Morehouse Instrument Company

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# Force and Torque Calibration Quarterly

**INSIDE THIS ISSUE:**



## A Message from the President

Welcome to our second newsletter. It has been an interesting experience writing this. I anticipate that about 500 people are reading this newsletter, and I am hoping that everyone reading this takes something positive away from it. Whether it is a laugh, something to make your lab more productive, or general knowledge of potential measurement errors and how to avoid or quantify these errors, I hope you are gaining some knowledge. I am drafting this message from 38,000 feet above the ground and am amazed at all the testing required to allow me to draft this from the troposphere. From the wind tunnel simulations, to the torque measurements, to the testing of this computer, almost every item is tested in some fashion. The keys on my keyboard are most likely tested for operational forces, all to ensure that everything works the way it should. No matter what you are testing, I think some general six sigma or lean principles can help almost all organizations become better.

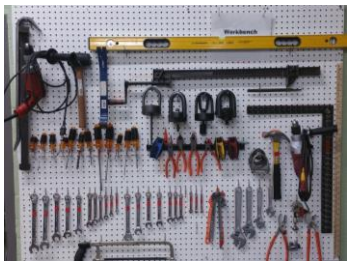
Our first newsletter focused on point of use to save time. I have completed the lean champion program and have finished the six sigma black belt program and feel compelled to share some of this knowledge with you. In this issue, we are going to focus on 5S (6S if your organization includes safety). We are also going to start a new section titled "Meet the Morehouse Staff." We figure we have some interesting people here with some good stories to tell.

-Henry Zumbrun

## What is 5S or 6S?

5S (or 6S) is a workplace organization method that is divided into the following categories.

The first of these categories typically starts with *sort*. During the sort phase, it is necessary to remove all unnecessary items from the lab. If you are unsure if an item is necessary or not, the suggestion is to put the item to the side and put a red tag on it. The red tag should have the current date on it and another date for removal if the item is not used within the specified accepted time interval. The second phase is *set in order.* During this phase, the lab should arrange all necessary items in order so they can be easily selected for use. (Remember the article in our first newsletter called "Point of Use to Save Time.") The next phase is *shine*, and as the word suggests, this is as simple as cleaning everything. Malcolm Gladwell's *The Tipping Point* eludes to the overall effect of a clean environment on productivity and attitude. The book cites the New York City subway system and how keeping the subways clean drastically reduced crime. Gladwell highlights the effect a clean environment can have on productivity. Next, we should *standardize* the workplace. Make a place for things and keep them in their place. A shadow board can be a useful tool. The next step is simple; it is developing procedures to *sustain*, which may include weekly audits. Sometimes the final sixth "s" is for *safety*, since a safe workplace is a necessity.



Example above on creating a shadow board. In the bottom picture you can see a wrench is missing.

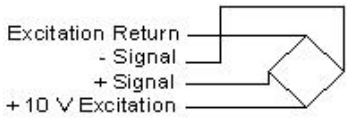
*"A 6-wire cable should be the desired choice if you intend on interchanging cables or are operating in an uncontrolled environment."*

# Potential Measurement Error

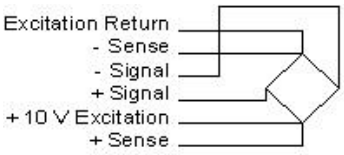
## 4-Wire Versus 6-Wire

In our first newsletter, we ran a small article called "Whoops, I Accidentally Severed My Cable Again." This article alluded to a difference between using a meter wired with a 6-wire setup versus using a 4-wire setup. The article mentioned that replacing a 4-wire cable may cause a change in output, while a true 6-wire setup with a meter capable of reading sense lines can eliminate the majority of errors associated with different cable length and gauge. To understand this error, we conducted our own tests. We also filmed a video and posted the results on our website.

In understanding the errors associated with a 4-wire cable, we must first understand why this error exists. In general, cable resistance is a function of temperature. The temperature change on a cable affects the thermal span characteristics of the load cell/cable system. On a 4-wire cable, this will affect thermal span performance. Simply put, as the temperature changes, the resistance of the cable changes and can cause a voltage drop over the cable length. A 4-wire setup simply cannot compensate for variations in lead resistance. Substituting a cable of a different gauge or a different length will produce additional errors. A known example of this involves changing a 28-gauge or 22-gauge cable. On a 28-gauge cable, there will be a loss of sensitivity of approximately 0.37% per 10 feet of 28-gauge cable. On a 22-gauge cable, there will be a loss of sensitivity of around 0.09% per 10 feet of 22-gauge cable. The majority of this error can be eliminated if a 6-wire cable is run to the end of the load cell cable or connector, and is used with an indicator that has sense lead capability. With a 6-wire setup, the sense lines are separate from the excitation lines, thereby eliminating effects due to variations in lead resistance. This allows long cable runs in outdoor environments with extreme temperatures.




Pictured Above: A standard 4 wire connection



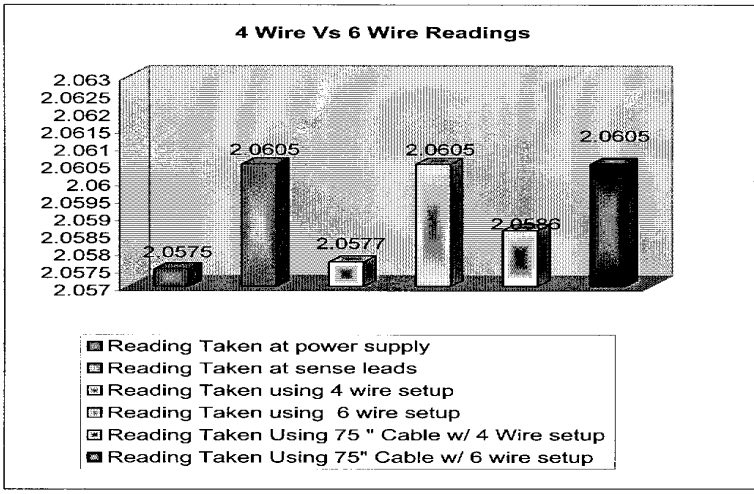

Pictured Above: A 6 wire connection with sense tied into the same pin as excitation on the cell.

Wiring a 6-wire cable for sense is as easy as running two lines from the load cell's positive excitation pin and two wires from the load cell's negative excitation pin; the remaining 2 wires are run to positive and negative sense. The 6 wires then feed into the meter with positive excitation and positive sense running to the meter; negative excitation and sense are run to the appropriate meter connections, as well as positive and negative signal. The results below demonstrate the difference that cable length can make on output. It should be clear that a 4-wire cannot be interchanged without requiring a recalibration of the entire system. A 6-wire cable should be the desired choice if you intend on interchanging cables or are operating in an uncontrolled environment. In the video we posted, we observed a difference of 0.106% between using two different length but same gauge cables. The test below shows a difference in output of around 0.05% by reducing the 4-wire cable by about 40 inches.

**4 lead Vs 6 Lead Wire with 114" vs 75" Cable using Interface 1000 LBF Load Cell**

HP TEST W 1000 LBF Interface Load Cell loaded to 1000 LBF

| | | |
|---|---|---|
| Reading Taken at power supply | 10.0823 | |
| Load Cell Reading | 2.0575 | |
| Reading Taken at sense leads | 10.0677 | |
| Load Cell Reading | 2.0605 | |
| Load Cell Signal | 20.745 | |
| Reading Taken using 4 wire setup | 2.0577 | |
| Reading Taken using 6 wire setup | 2.0605 | |
| Reading Taken Using 75 " Cable w/ 4 Wire setup | | 2.0586 |
| Reading Taken Using 75" Cable w/ 6 wire setup | | 2.0605 |



# Morehouse Machine Shop Supervisor

Since Morehouse was founded in the 1920's, we have always been fortunate to employ some very skilled machinists. I said "machinists," not "machine operators." We have been able to find very talented people who can take a rough sketch and turn that sketch into a finished part. Ideally, a customer would provide a nice drawing with specified tolerances and our machinists would take that drawing, machine the part, verify the tolerances and send the part back to the customer. The person in charge of the Morehouse machine shop is Brian Ruppert.

Brian has over 25 years' experience making parts, welding, painting and programming CNC's. His tasks involve performing and scheduling work, improving shop processes, working with engineering to analyze new products, and supervising Morehouse shop staff to verify that they are working up to the quality guidelines established by Morehouse Instrument Company. When I asked Brian to write an article on running the machine shop, he wrote the following:

"I am very proud to be part of the Morehouse family. I first started working at Morehouse 16 years ago, polishing proving rings. I came to Morehouse with 12-plus years' experience and was forced to start at the bottom. I was okay with this since I had worked at several other machine shops and welcomed the change of attitude from 'you are just another employee,' to a family-run business where the owners care about your well-being and encourage employee feedback and suggestions for improvement.

The first day I saw these products, I felt as if I was in a whole different world, and I knew I was ready for the challenge this new world would bring. One of the more challenging machining processes has been turning a raw forging into a precision proving ring. Another challenge was making special products for NASA. These products are currently being operated on the International Space Station. Making adapters for customers' specific use can be a challenge if the requirements involve more exotic material. Some products have required more extensive machining knowledge such as special 4"-12 ACME thread calibration adapters, engineering's recently designed tie bars with buttress threads. There are also cases when a customer sends in an instrument for calibration and the lab needs us to make a part ASAP. We have made a variety of parts, from alignment plugs, spindles for grinders, test fixtures, calibration fixtures, and adapters with magnets in them for the calibration of a tensile tester. I take great pride in anything our shop makes and strive for 100% customer satisfaction. We can take an idea from a customer's vision and make a fully functional, quality part. If you have any ideas, or parts that need made, I am up for the challenge."

- Brian Ruppert

PICTURE OF BRIAN RUPPERT

PICTURE OF FINISHED CUSTOM ADAPTER

PICTURE OF SPINDLE BEING TURNED

# Measurement Corner with Dilip Shah

*Single Measurement Bliss!*

When you make a first measurement, everything looks fine. It is when you make a second, repeated measurement and it is different from the first measurement that doubt begins to arise. Which one is the correct measurement? Then, you take a third measurement, and it is different from the first two! That is why I joke that you should have stopped after the first measurement. This would be our single measurement bliss scenario. But, bliss is also ignorance in disguise.

If the first measurement was made in error, the subsequent repeated measurements may have caught that error. Repeated measurements also provide information about the precision of the measurement. The precision can be quantified with the standard deviation of the measurements.

When repeated measurements are made, it is important to report both the average and the standard deviation. Since the average tends to hide extreme values (one can have their head in an oven and feet in ice and on the average, they feel fine!), the standard deviation will show the higher variation. If the standard deviation is smaller, the average will show a shift in data, if there is one.

Sometimes, making more than one measurement takes time and resources. So, there is always a decision about what constitutes a right balance. If a laboratory is keeping Statistical Process Control (SPC) charts, or has the measurement uncertainty estimated for their measurement process, it might be possible to get away with making a single measurement and achieving that bliss. In complying with ISO/IEC17025 requirements, it is always good to work smarter and not harder.

By keeping accurate records with SPC charts, one may be able to satisfy multiple ISO/IEC 17025 requirements and also assure the measurement confidence of the critical parameters. It is all about killing five birds with one stone.

In future columns, we will discuss some of these issues in more detail.

Dilip A. Shah is a consultant specializing in ISO 17025, ISO 9001, SO/TS16949 and Measurement Uncertainty.

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# Upcoming Events

On May 19-20, we are promoting an A2LA 2-day class on Risk Management. This is a topic that **any design engineer should have knowledge of**, and we welcome the opportunity to help A2LA promote this 2-day class in the York area. Registration for the class can be found here: http://www.a2la.org/training/MUrisk.cfm?private=no

Morehouse will be at the NCSLI conference in Grapevine, Texas, from July 18th through July 24th. During this time, we will be giving 2 half-day tutorials:

Sunday, July 19th 8:00 AM-12:00 PM – T12 Force Calibration

Monday, July 20th 8:00 AM-12:00 PM – T20 Fundamentals of Torque Calibration

# Thank You and Future Newsletters

If you've made it through our second newsletter, I would like to extend a giant "Thanks, we must be doing something right." If you like the newsletter or have suggestions for us, we would like to hear from you.

Do you have a topic you would like to see covered, or would you like to submit a guest article for an upcoming newsletter? Please feel free to contact us with topic suggestions or article proposals. We are always looking to improve, so please feel free to contact us and provide any feedback.

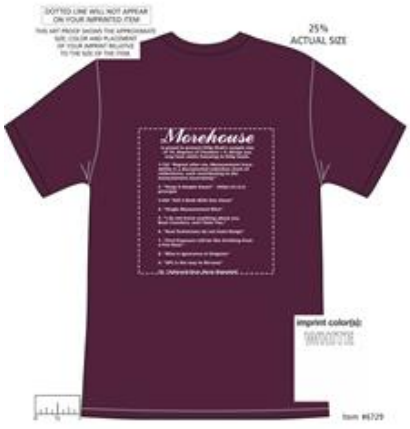
Please email any correspondence to hzumbrun@mhforce.com

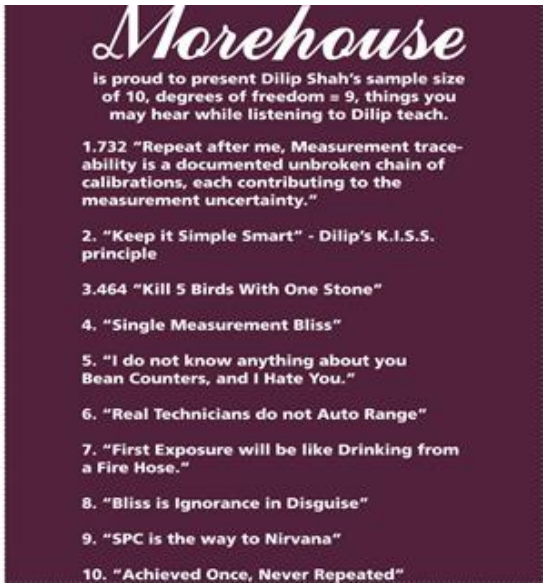
**Recommended Beer and Movie this quarter:**

I figured I'd use this space to occasionally recommend a good beer, a good film, or both. Film: *John Wick* (revenge flick starring Keanu Reeves), Paired With: Samuel Smith's Oatmeal Stout

## Trivia Question: The first two people to answer correctly will win a Dilip Shah's "Things you may hear when listening to Dilip teach" t-shirt.

**Question: Morehouse is a recognized name in the metrology field. What are two other institutions that share the same name? (Hint: There are more than two, and one makes a pretty good beverage.)**




**Please email your answer, shirt size and mailing address to hzumbrun@mhforce.com**