Contributing Factors to Load Cell Accuracy

A Technical White Paper by Interface

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There is a saying that close only matters in horseshoes and hand grenades. This could not be truer in the world of engineering today. As technology becomes more advanced, the margin for error gets slimmer and slimmer. Whether it's Apple® trying to fit more advanced components in their latest iPhone® without changing the phone's size or automotive manufacturers creating robust new safety features, every little detail matters.

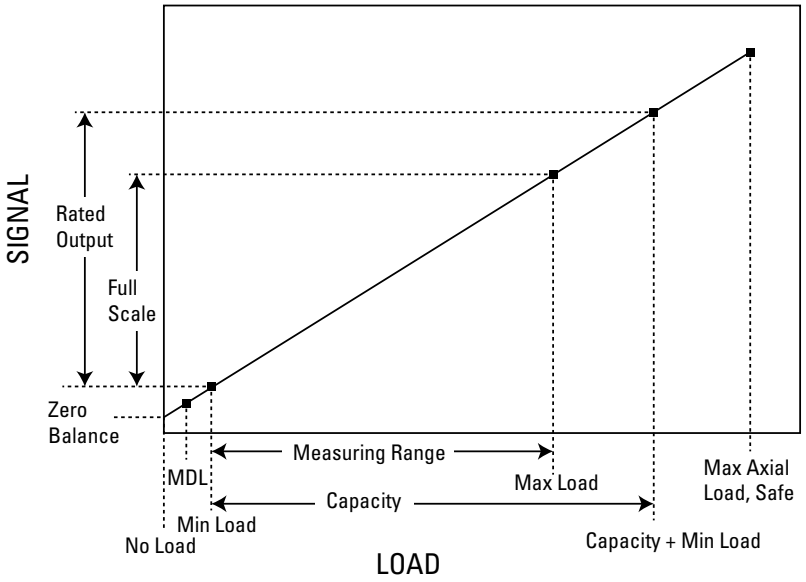
Accurate force and torque, down to a decimal of a pound of force (lbf), is a detail that cannot be overlooked in design. One of the pillars of product accuracy is dependent on the load cells that are used to measure force and torque values for an OEM's product inventions and advancements.

Load cells come in many shapes and sizes and are used to measure everything from the force of the material inside of an IV bag for medical applications, to the thrust power of a rocket engine. If measurements are even a tiny bit off in either of these examples, either patient health is at risk or the enormous investment into a rocket engine is in jeopardy.

In this white paper, we detail the importance of accuracy, the factors of accuracy and the ways engineers can avoid failure.

Why is Accuracy Important?

Load cells are the key component to testing and measuring force, weight and torque for just about every product imaginable. They are used in the design of products to determine various force and torque specifications; anything from frictional losses to fatigue life. They are also installed on products or systems that are already complete. These load cells are used to track factors of force in real-time and over long periods to help with preventative maintenance or to collect data for future product development.



As stated above, accuracy* is the difference between a solid, sturdy and quality product, and a product that becomes a liability to its user. Depending on the application, inaccurate designs or stress tests can lead to product failure and even death.

One of the products Interface load cells are used for is a heart stent which keeps a patient's arteries open and blood flowing to their heart. Once a stent is implanted in the patient's body, it's there to stay for the rest of their lives. Interface load cells are used to stress test stents so that the manufacturer can guarantee that it will not fail during the remaining lifetime of the patient.

The design of the Giant Magellan Telescope being constructed in Chile is another example of why engineers need accurate tools. The Magellan Telescope uses a unique glass material for the mirrors which can flex. This is the technology that allows scientists to peer deep into space. The tension on the glass caused by flexing needs to be accurately measured by load cells to ensure it doesn't flex beyond its limit. If it does, the glass will break and cost the Magellan team significant money and time losses. The difficulty of shaping each mirror segment is compounded by the fact that these large segments must have the same curvature to exacting standards in order to properly perform together. To achieve the stringent demand for accuracy, the load cell has to be extremely well calibrated and accurate.

** We are using the term accuracy throughout the white paper when describing our load cells performance in areas of non-linearity, hysteresis, and creep, temperature effect on zero and sensitivity, off-axis loading, and repeatability as a means of clarity for the reader.*

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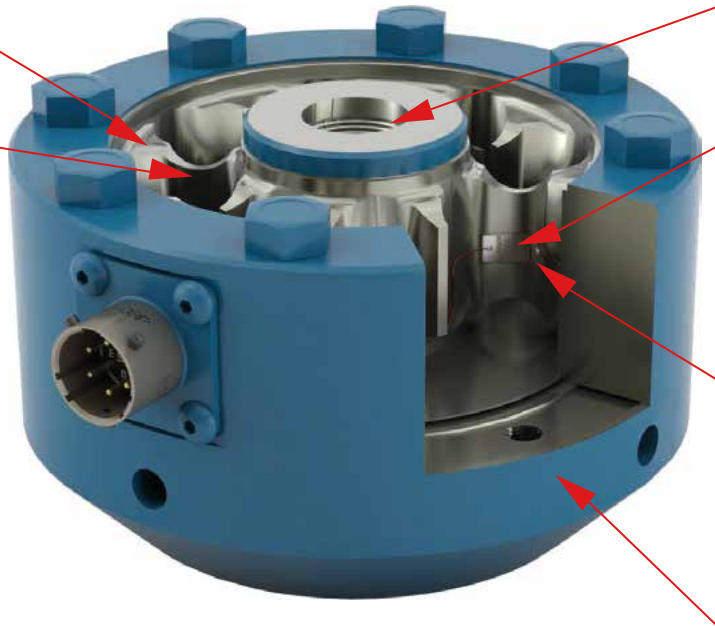
Contributing Factors of Accuracy in Force Measurement

How does an engineer ensure that the tools they use to design a product are providing them with the most accurate data possible? It all starts with the load cell and how it is designed. For almost every situation in product development and testing, there is a load cell to fit the precise need. Interface develops a wide variety of off the shelf standard, as well as modified and custom load cells for a number of different applications in various sectors. Each application has its own distinct measurement requirements.

These are some of the main factors Interface takes into consideration when designing a load cell. It is important for customers to know the conditions their application will be subjected to in order to select the correct measurement tools.

In-House CNC Machining
- Total control of manufacture and quality standards

Moment Compensated during Production
- Reduces the effects of off-axis loads



High Quality Threads
- 0.002” perpendicularity
- 0.003” concentrically

Proprietary High Output Strain Gages
- Matched to flexure for best performance
- 8-16 Strain Gages per bridge

Temperature Compensated Strain Gages
- No signal loss from compensation resistors
- Measures temperature at the strain gage

TRUE Fatigue Specification
- Fully reversed cycles through zero at full capacity

Class Leading Performance
- Published accuracy (Static Error Band) specification as low as ±0.02%FS and actual performance as low as ±0.01%FS on a regular basis
- Will never be less accurate than published spec

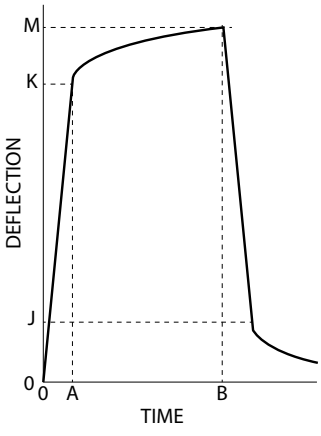
Accurate Machined Base (0.0002” flatness)
- Provides excellent mounting surface

Contributing Factors of Load Cell Accuracy

There are many additional factors that contribute to poor data and bad accuracy when working with load cells. These are the primary considerations to take into account.

Creep: This term used to describe the change in load cell output occurring with time while under constant load and with all environmental conditions and other variables also remaining constant. Creep occurs because materials very slowly deform over time when under constant load.

Side and Eccentric Load: Most load cells are designed to measure force in one certain direction, which is determined by the way the load cell is mounted (more on this factor below). Inappropriate loading will cause side and eccentric load, which risks reducing the life of load cells and distorting measurement results.



Creep

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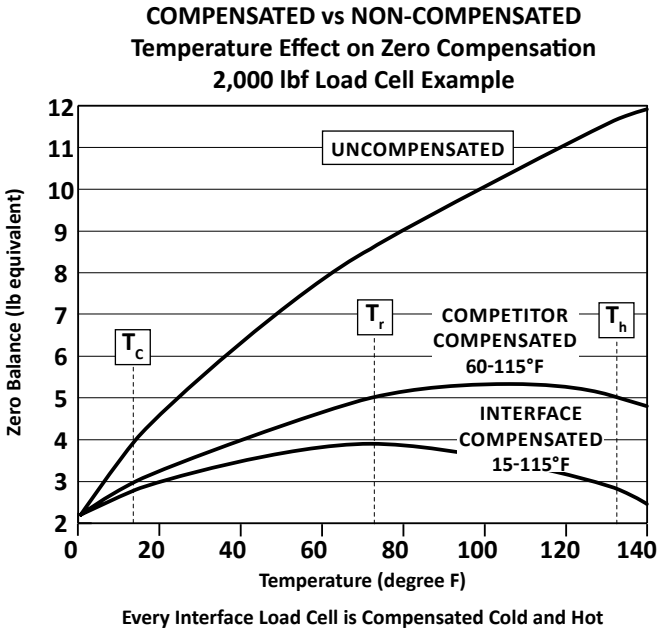
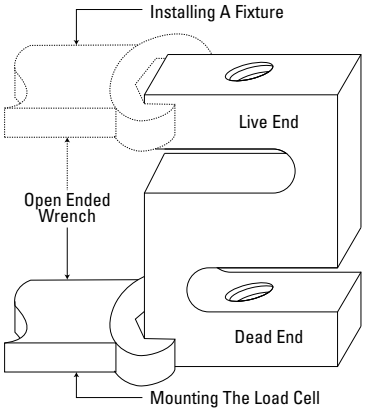


Temperature: Change in temperature during the measurement process is a significant factor in determining accurate load. The temperature in the air can affect the sensitivity of the load cell and provide inaccuracies if not accounted for. Engineers who are selecting a load cell need to be clear with load cell sellers that the product or component they are measuring needs to perform in certain temperatures.

Humidity: Similar to temperature, humidity also plays a factor in measurement accuracy in certain load cell designs. The effect humidity has on the load cell is a slower process; however, over time it can skew the data. If your environment includes high humidity levels, work with you load cell provider to ensure the correct design is selected for this environment.

Mounting Process: This is one of the most important factors for load cell accuracy. A load cell that is mounted off-center will significantly decrease the accuracy of the load cell because the mating process between the product you are measuring, and the load cell determines the sensors ability to perform accurate readings. Always make sure to follow the mounting instructions that come with the load cell to ensure accuracy.



** Interface always includes the worst-case accuracy values on its product spec sheets, unlike our competitors who often include average or nominal values. We feel confident that our products will never measure at the worst-case; however, it is important to be transparent about the lowest possible value. It is also true that Interface products' worst-case accuracy routinely beats our competitors' best-case.*

How to Avoid Accuracy Failure?

There are many ways to ensure you are getting the most accurate data possible out of your load cell. To start, always consult your load cell provider or the load cell manufacturer. They can help you select the right load cell and can teach you how to properly care for the load cell and maintain accuracy. Once you have become comfortable with the process of using your load cell, there are multiple steps to maintain it and ensure it remains accurate.

Utilize a Golden Part

A golden part is the original part that you collected data from using your load cell. You will want to select the golden part as soon as you receive your load cell and then whenever you are uncertain about data gathered from the load cell, double-check it on the golden part. If you aren't receiving accurate readings on the golden part, that means the load cell needs to be recalibrated.

Avoid Misusing the Load Cell

As noted, load cells come in numerous shapes and sizes and there is typically a load cell for any application. If you are using a load cell for unintended purposes by overloading it, you will eventually decrease the accuracy of the load cell or risk breaking it. Misaligned mounting and improper mounting can cause overload and eccentric load which will also decrease performance. It can also wear out the threading which will also impact accuracy.

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Set a Preventative Maintenance Schedule

Load cells, and Interface load cells in particular, should have a very long lifetime. Some of Interface's very first load cells ever manufactured more than 50 years ago are still in use today. In order to maintain load cell accuracy, you need to set a preventative maintenance schedule to recalibrate your load cells. It is recommended that you calibrate your load cells every year. When you first start using a load cell, you may want to recalibrate more often until you understand changes that occur with the load cell over time.

Recalibration

When it is time for recalibration, consult the load cell manufacturer to perform the recalibration. Interface completes more than 100,000 National Measurement Institute (NMI) traceable calibrations annually. In addition to servicing our quality products, we can provide calibration services for other manufacturer's load cells, as well as custom calibration services when needed. Recalibration is important for performance, and it also affects safety and compliance.

Interface is the Gold Standard for Load Cell Accuracy

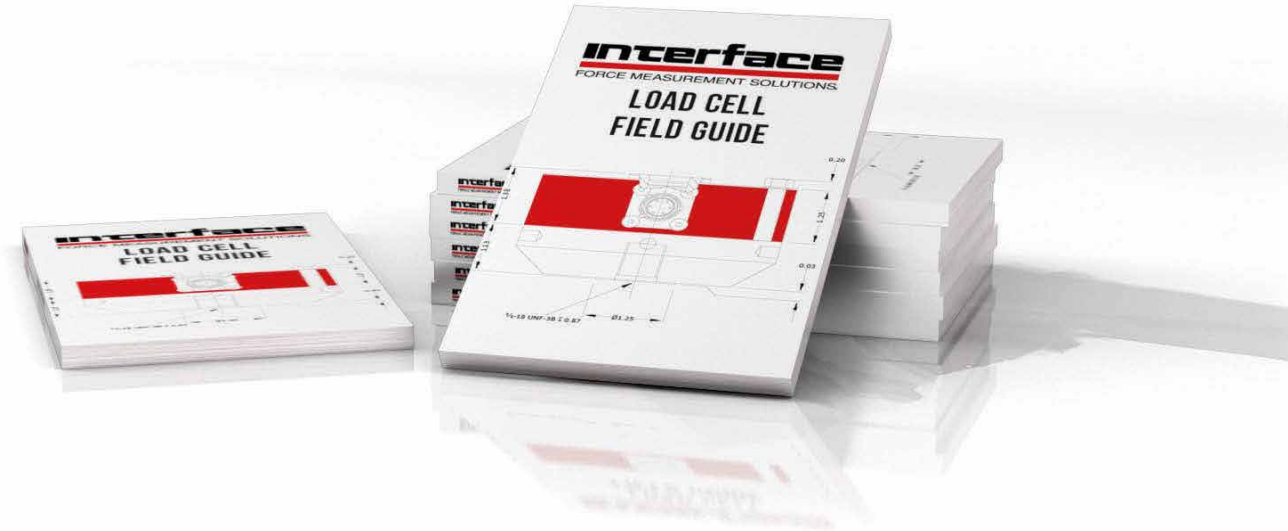
Accuracy in the products we develop at Interface is paramount to our success as a manufacturer, and to the quality and high performance requirements of our customers. We pride ourselves on being the most accurate load cell manufacturer in the market.

Our success is backed by the fact that over the past 50 plus years, our load cells and torque transducers have been used in nearly all industries, providing reliable measurements to tier one companies and organizations such as Boeing, Airbus, NASA, Ford, GM, Johnson & Johnson, National Institute of Standards and Technology (NIST) and the National Metrology Institute of Germany (PTB).

Interface maintains the highest degree of performance by managing the entire process, from design and machining, to strain gage manufacturing and assembly. This is how we ensure accuracy. It is our vertical integrated process that allows us to control the production of our force measurement products from start to finish. That is why we are the gold standard in load cell accuracy.

For more information on Interface, our products and our calibration services, please visit us at www.interfaceforce.com.

The Interface Load Cell Field Guide is also available on paperback or digital download on Amazon.



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Interface is the world's trusted leader in technology, design and manufacturing of force measurement solutions.
Our clients include a "who's who" of the aerospace, automotive and vehicle, medical device, energy, industrial manufacturing, test and measurement industries.

Interface engineers around the world are empowered to create high-level tools and solutions that deliver consistent, high quality performance. These products include load cells, torque transducers, multi-axis sensors, wireless telemetry, instrumentation and calibration equipment.

Interface, Inc., was founded in 1968 and is a US-based, woman-owned technology manufacturing company headquartered in Scottsdale, Arizona.

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