Calibration: Meeting Customer Requirements

BY LARRY MARTOF

The dimensional and finish quality of your work is directly related to the calibration of your tools, equipment, and measuring instruments.

CALIBRATION IS ONLY REQUIRED FOR THOSE FABRICATORS, ERECTORS, BRIDGE BUILDERS, AND COMPONENT MANUFACTURERS who desire to meet customer requirements and who desire to meet the highest standards for quality and excellence. Calibration is one of your most customer-facing processes and is one of those wonderful unwritten customer requirements. They expect you to know what an inch is. The dimensional and finish quality of your product is directly related to the accuracy and confidence level of the tools, equipment, and measuring instruments used to produce them.

Let's roll back the clock to a time before calibration standards—a time at which we find that a very powerful customer has commissioned someone to build a boat for him. The customer provided the following dimensions:

300 cubits by 50 cubits by 30 cubits

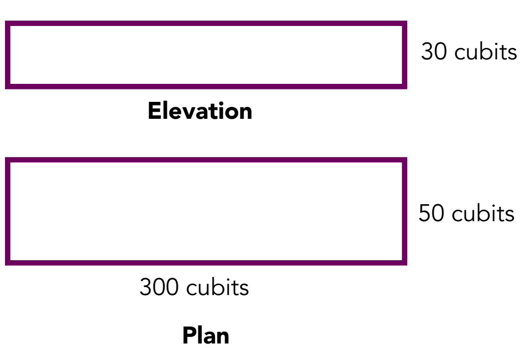
With these directions the fabricator started to plan his build. Let's say he decided that in order to meet the customer's timeline and deliver the product before bad weather set in, he would hire an assistant. He decided that each of them would start in one corner, then work down the side and meet at the other end. He supplied a second set of prints to allow them to work independently. A few days later they met at the other end with a small problem, as illustrated by the figure below.

The immediate reaction, of course, was to begin blaming each other for making the mistake and not being able to measure and count right, etc, etc. The root cause of the problem was that they didn't have a standard to build by. The customer specified dimensions in cubits, which was a normal means of measuring at that time. So if an inch is an inch, isn't a cubit a cubit? Not really. A cubit is equal to the distance from the tip of your middle finger to your elbow. For the average man this is approximately 18 in., but it can range anywhere from 17 to 21 in. Translate this to the dimensions of the boat, then translate the measurements to feet and we get the following range:

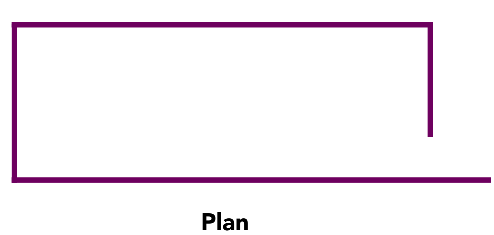
$$475 \pm 50 \text{ ft. by } 78 \pm 8 \text{ ft. by } 48 \pm 5 \text{ ft.}$$

If you fabricated a bridge, building, or other steel product with this amount of variance, how long would you be in business? Fortunately, the fellow in our story did construct the boat on his own, so using only his arm for measurements everything came out just fine.

Back to this topic of calibration. The National Institute for Standards and Technology (NIST) houses and controls the standards we use for measurement today. They use very controlled environments and very stable materials for these standards. Then, test laboratories create traceable items to the NIST standards and eventually, through the chain of traceability, we get accurate tape measures, squares, levels, lasers, and other measuring tools of the trade. And in the modern world of steel fabrication and construction, the dimensional tolerances continue to become tighter and tighter—hence the need for well-implemented and maintained calibration programs. These requirements are described in the AISC *Standard for Steel Building Structures* in element 14 and in ISO9001 in clause 7.6.



Customer Drawing



As-built Drawing

Quality Corner is a monthly feature that covers topics ranging from how to specify a certified company to how long it takes to become a certified company. If you are interested in browsing our electronic archive, please visit **www.aisc.org/QualityCorner**.

Two common myths surrounding calibration deserve a closer look:

Myth #1

We don't do calibration, we verify. Well, by definition verification is the process used to examine and prove the accuracy or correctness, and calibration is the act of verifying and adjusting the accuracy of a measuring instrument. So calibration begins with verification, which may lead to adjustment and verification of the adjustment. One could say that calibration begins and ends with verification. One caveat to this is that under automotive and aerospace standards (TS16949 and AS9100, respectively) calibration can only be performed by a certified lab. For those of you that are looking into these industries, be sure you inquire whether or not your work will come under either of these very stringent standards. For the rest of us, we can perform our own calibration with traceable NIST standards. But we do need to ensure the accuracy of our standards, sometimes referred to as "masters," by having them periodically certified by a qualified test lab.

Let's look at pre-installation verification (PIV) for the bolting process. The purpose of this is to verify that the fastener assemblies and also the pretensioned procedures perform as required prior to installation through lot testing. Typically we use a lab-certified tension calibrator (Skidmore is one brand name, e.g.) to perform the acceptance testing of the lot of bolts per our written procedure. The tension calibrator is our standard or "master," and we verify that it has a current calibration certificate. Likewise, we may use our calibrated "master" volt/amp meter to verify the output of welding meters.

Myth #2

Software calibration is stupid. Well, it isn't really, when done properly. Calibration of software is performed during the software development life cycle (SDLC) in the verification and validation phases. Software calibration is done by following very strict test scripts using validation tools and programs approved through a predefined testing protocol. When you purchase commercial software programs (often referred to as COTS—commercial off the shelf) you are paying indirectly for all of this testing, and the software can be considered calibrated with no need for any further calibration. If you decide to begin writing software code and developing your own programs, then you will need to do a lot of research into SDLC.

"But what if I made a really slick program in Excel and it does all sorts of very critical calculations?" First and foremost, all you have done is manipulated functionality already present in the software and created a spreadsheet or workbook. The software is calibrated and will remain intact. As for the equations you have created, one could say "garbage in, garbage out!" You need to verify that you are getting the desired result, but know that this is not software calibration. So your CAD, Excel, Access, Fabtrol, Steel 2000, or other purchased software does not require calibration. If you are using tools such as Visual Basic to enhance your software solution capabilities, then you should also create some basic test scripts to verify that your manipulations are providing the desired result as a part of your design process. Using clause 7.3 of ISO 9001:2000 "design and development" as a reference may assist in this process. If you use and document a controlled design process, you can avoid any non-conformances with the AISC *Building Standard* section 7.1.3.1 because your design will have covered all of the bases.

Let's return to the customer-facing side of calibration. Maintaining a well-documented and defined process for measuring equipment will ensure that you are meeting customer requirements for dimensional and finish tolerances. It also gives you the ability to proactively resolve defects that may occur from out-of-tolerance measuring equipment by knowing what product was measured and what was used to measure it. Keeping control of all measuring devices in the shop will ensure a high confidence level and allow for more advanced quality methods, such as in-process inspection and quality assurance, and will help you move away from 100% quality control inspection—thereby reducing costs, increasing confidence, and driving accountability and ownership in the product and process. These are the key building blocks to advanced techniques of "Lean Six Sigma" (a business improvement philosophy that results in faster output with better quality), but we will save that for a later article. MSC

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Best practices to keep your customers satisfied and to keep your confidence level high in regards to calibration:

- ➜ Calibrate new tape measures against a certified master at full length to ensure there are no printing or manufacturing defects, and then put a process in place to periodically check for damage to the sliding end and general condition.
- ➜ Using your master tape, calibrate your squares using the 3-4-5 triangle rule.
- ➜ Create a design drawing for a test piece, such as a beam line or drill line, that can be fabricated on your computer control equipment. Create a spreadsheet of the dimensions on the test piece drawing. Run the test piece, measure it with your master tape, and record the results on the spreadsheet. Perform this test piece process quarterly and compare the readings in the spreadsheet to watch for indications of drift or wear. Make the appropriate adjustments or use the information to guide the factory technicians in making adjustments and repairs.
- ➜ Have electronic test equipment—such as amp/volt meters for testing welding equipment, ultrasonic tester, vibration analyzer, etc.—calibrated by a certified calibration lab annually and require them to provide a report of the test results for the as-received and as-returned data. This information will assist in determining any drift that may require a shorter calibration frequency.
- ➜ Be sure to include dry film thickness gauges, weld gauges, welding equipment, and other equipment that is used to provide evidence of product conformity in your calibration program.
- ➜ Expand your calibration program beyond inspectors.