Innovations in Proficiency Testing

Jeff C. Gust
Vice-President
Quametec Proficiency Testing Services

Quametec Proficiency Testing Services has brought new innovations to proficiency testing by implementing pivot laboratory measurements into commercial proficiency testing schemes. When the proficiency test provider acts as the pivot laboratory, the customer benefits by increased quality in the proficiency test, and receipt of final test results immediately. Quametec Proficiency Testing Services has achieved accreditation from the American Association of Laboratory Accreditation as a provider of proficiency testing services for the calibration industry.

Developing technically sound proficiency tests which also meet the requirements of ISO Guide 43-1, Development and operation of proficiency testing schemes, and ILAC G13:2000, Guidelines for the Requirements for the Competence of Providers of Proficiency Testing Schemes, is a rigorous and detail oriented task. When Quametec Proficiency Testing Services began operation in January of 2003, in addition to becoming accredited as a proficiency test provider for calibration laboratories, it was also a goal of the company to develop new models for commercial proficiency testing. Quametec has brought several innovations to the design, development, and execution of commercial proficiency tests. The most significant improvements include the design of tests that ensure validation of the participants' best measurement capability, and implementing the best measurement practices from the calibration laboratory into proficiency tests. This paper will focus on the technical details and benefits of one such innovation, pivot measurements.

Pivot laboratory measurements are not a new concept to proficiency tests, interlaboratory comparisons, and round robins. This concept however, has not been routinely employed in commercial proficiency tests at this point in time. Although the two main documents that drive the quality requirements of proficiency test providers, ISO Guide 43-1 and ILAC G13:2000 do not explicitly mention pivot laboratory measurements, the concept has been well understood to be a good part of any interlaboratory comparison. ISO Guide 43-1 does however, state in 5.6.3 "Where possible, the coordinator (of the proficiency test) should also provide evidence that the test items are sufficiently stable to ensure that they will not undergo any significant change throughout the conduct of the proficiency test." It is critical to the design of a successful proficiency test that the developers understand the metrological characteristics of the artifacts, and when necessary, to implement additional measurements, such as pivot laboratory measurements into the proficiency test in order to ensure that the stability of the artifact is well understood.

For some proficiency tests, such as the measurement of a solid stable material, like the internal diameter of a plain cylindrical ring gage, pivot laboratory measurements may make little to no improvement to the proficiency test, and therefore may not be required. NCSL RP-15, Guide for Interlaboratory Comparisons notes that "the pivot laboratory's primary function is to monitor the traveling standard during the ILC to ensure detection of any changes that might affect the outcome of the ILC." It can be shown that other proficiency tests can be greatly improved by the introduction of pivot measurements, especially when the artifact may be affected by transportation or other effects. Examples of proficiency tests where the artifact uncertainty is better understood through pivot laboratory measurements are; mechanical artifacts, such as torque wrenches and pressure gages which are made up of many mechanical parts that are sensitive to the mechanical shock of transportation and also experience mechanical wear with operation. Complex electronic instruments such as digital multimeters and precision transducers are also sensitive to transportation effects and exhibit component drift over time. Precision electrical instruments such as standard resistors and zener reference standards are also sensitive to the mechanical shock of transportation and due to their design the reference value often has a significant rate of change over time.

In order to address the requirement from ISO Guide 43-1, 5.6.3, all accredited proficiency test providers or organizations that comply to ISO Guide 43-1 implement pivot laboratory measurements in the simplest sense into their proficiency test design. This is most often accomplished by reviewing the difference in reference

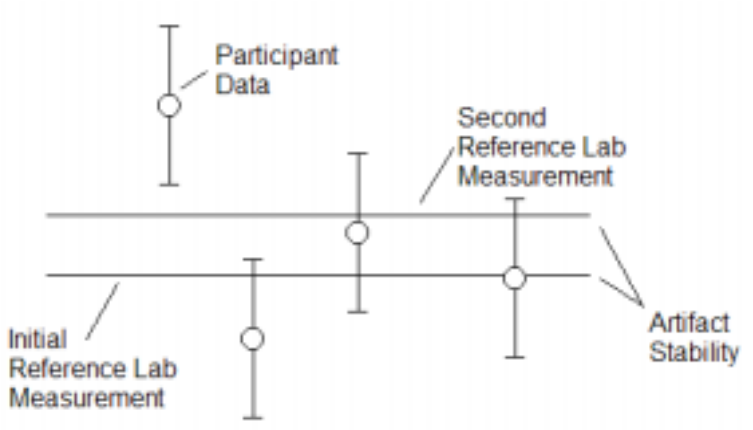

Figure 1, Artifact Stability for a Sufficiently Stable Proficiency Test.

laboratory (the laboratory used to provide the reference value for the artifact in the proficiency test) measurements to quantify the stability of the artifact during the period between measurements at the reference laboratory. The uncertainty associated with the difference in the two reference laboratory measurements must be combined with the uncertainty of calibration associated with the artifact in order to produce the expanded uncertainty for the proficiency test.

If the artifact is sufficiently stable throughout the proficiency test, the difference between reference laboratory measurements should be minimal, as shown in figure 1.

If the artifact is not sufficiently stable throughout the proficiency test, the difference between reference laboratory measurements may be significant, and perhaps be many times larger than the reference laboratory uncertainty. The resulting expanded uncertainty for the proficiency test may by much larger than the uncertainty reported from the participants in the proficiency test. When the expanded uncertainty of the proficiency test is larger than the uncertainty reported by the participant, the test does not verify the technical proficiency of the laboratory to the level that is desired by the participant, and is of little overall value to the participating organization.

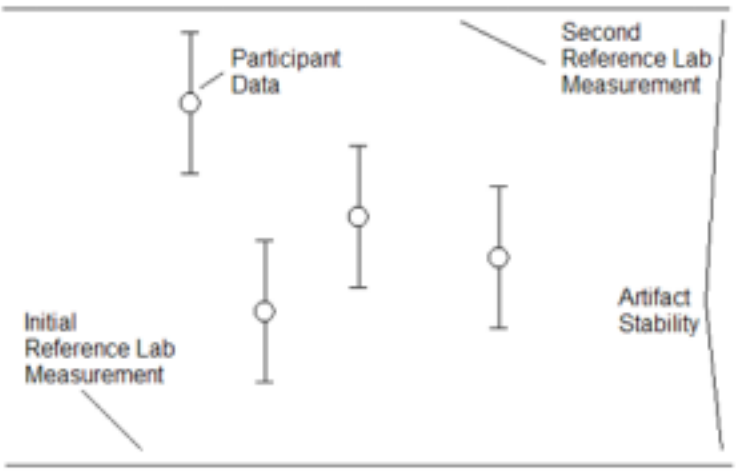

Figure 2. Artifact stability for an insufficiently stable proficiency test.

In order to improve the quality of the proficiency test, and the value that participants receive, pivot measurements can be introduced. The number of pivot measurements performed during a round (the period between reference laboratory measurements) depends on the type of proficiency test/artifact used, and the cost to perform a pivot measurement. Some proficiency tests employ a design where a pivot measurement is performed between every two or three participants as show in figure 3, or before and after each participant, which is the most conservative design (shown in figure 4).

The pivot measurement itself may be performed by an accredited calibration laboratory, but it is not absolutely necessary. The critical elements of a pivot laboratory measurement is that the measurement process itself is technically sound, and the instrumentation involved has sufficient resolution and sensitivity to detect small changes in the reference value of the artifact.

The quality of a proficiency test is immediately improved with the addition of appropriate pivot measurements. Such improvements are 1) the stability of the artifact can be determined for each participant during the time of their test; 2) Pivot measurements can detect and be used to quantify artifact reference value drift over time 3) Pivot measurements will alert the proficiency test provider to any catastrophic changes to the artifact, and allow the proficiency test provider to rescue previous participant data from becoming rendered ineffective by expanding the uncertainty of the proficiency test to be much larger than it actually was during the time of their participation and perhaps the most significant benefit 4) allows for immediate closure of the proficiency test for an

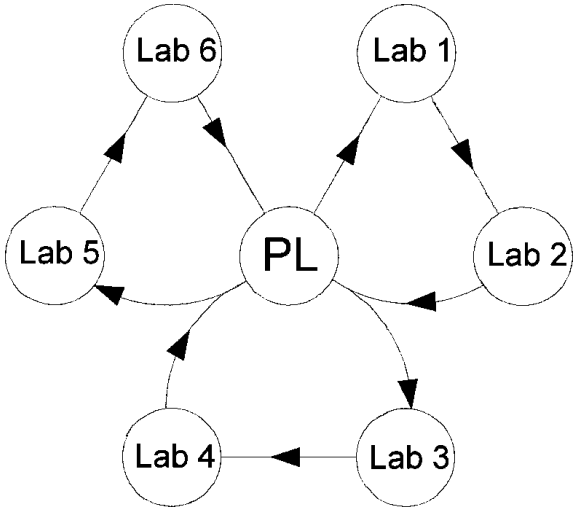

Figure 3. Proficiency test with pivot test performed between every two or three participants.

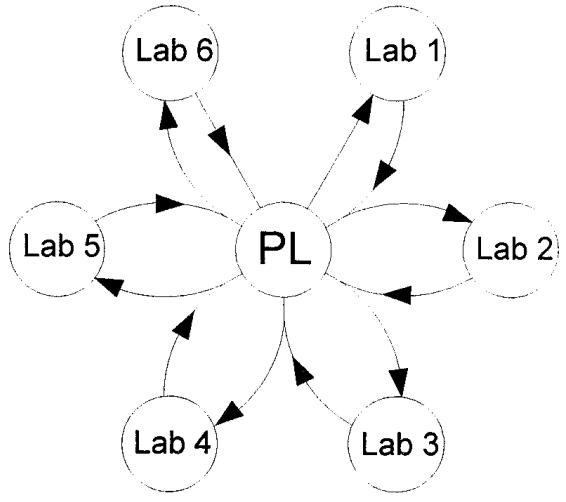

Figure 4. Proficiency test with pivot measurement taken between each participant.

individual participant so that a final report can be issued to them.

The last benefit mentioned is made possible if pivot laboratory measurements have been performed from the time of receipt of the artifact from the reference laboratory including pivot measurements before and after the participant's measurement, the stability of the artifact for each participant can be quantified, and any drift from the reference measurement may be quantified. If both of these components of uncertainty are combined with the uncertainty of the artifact reference value as established by the reference laboratory, an expanded uncertainty may be determined for the individual participant. This allows the proficiency test provider to produce a final report and issue it to the participating laboratory immediately, rather than requiring the participant to wait months (or years) until the artifact is sent back to the reference laboratory to determine the artifact stability as is the case for proficiency test providers who do not perform pivot measurements. It is desirable to reduce the amount of time to produce the participating laboratory's final report to a minimum in order for the laboratory to receive immediate feedback on the quality of their measurement process, and allow them to act upon the results.

Pivot measurements have been employed for all proficiency tests that Quametec Proficiency Testing currently provides. The inclusion of pivot measurements to our proficiency testing process has provided immediate benefits in that the participants can receive their final reports without delay, and provides an additional level of confidence to all parties that the proficiency test is technically sound and sufficiently stable.

Jeff Gust, Quametec, gust@quametec-pt.com.