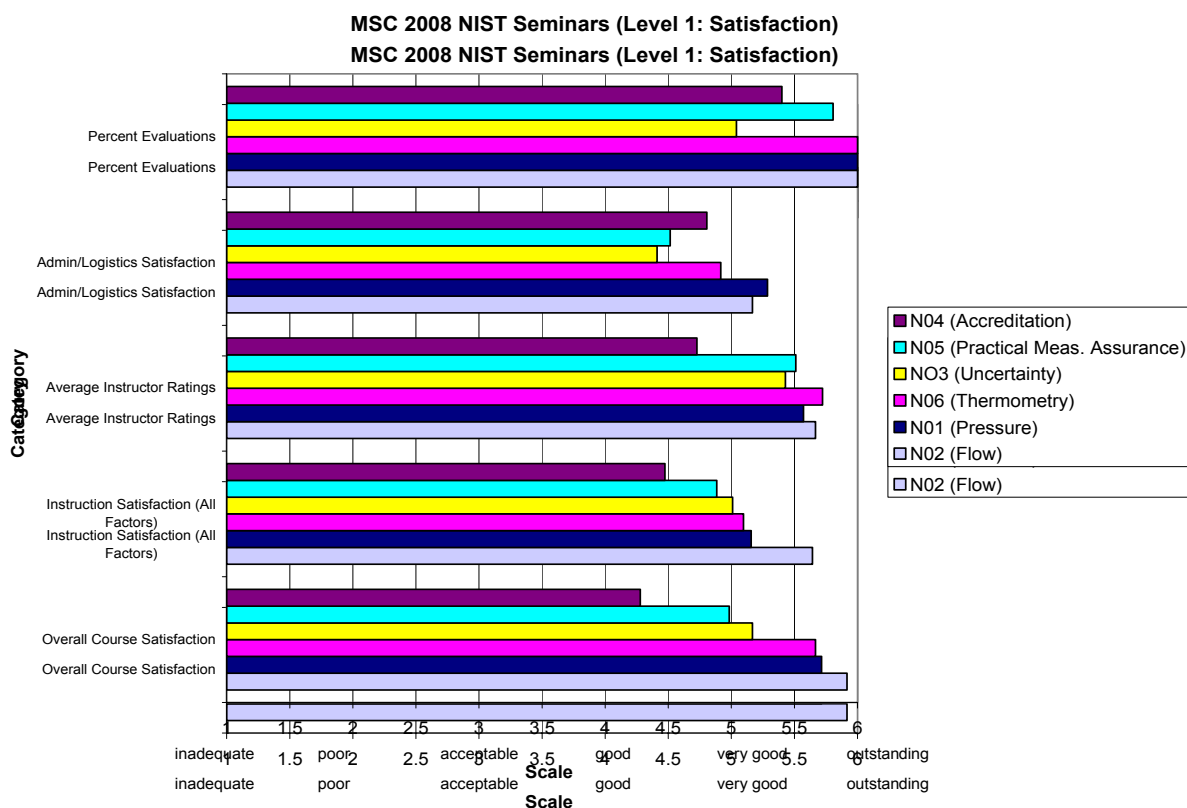


Figure 1. NIST Seminar Satisfaction

Instruction satisfaction is compiled from all questions relating to the instruction section in question 3. It covers evaluation of the instructors as well as questions on pace, content, instructional level, AV, demonstrations, discussions, and handouts or other materials. This is broken down in the section so each instructor can make individual improvements in subsequent seminars as needed. In the evaluation of what students liked best or least, we see examples at both ends of the spectrum such as “pace too slow” and “pace too fast” – from the same course. It is especially hard to gauge and adjust this with the larger courses.

Measuring Learning

A question was added this year to assess the student’s perception of learning. Again, Learning is noted as Level 2 in the learning evaluation models. We used a self assessment method where students were asked to assess their knowledge before and after the seminar. One person astutely noted that their answers to the question about what they knew ahead of time would have been different had they answered the question at the beginning of the session. Alternative approaches to evaluation at Level 2 could include a pre-test and a post-test and assess the results. Students of NIST seminars would probably not see pre-tests and post-tests very favorably, but generally are not opposed to self-assessment. We don’t have any history on this measure yet, but the results from the 2008 seminar are shown in Figure 2 as the “student perception of learning improvement”. It will be interesting to see trends in subsequent years and perhaps improve how we assess learning.

In addition to the numerical value of questions related to customer satisfaction, learning, and application are questions that we compiled so that we can make continual improvements in our training courses and so we can understand what the students find of value.

Measuring Application, Impact and Return on Investment

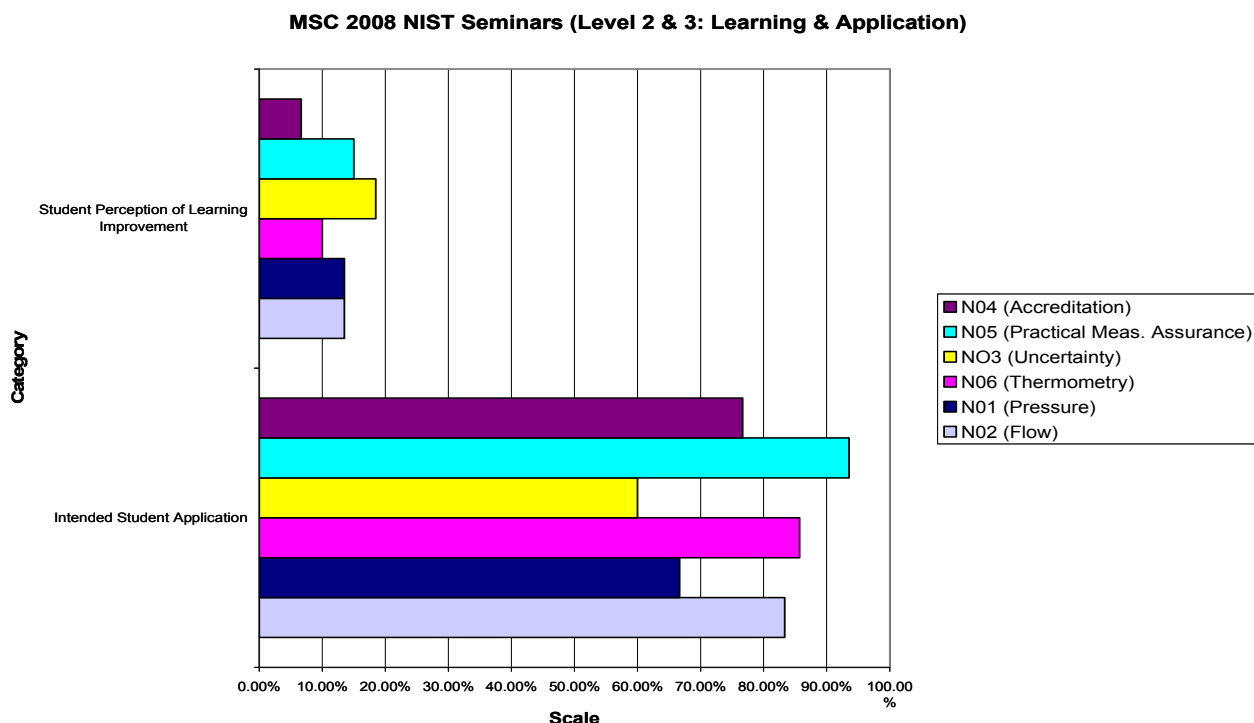
Level 3 in the learning assessment model relates to Application. Over 60 percent of our 2008 MSC students plan to apply something they learned from us in their work. Overall, this is pretty good based on regularly asking application questions in WMD courses and the fact that we didn’t discuss these concepts among instructors before the sessions. It will be interesting to see the trend over time as instructors of our seminars begin focusing on getting students to commit to applying concepts on the job. One of the things we say in the WMD laboratory courses (primarily mass, volume, and special topics conducted in regional State laboratory groups) is that “we don’t care how much you know if you don’t apply it in the lab.”

One of the keys to measuring Level 4, Impact, is whether they apply concepts and skills we taught or not. In the WMD program one of our measures of training application is the result of the laboratory measurements in proficiency tests. We have been measuring improvement in PT results and numbers of corrective actions for the past two years. However, we have a fairly captive audience since the State labs are required to attend our training and participate in PTs if they want their laboratories recognized or accredited. We have also begun using PTs as a post-test to our seminars.

One of the other formal approaches to measuring impact at Level 4 is to conduct a follow-up evaluation of our students at about 45 days after the sessions and ask the following questions:

1. We asked participants in your class at MSC what they would apply in their laboratories, and would like to know: Have you applied any of the concepts we covered in the seminar?
2. If you have applied concepts, what concepts did you apply and what has been the impact?
3. If you have not applied anything but intended to do so, what were the barriers that prevented your implementation?

Figure 2. NIST Seminar Learning & Application



Answers to question two allow us to begin capturing stories and data about the impact of our training efforts. Answers to question three allow us to tell the next class what kinds of things were barriers to help them plan to overcome barriers, or allow us to modify what or how we cover something to help the next class achieve successful implementation. From a positive answer to question two with data, we can begin to capture return on investment (ROI) information. This is useful for MSC and for NIST in terms of marketing the value of these seminars and our time in conducting the seminars. This data and ROI is useful to participants in the long run because they can use it as a management tool to help support staff training efforts and the impact on their bottom line. *We plan to send a follow up email to the entire group of students from this year's MSC NIST Seminars and will share results with all of the instructors.*

Training Needs Assessment

The course evaluation form is also used to identify training needs. Training Needs Assessments are a key part of accredited or authorized training programs, particularly if we get to a point where we offer continuing education units (CEUs) or credit (through organizations such as the American Council on Education (ACE). The American Council on Education, is the major coordinating body for all the nation's higher education institutions, and seeks to provide leadership and a unifying voice on key higher education issues and to influence public policy through advocacy, research, and program initiatives. Long-term, it would be an added value of the NIST courses to offer CEUs and/or credit.

Training needs that were summarized from all course evaluations were organized by topic and are in the following section.

Compiled Summary of Needs Assessments from NIST Seminars

Some of the comments were related to items taught in other seminars than what is specified. E.g., some of the uncertainty comments were from the technical parameter courses. Some items have been edited if they were not related to a specific course we could teach.

The 2008 participants said: "I need the following additional training:"

Metrology Management Concepts

- Management course

- Program management
- ISO 17025, never heard of it before this class

Metrology Principles & Concepts

- Statistics
- Statistics - again
- Refresher statistics
- Design of experiments
- Software V&V; Exercises on what to do when standards are found out of calibration.
- Excel for dummies
- Excel
- Proficiency testing
- Intermediate PTs
- Advanced. Intra-laboratory methods
- N05 (practical measurement assurance)
- Traceability concepts (add to practical measurement assurance course)
- Expand this course (measurement assurance) and apply to areas beyond mass and volume practical examples/exercises.
- I could use a whole week of this course (measurement assurance)
- Uncertainty
- Uncertainty analysis
- Uncertainty analysis
- Real life examples of uncertainty analysis
- Distributions such as U shaped; Bias and drift understanding
- Discussion over how to best apply GUM; don't know how, when, why to use appropriate equations
- Clearly detailed examples on uncertainty problems; not enough step-by-step process information
- Uncertainty calculations (which I believe is already offered)
- Advanced. Monte Carlo Methods
- Uncertainty budgets
- Uncertainty budgets and calculations
- Would like to see some examples of calibration procedures that are acceptable. For me, knowing the appropriate level of detail to place in a calibration procedure is very important. Experienced calibration technicians might not need a step-by-step procedure. What level of detail is the auditor looking for? Could we see some examples? What if two different auditors have two different opinions on this?

Metrology Parameters & Skills

- N01 (pressure)
- N02 (flow)
- Basic mechanical metrology for non ME engineers
- Dimensional metrology
- Deadweight piston gages, vacuum system pumping and assembly
- Piston gage
- Vacuum system design
- Vacuum pumping/systems, higher pressure
- More practical application thermometry in industrial applications
- I will look at the NIST temperature schedule for my temperature technicians
- Microwave processes

SAMPLE COURSE EVALUATION - STUDENT

Directions: Please indicate your evaluation of the item. Please feel free to include additional comments where appropriate. Use the back of the form for additional comments as needed.

1. Overall Satisfaction

Don't Know or Doesn't Apply	Disagree	→	→	→	→	Agree
0	1	2	3	4	5	6
0	1	2	3	4	5	6

- This seminar/tutorial/workshop exceeded my expectations:
- I would recommend this seminar/tutorial/workshop to others:
- I liked the following thing best about the seminar. Why?
- I liked the following thing least about the seminar. Why?
- If I were to improve this seminar to make it more effective, I would:

2. Satisfaction: Administration & Facility

Don't Know or Doesn't Apply	Inadequate	Poor	Acceptable	Good	Very Good	Outstanding
0	1	2	3	4	5	6
0	1	2	3	4	5	6

- The registration process was:
- The class room (& laboratory where used) was conducive to learning (lighting, sound, seating, temperature, equipment, standards):

3. Satisfaction: Instruction

Don't Know or Doesn't Apply	Inadequate	Poor	Acceptable	Good	Very Good	Outstanding
0	1	2	3	4	5	6
0	1	2	3	4	5	6
0	1	2	3	4	5	6
0	1	2	3	4	5	6
Don't Know or Doesn't Apply	Disagree	→	→	→	→	Agree
0	1	2	3	4	5	6
0	1	2	3	4	5	6
0	1	2	3	4	5	6
0	1	2	3	4	5	6

- Instructor _____ (skill, knowledge, delivery):
- Instructor _____ (skill, knowledge, delivery):
- Instructor _____ (skill, knowledge, delivery):
- The length and pace of the seminar were:
- The technical content was relevant and applicable to my work:
- The instructional level of difficulty was appropriate for me:
- Audio/visual presentations (lectures & demonstrations) contributed to my learning:
- Discussions, demonstrations, application exercises, question/answer time, and homework contributed to my learning:
- The seminar handouts & materials contributed to my learning:

4. Learning

≤ 40 %	41 %	51 %	61 %	71 %	81 %	91 %
	to	to	to	to	to	to
≤ 40 %	41 %	51 %	61 %	71 %	81 %	91 %
	to	to	to	to	to	to

- My understanding of this topic prior to attendance was at this level:
- I think my current understanding of this topic at the end of the seminar is at this level:

5. Application

- I learned and will apply the following items in the performance of my job:

6. Needs Assessment

- I need the following additional training or courses to improve performance of my responsibilities:

APPENDIX B – NIST 2010 45-DAY FOLLOW-UP SURVEY RESULTS

Examples of actions taken (Level 3 Application):

- Updated our Quality Manual to better align with the requirements of 17025.
- The training helped me recognize other areas in our laboratory that uncertainty formulations can apply to. Also helped us understand what uncertainty is so we could explain our processes better to our customers.
- In development procedures and program for NVLAP Accreditation.
- Policies and procedures on calibration in-house as well as vendor services with no 17025 capabilities
- We have verified our in house calibration methods against your training.
- We have performed uncertainty calculations by following instructions from the seminar. They are helping us with our ISO/IEC 17025 Accreditation.
- We are in the process of applying concepts learned at this course. Once they are implemented, I'm sure there will be an impact.
- Used uncertainty analysis to compare lab measurement values to NIST certified standard values in round robin inter lab studies
- During the course, we discussed the importance of doing a validation/verification on calibration software. In my department, we discovered that there were errors in the software code for a gun turret tester currently in use in the fleet, causing the tester to show a pass when, in fact, it was out of tolerance. We now will be reviewing all software and are training two engineers on LabView and software review techniques.
- We followed class notes and examples to model our measurement uncertainty due to long term drift. There was an example given in the class and is so perfect for our use. We have been troubled by this. It is for our Navy primary lab and has a significant impact.
- Increased general knowledge of thermometry. Care and feeding of temperature standards.
- I have applied my increased understanding of uncertainty to my daily exposure of uncertainty discussions and also plan to assist in updating an SOP regarding Measurement Uncertainty.
- Started to track uncertainties that were not tracked in the past. No impact.
- Yes. Developing measurement uncertainties at a customer's request so that the product could be released to the customer.
- Starting our TPW, profiling our SPRT's.
- I have used the Traceability area to prove that standards we are using are traceable.
- Used ice bath for zero measurements and TPW measurements to evaluate SPRTs including control charts.
- We added more criteria to our existing software validation process.
- I am applying concepts learned, and making available the Kragten spreadsheet for our uncertainty estimating processes. I'm experienced in uncertainty analysis, but the Kragten spreadsheet is exactly the tool I've needed.
- We are implementing uncertainty budgets for our internal calibration system.
- Top reasons for failing to implement ideas: time, priorities, resources, management support.

Examples given regarding impact (Level 4 Impact):

- The advanced material and theoretical background presented was very comprehensive. It would have been helpful to have one simple, basic step-by-step example of a calculation starting right from the measurement data.
- Great training. Very knowledgeable staff. Love the hands on applications.
- Wonderful Course!
- I would highly recommend it.
- One thing that I took away from the course was that even though something may be statistically out of control, corrective action may not be required, depending on the required tolerances for the application of the equipment. This has been difficult for me to promulgate around my office, as many of our engineers are not able to understand the concept of "use specifications" which are dependent on application of the equipment, as opposed to design specifications. It may take some time to move away from an academic mindset regarding calibration toward a more practical approach.

- The time and effort made by the instructors was greatly appreciated; it was "one-on-one training" and this was an incredible opportunity. Thank you!
- The measurement uncertainty training has allowed a \$6 M piece of hardware to be released to the customer.
- In the future a CD of course materials and/or handouts would have been useful.
- The second day was better than the first. I understand the instructors wanted us to know the background behind the method; however most of the class is looking for an answer to the problem. When I get back to the office, I need to calculate uncertainties for X number of activities before the next 3rd party audit. The second day did a better job solving this problem. For about 10 % of the class, the first day was very helpful. I hope to be one of them in the future.
- I have found that uncertainty estimating is often over-simplified, or even over-complicated. The NIST course and the almost intuitive Kragten spreadsheet better prepared me to train our technicians in how to go about estimating uncertainty in a practical yet technically correct manner.
- After the NIST course I attended the half-day "Uncertainty Made Easy" Tutorial session by Peter Hanes of the NRC. It was a very good tutorial, but it's important to know how each element of uncertainty analysis affects the final estimate so that any shortcuts are well reasoned and defensible. The NIST course provided that kind of insight.

Training Requests (Needs Assessment):

- With respect to the Uncertainty seminar, I would like to see more worked examples of scenarios that span multiple disciplines from the simple to the complex as supplemental to the main course materials that are rightfully general in nature and structured progressively in difficulty. The thing I find most intimidating is not being able to make a sound business case to management as to how our business and our customers could benefit from what I've learned. It's one thing to understand the technical details, but quite another thing to move an organization in a new direction.
- Dimensional applications
- I think an expansion of this course into three days, or a dedicated course for software validation/verification would be beneficial.
- I would like to see NIST use our test cases in tutorial. Of course, attendees should prepare and email test data to NIST before class starts.
- RF/Microwave measurement and developing uncertainties for measuring high power.
- I thought the Uncertainty course was extremely helpful and well-presented. However, it would have been helpful to me to see example(s) wherein measurements of a transducer, for example, are recorded at approximately 20 %, 40 %, 60 %, 80 %, and 100 % of Full Scale and wherein that process is repeated say every 6 months and THEN all that data is used to calculate an uncertainty for the transducer. It's a little fuzzy to me how to handle multiple sets of data up and down the allowable range of a Unit Under Test. This scenario will be quite common for me as we grow our documentation.

APPENDIX C – NCSLI 2010 FOLLOW-UP SURVEY RESULTS

Questions from the 2010 NCSLI Follow-up Survey

1. *These learning objectives helped me and my organization get the value for our investment in the 2010 Conference.*

- We're very interested in accreditation, peer networking, measurement techniques, et. al.
- All of the learning objectives have been helping me a big improvement from my home metrology lab & "I want to be with NCSLI technical member forever."
- Not enough learning and too many paper presentations that appeared to have conference fee credit as their main purpose.
- The conference provides the opportunity to accomplish all the above!
- Networking and vendor information was most valuable. Only a handful of presentations had significant value - mainly Z540.3 and quality implementation was the highest value.
- Phenomenal tutorials, paper presentations, and networking opportunities. This conference more than pays for itself.
- Significantly expanded our network of peers.
- Mandating the answers cancels the purpose of survey.
- Well attended. Got to see several current customers, and had the opportunity to learn about business opportunities in the area.
- I would benefit more to some easier listening. Most choices were very complex leaving not many options for persons in the Quality business less the 5 or 10 years.
- So many sessions to go to, so many exhibitors to see, & so many concurrent committee meetings that I really need 2 or 3 clones to help me be everywhere I want to be.
- The conference was very well organized and informative as well for a metrologist.
- Some lectures given measurement techniques that include methods and techniques that have no validation and without professional basis that may be misleading. As we all know ISO / IEC 17025 requires only use valid methods. It is not appropriate to allow by international metrology conference to give place to unprofessional lectures without any disclaimer information and without giving any stated notes regard this fact to prevent the misleading of participants and listeners to a lecture. Considerable part of the lectures was presented without summaries and full lecture allowing the members the full information of usefulness to be use after the convention, especially on the parallel sessions that you can be present only at one place at time.
- The place given to chemistry and biology is very small compared to other metrology conferences.
- I enjoyed the gathering of some of the best minds in the country and their accessibility. Non-Empowered R&D Scientist (NERDS) rule!!!
- The networking opportunities at this conference are great. The more involvement by calibration laboratories, the better this conference will become.
- The conference is a valuable networking tool.
- A very rewarding conference.

2. *What were some of the new concepts, ideas or principles that you heard or learned?*

- Job Hazard Analysis concepts were shared back in our laboratory and implemented into our safety processes (since they were readily available, it was easy to implement).
- I don't have any at the moment.
- Z540.3.
- That the development of paragraph 5.3 in Z540.3 was driven by persons that stand to receive economic gain based on the change in language.
- How to develop training materials.
- I worked with the Z540.3 working group to get a better understanding of the document.
- Metrology Education programs at the University level, Measurement Uncertainty.
- The RFID case study that was presented as a paper was very interesting. We are looking at the applications within our company.

- Always on the lookout for new M&TE. One of the more valuable aspects of the conference is interacting with the vendors, and getting new ideas for test equipment.
- Web 2.0 ideas for communication. Some new metrology related analysis techniques.
- Some calibration interval techniques.
- The blackbody discussion was useful as it verified our current calibration process.
- Give me an opportunity to present my experience provides members a rich opportunity to exchange ideas, techniques, and innovations. "I want to be with NCSLI technical member forever".
- Various details associated with achieving accreditation.
- Always interesting to see how one area ties into another or how one areas problems/solutions can be used elsewhere.
- Information given my Tom Harper from Fluke Hart Scientific.
- As a member of the BoD I spend most of my time working at the conference toward the benefit of the attendees. Very True!
- The idea that DHI Compass integrates directly into Fluke MetCal/MetTrack - this is huge for our operation.
- I am just starting out so I learned the most from the basic courses.
- Selecting metrology software vendors (from tutorial), improvement to calibration of micrometers & calipers (tutorial), developing training plan for metrologists (tutorial), universal basics of substituting standards (paper), approaches in delay dating (committee meeting & networking), chemistry traceability to Standard Reference materials instead of NIST or SI (paper/forum), challenge of applying TUR>4:1 when you don't know either of the ratio uncertainties (committee), innovation game-plan & matrices (paper), different types of RFID & their applications, calibration SOP stream-lining (networking).
- Review of calibration frequency.
- Requirements for 17025 accreditation & measurement uncertainty.
- RFID use to track instruments.
- That a presenter should have learning objectives in mind when preparing a talk or paper. Also learned about the concept of hazard analysis in the workplace.
- What I can do to get children interested in metrology careers.
- Collecting objective evidence.
- Claiming traceability is not defensible unless associated measurements are accompanied by statements of uncertainty.
- Metrology training & educational outreach, non-normal measurement distributions.
- Mandating the answers cancels the purpose of survey.
- I was very impressed with the improvements that NRC has made in their resistance measurement capability. Also interested in the calibration interval discussion presented by FLUKE. I was also impressed by Malcolm Smith's encouragement to the group to participate in the national event in Providence...I rarely hear NCSL leaders promote events and membership actively and I think they should.
- This was my first conference and I am new to metrology so for me, it was a completely new experience.
- I learned more about standards labs which I am interested in but th8is did not help a lot because I do mainly field calibration.
- The talks on legal metrology and forensic metrology were of interest to see if they compare to "traditional" metrology.
- FDA List of FDA Inspector deficiencies.
- I learned more about ANSI-Z540.3, and especially risk management.
- No new concepts.
- Uncertainty Calculation principles.... Basics on Temperature measurements. Vswr (RF) measurements...
- Other management perspectives on training and qualifications are proving very useful in a reorganization initiative.
- Microwave VNA calibration, substituting standards, RFID for asset management.
- Chet Franklin's presentation.
- CMM measurement of small arm gages for the Navy.

- New products - Crystal Engineering pressure fittings. Measurement Uncertainty and interlaboratory comparisons.
- Web 2.0 and Virtual Meetings.
- Overview of Temperature Calibration from a general standpoint.
- GD&T Training concepts, Calibration of Step Gauges, Using a CMM for calibration and apply the reversal technique
- Gas mixer system. Calibration techniques for CMM Training.
- That we are not unique in South Africa with respect to problems being experienced in the laboratory environment. 2) That NCSLI has not yet been as successful as the National Lab Association in SA in bringing the calibration and testing lab communities together which is a valuable lesson we have learnt. 3) Was really impressed and interested in the presentations about the new "smart" technologies.
- Calculating Uncertainty budgets.
- The opportunity to interact with vendors and learn about the newest in their equipment line helped make our process improved.
- Developing training material from technical content.
- Smart Grid issues.
- Effects of thread loading on force measurements ...
- Proficiency testing, Measurement Uncertainty.
- Metrology Ambassador is a great tool to get into the schools.
- Secondary temperature standards - differing temp ratings for probe and transition/handle which if not adhered to could cause instrument damage.
- New calibration techniques.
- I saw new equipment and met customers.
- Uncertainty, decision rules, proficiency testing, ring gauge calibration issues, calibration software.
- I was able to learn of several developments by various calibration equipment suppliers. I was also able to learn some needs of calibration laboratories doing infrared thermometer calibrations.
- The training activities were worthwhile.
- The "Train the Trainer" full day tutorial was very useful in outlining key elements and suggesting enhancements for successful training programs. The Keynote Address and the Smart Grid session (9E) (among other sessions) were good reminders that government CAN do great things despite the efforts of many in this country to disparage and weaken government agencies. Session 8A, in particular the --- Dobbert presentation, had useful insights into setting specifications.
- Managing uncertainty with different ways. Be a Metrology Ambassador, etc.
- Measuring lab service levels.
- Ability to provide RH calibrations <10 %. New capability/equipment for accelerometer calibrations. ---- More discussion between peers on achieving Z540.3 compliance.
- Training and the new workforce. Shared ideas on how to improve laboratory operations through improved training.

3. I did apply these "lessons learned" on my job.

- The ANSI Z-540 and ISO 17025 discussions were enlightening and we still have work to do in the area of accreditation.
- Promote cooperative efforts for solving our common problems faced by measurement and test laboratories. "I want to be with NCSLI technical member forever."
- What I am able to get out of the conference, I always take with me and apply toward bettering practice or efficiency.
- Used process & tools from Selecting & Implementing Software to choose software (hoping it stays in the budget, now). Streamlined SOPs (and eliminated ~30 SOPs by combining into 1 SOP). Updated calibration SOP for micrometers & calipers. Working on developing training plan for Calibration Lab.
- Still investigating, too early to decide.
- The application of lessons learned is ongoing and will continue into the future.
- Not yet, but will over time.
- I have not yet.
- I learned some things in dimensional class which will help me.

- We will look into this measurement technique for the Air Force as well.
- We are currently ramping up on both Proficiency testing, Measurement Uncertainty. I would have put strongly agree had we already started.
- I intend to improve training programs based on the “Train the Trainer” session, but I haven't had the time yet.
- Our business is a commercial enterprise meaning the improvements and changes must be implemented over a longer period of time vs. a regulatory requirement.
- Updating our local training program and provided insight into the needs of new calibration personnel.

4. I did enlist my supervisor/manager/organization in accomplishing these objectives.

- My manager sees the values of NCSLI, encourages participation of our department (budget permitting) and attends NCSLI himself.
- I wrote a review for management and all our laboratory personnel.
- NCSL International is a nonprofit organization, whose membership is open to any organization with interest in the science of measurement and its application in research, development, and education.
- We as an organization are moving to obtain NVLAP accreditation, and info I gathered at the conference has helped in our organization's implementation plan.
- This is not a problem in my organization since our organization is so deeply rooted within NCSLI.
- For budget items, I definitely need management support. Trying to overcome bias of not being “revenue-generating” by focusing on revenue-equivalent of cost-savings.
- Activities are ongoing.
- Time frame too short.
- I will report what I learned.
- I am a single-person organization.
- Little interest from management. Production focused/oriented.
- I am in a position to implement within the lab but will be working with the rest of our fleet for future implementation.
- From a commercial calibration lab point of view, I still believe a large part of the issues in the field of metrology are still uncertainty related!
- Full report was issued to my organization.
- Metrologists, by their very nature have become accustomed to having to make things happen. Furthermore, metrologists are notoriously bad at motivating things to management - and in most cases, management are too busy fighting the corporate battles of finance and strategic management to get deeply involved in the technical issues at lab level.
- Mostly on my own.

5. The implementation of the objectives and lessons learned did have a positive influence on our organization.

- Also networking opportunities w/ practitioners from NVLAP, NIST, the national laboratories, and from industry.
- Congratulations! It was my first time in the conference and I really appreciated it.
- There can never be enough information. It's good to hear questions and answers from all parties, novices and experts both.
- With the wide representation of experience provides members a rich opportunity to exchange ideas, techniques, and innovations having an excellent benefit to my organization.
- Always a good chance to meet customers and get feedback from them. Also, keeping abreast in changes in equipment and the industry in general.
- Always!
- All implementations have been a benefit to our organization. Hoping metrology asset management software stays in budget for 2010.
- Establishing traceability by properly documenting test results and the associated uncertainties will give us more confidence in the performance of our jobs.

- Time frame too short.
- I expect they will.
- As government operation change is slow but the interaction from the conference certainly helps facilitate the needed changes.
- Difficult to implement.
- Attendance of NCSLI opened my eyes to the bigger international picture of metrology in the US, which I had never had the opportunity of experiencing before in my 30 year long metrology career!
- Will have a positive influence.
- There hasn't been time yet for any influence to be felt.
- Insight shared made some new ideas more complete which lead to easier implementation.