

Force and Torque Calibration Quarterly



A Message from the President

Welcome to our seventh Morehouse Instrument Company newsletter. 2016 has been an exciting year. We hired additional staff to strengthen our calibration laboratory's ability. The goal of improving our ability is to make better measurements and better educate our technicians. We hired a PhD who has a very strong background in statics and statistics. We hired this person to help us make the improvements necessary

to fulfill our mission of being regarded as the best independent force and torque calibration laboratory in the world. Being the best means that the company must always strive for continuous improvement. We must level our machines to better than 0.1 degree, we must run SPC, and address various adapters needed to improve alignment. For tension, we created adapters recommended in ISO 376; in compression,

we created new alignment rings and ball adapters, and have made improvements to all our force machines.

To better serve our customers, we are continuously taking steps to improve our reputation of great service. Morehouse Instrument Company strives to provide superior customer service and calibration solutions while maintaining high-quality standards.

-Henry Zumbrun

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Designing Force Adapters

When designing Quick Change Tension Members, we first looked to a published standard and the recommendations in the International Organization for Standardization. ISO 376 recognizes the importance of adapters in reproducibility conditions of the measurement. Proper adapter use in accordance with ISO 376 Annex A helps ensure the reliability of reported measurements. ISO 376 Annex A.4.1 General states, "Loading fittings should be designed in such a way that the line of force application is not distorted. As a rule, tensile force transducers should be fitted

with two ball nuts, two ball cups and, if necessary, with two intermediate rings, while compression force transducers should be fitted with one or two compression pads."

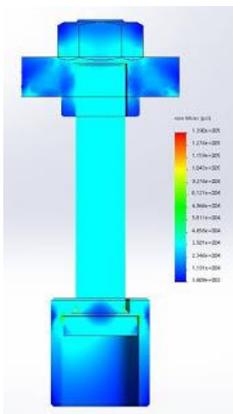
To ensure safe utilization of these adapters, stress analysis was performed using Solidworks. The area of stress concentration where the shaft meets the spherical radius flange was given particular scrutiny. This transition was modeled, and the FEA results were verified using Roark's formula for a radius on a bar with a step in diameters loaded axially. The diameter of the spherical

flange was used as the larger diameter (D) and the shaft diameter as the smaller diameter (d). A stress concentration factor (K_t) is determined from a chart with a curve for the ratio of the two diameters (D/d) and the ratio of the transition radius (r) to d. This factor is applied to the stress calculated by dividing the force capacity over the cross sectional area of d.

Morehouse Design Notes:

1. Roark's formula was used to verify FEA results.
2. Design used spherical radii called out in the ISO 376:2011.
3. Safety factor of 2:1 implemented in design.

-Jim Wagner



Example of Stress Analysis on a Quick Change Tension Member

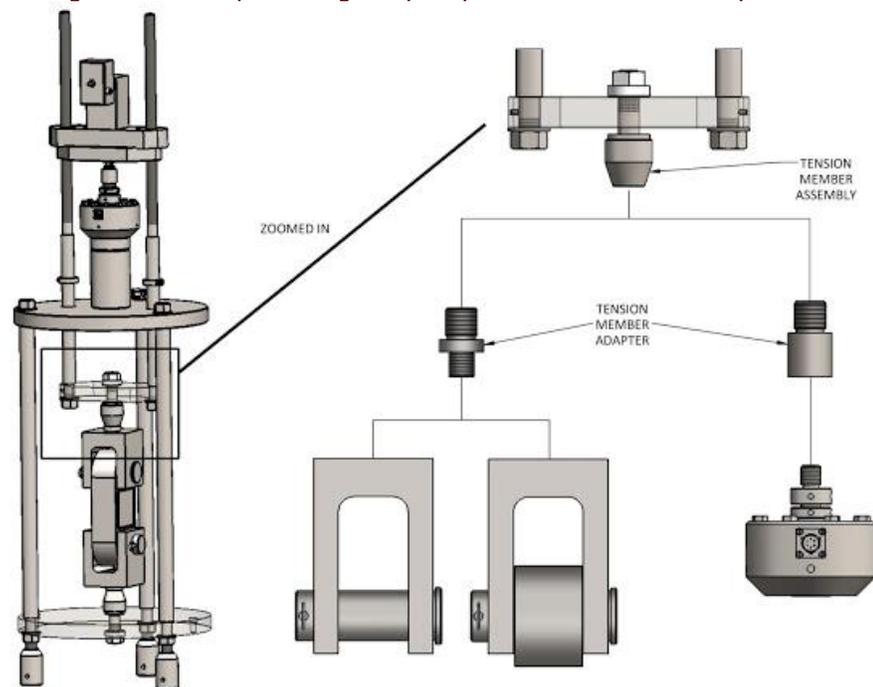
Reducing the changeover time allows for a more efficient calibration process that does not sacrifice quality, while improving cycle time. Moreover, shorter cycle time allows for improvements regarding on-time delivery, lowered costs from excess inventory, and an increase in machine capacity levels.

These adapters simplified our laboratory setups, improved our performance with better alignment, and were cost-effective compared to the alternative of multiple pieces of threaded rod or multiple rod end type setups. As a result of optimizing the calibration setup, we were able to standardize production flow, provide better measurements, and free additional floor space for future expansion.

Quick Change Tension Members

Improve your measurement process, save space, and reduce long-term costs.

Morehouse employees went through a lean manufacturing course. Part of this course emphasized reducing cycle time by reducing the amount of time it would take to set up equipment for a load cell calibration. During the class, the concept “quick changeover” was discussed and applied to a single piece flow. We had the idea to apply some of these setup reduction concepts to our force calibration lab since the lab workflow mimics that of single piece flow production. We discovered that a set of universal tension members in our calibration machines could be used along with a few mating adapters, and this reduced three shelves full of various adapters down to half of a shelf. Soon after building these for our lab, visiting customers started asking for their own sets, and we decided to start offering Quick Change Tension Member Assemblies. **Do you want to improve your measurement process, save space, and reduce long-term costs of purchasing many adapters for each instrument you need to calibrate?**

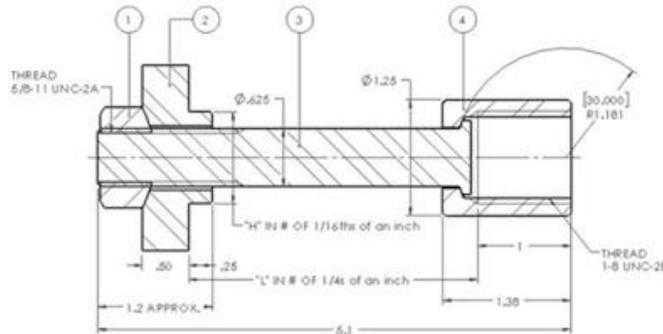


Quick Change Tension Members and Adapters help with the following:

- Reduce Tension Changeover Time
- Improve Alignment by Using a Spherical Radius Contact as Defined by ISO
- Improve Alignment and Create Better Repeatability
- Reduce Overall Calibration Cycle Time
- Simplify Setups by Using One Tension Member with Several Adapters
- Standardize Production Flow
- Available for Capacities up to 500kN or 112,000 lbf.

Full Product Guide on Quick Change Tension Members can be downloaded [here](#)

James Wagner, Chief Design Engineer



Morehouse Quick Change Drawing

James comes to Morehouse with over 15 years of experience as a mechanical engineer. James graduated from the University of Pittsburgh with his bachelor's degree in mechanical engineering in 2000. He passed the Fundamentals of Engineering (FE) Exam to attain his Engineer in Training (EIT) certificate in Pennsylvania in 2005, while working for a small defense contractor that manufactured mobile electronic equipment shelters. Shortly after that, James became a research and development engineer/scientist for a commercial aerospace company in Wichita, Kansas. During his 8 years in research and development, he worked on developing various manufacturing processes used to make large commercial airplanes, military helicopters, and business jets. These technologies included 3D printing of metal parts, hot and cold forming of metal parts, and composite part manufacturing in and out of autoclaves. Indicative of his desire to keep learning, he completed his master's degree in mechanical engineering at Wichita State University in 2013.

Now that James has been with Morehouse for over 6 months, he has already developed new products to help calibration laboratories reduce their uncertainty and cycle time with the design of new tension member assemblies that meet the specifications for spherical radii called out in ISO 376. The main improvement with these tension members is greater clearance between the shaft and hole of the couplings. This revision ensures that any possible misalignment in a calibration machine will be mitigated, and that the line of force will be directly through the cell being calibrated, thus eliminating any eccentric loading that might otherwise occur.

James has spent years as a project engineer helping to develop new complex products that are part of the latest composite aircraft now entering service and carrying passengers around the globe. Now he is using his talents and skills to help Morehouse continue to be regarded as the world's best resource for calibration services in the world.

James holds a private pilot's license for single engine land aircraft and is looking to join a local flying club to share the joy of flight again with his wife and two young boys. When he is not performing FEA analyses, James likes to relax by playing the piano, guitar, sports and video games.

If you have any problems that Morehouse can address, please do not hesitate to contact James; he will be happy to learn about your challenges and will strive to provide the best solution. He is already working hard to provide new solutions for calibration needs that had not previously been addressed by Morehouse in the past. Keep an eye out for new product announcements and developments by following Morehouse on LinkedIn and Facebook, and be sure to subscribe to the newsletter and [blog](#).



Pictures of James Wagner and Pilot Jim!



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If interested in any Morehouse products or services contact

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ISO 376 recognizes the importance of adapters in reproducibility conditions of the measurement. Proper adapter use in accordance with ISO 376 Annex A helps to ensure the reliability of reported measurements.

ISO 376 can be purchased [here](#)

http://www.iso.org/iso/catalogue_detail.htm?csnumber=44661

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Upcoming Events

September 13, 2016 & May 8, 2017 *Implementing Metrology and SPC concepts with MS Excel*, Instructor **Dilip Shah**

This one-day workshop prepares the metrology professional to apply the power of Microsoft Excel's mathematical and statistical tools to assist in managing the laboratory's Quality Management System, including Measurement Uncertainty. The class serves as a prerequisite for the Measurement Uncertainty workshop and reduces the amount of time spent learning both the Excel and Measurement Uncertainty estimation techniques at the same time.

December 5-6, 2016 & May 9-10, 2017 *Applied Fundamentals of Force Calibration*, Instructors **Henry Zumbrun (Morehouse)** and **Dilip Shah (E=mc³ Solutions)**

This course will cover applied force calibration techniques and will include live demonstrations using secondary standards to exhibit potential errors made in everyday force measurements. The measurement errors demonstrated and discussed will include errors associated with improper alignment, use of different and/or incorrect adapter types, thread depth and thread loading. The course will cover the basics of measurement uncertainty and will provide the tools for anyone to be able to estimate Measurement Uncertainty for a Scope of Accreditation CMC or to report a customer's measurement uncertainty.

Thank You and Future Newsletters

If you've made it this far, I would like to extend a giant "thank you" for reading our seventh newsletter.

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

Web Page Links:

Training Class
<http://www.mhforce.com/customer-education>

Morehouse Quick Change Tension Members Guide
<http://www.mhforce.com/s/QuickChangeTM-Guide-274R1.PDF>



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