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# Extra Sensor Perception

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**Abstract:** This article describes the importance of sensor verification. It also describes the benefits of a portable sensor verification system and how it can be an essential tool that compliments any program in which sensors are used for control manufacturing or during critical testing.

**Keywords:** portable, sensor verification system, reliability, calibration

## 1. Introduction

Whether in the test lab, on the production line, or integrated into final products for in-flight use, the aerospace industry relies heavily on instrumentation. Sensors are used for testing endurance, fatigue and system qualification. They are integral to wind-tunnel testing, for destructive or proof load testing and are also widely used for feedback in process control.

In all cases, reliability of test results is based on the assumption that the sensors are providing the correct information. Most tests consist of many sensors and multiple channels of instrumentation. These require a group effort with a high budget and thousands of man hours. When there is a discrepancy in the test results, the credibility of the sensor is immediately in question. It is quite time, labor and cost intensive if instrumentation must be sent back to a calibration lab for anything other than scheduled maintenance.

Test engineers require a vast amount of resources and a large budget for high precision test equipment including a considerable number of sensors and related instrumentation. Putting equal effort into ensuring and verifying the accuracy of the sensors and interfaced instrumentation should also be done; however, it rarely happens. Engineers are often content with the sensor calibration data furnished by the supplier or from outside calibration services. When sensor calibration drifts, more than defective

product or unreliable test result can be the outcome. It only takes one look at the problem that occurred with the US$1.5 billion Hubble Space Telescope program to drive home what a flaw due to wrong calibration data can do to both the finances and credibility of a program. Problems like this can be avoided by implementation of a reliable verification system and program.

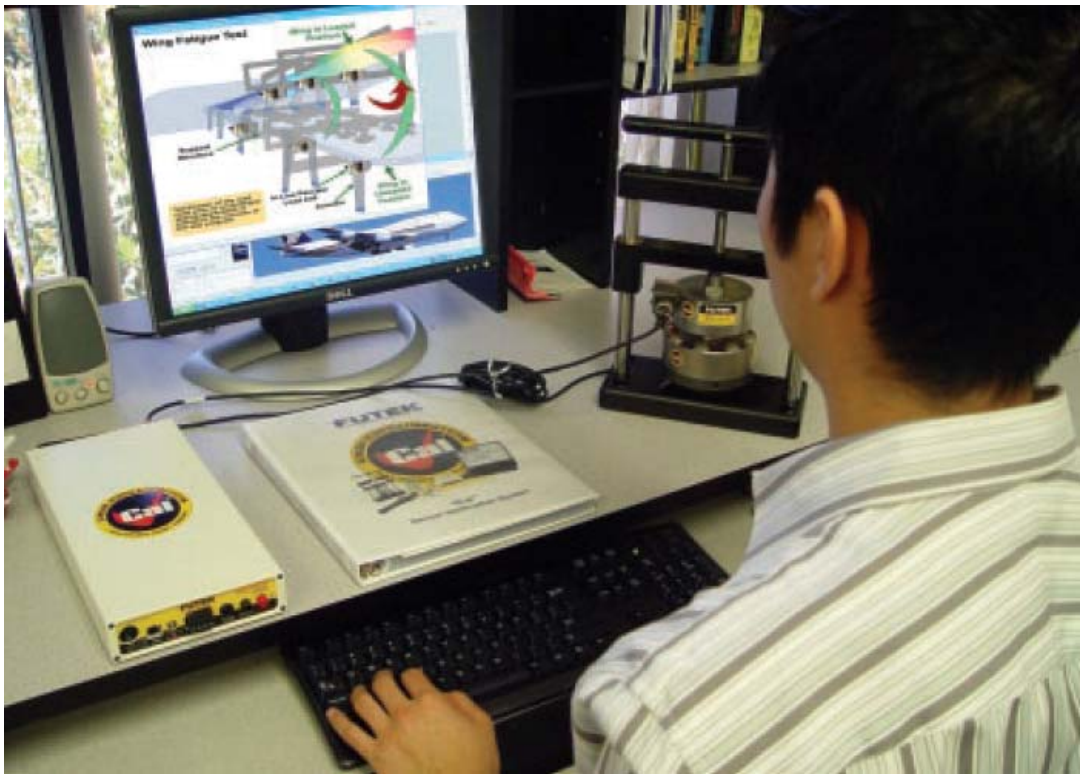

**Fig. 1.** A sensor verification system that is portable can become an essential tool that complements any quality program.

## 2. Maintaining Sensor Functionality

With the exception of occasional instrumentation upgrades, when developing complex test systems for aerospace test and flight applications, basic systems most often last for decades. Keeping them in calibration is an expensive issue. Furthermore, most companies are unsure of the calibration intervals required of their sensor products and assume annual requirements will be necessary or sufficient. At times, this is correct, but there are many instances where the intervals are shorter or longer than one year depending on the application cycles, handling and environment. When instrumentation designed for onsite verification was developed, the benefit was obvious. The ability to verify the functionality of any sensor on-site rather than needing to pull it off-line, put in a substitute that may or may not be in top calibration, and send the ‘suspect’ back to a calibration lab for functional testing saves time and money.

There are many existing calibration systems that can be used in-house, but they are large, complicated and require highly educated technicians. They are also often concentrated on only one or two aspects of instrumentation, not a wide range. Rather than invest in these systems, most companies would rather pay to ship sensors, or even full systems, back to a main calibration facility, often to discover that there is nothing wrong with the instrumentation and they should be looking elsewhere for the problem. It’s a costly and time consuming way to find this out. If the calibration has slipped, it does not tell them when it went out of specification. Should any parts built be considered defective? Should they recall and retest each of those parts ?

Using a portable calibration/verification device, calibrations can be calculated and verified anywhere quickly and precisely. Three main benefits are clear: First, any sensor that is drifting out of calibration can be tagged the minute it starts to fail instead of after serious problems occur. Secondly, the cost of using calibration labs for checking suspicious functionality is totally eliminated because only defective sensors will be sent in. Finally, a replacement sensor can be checked for functionality when it is put into the system while the other is sent out for recalibration. Below are examples of how verification was used to benefit specific applications.

**Test:** A group of test engineers were required to test airplane wings by applying specified forces at 150 locations under the wing. Utilizing actuators equipped with pancake load cells inline, they connected them to a multichannel data acquisition system. Each channel was preconfigured and scaled per given load cell calibration data. If any load cells were connected to the wrong channel or the wrong calibration certificate was used due to a mislabeled cable, then that channel or actuator would not apply the required load as specified. A much higher load would cause wing failure far earlier than expected and a lower load would validate a possible weak design. Either scenario would mislead the designers. Verification of each load cell system after installation and instrument configuration and scaling was used to ensure accurate results. The data was also used to create a signature test for comparison for subsequent testing.

**Production:** A fastener manufacturer was required by a major aerospace company to cold work special rivets using an automated collect system by applying a given force while opening and closing the chuck for a specified cycle. Due to the critical nature of the requirement, the customer required full documentation to support the fact that the forces applied were within tolerance. After a documentation control review, it was discovered that the sensor was not meeting the required specification after the annual re-calibration check. All fasteners were recalled and had to be replaced. A verification system was installed to check the sensor and the system prior to each batch setup following this major loss, and has prevented errors and given both the supplier and the customer a piece of mind.

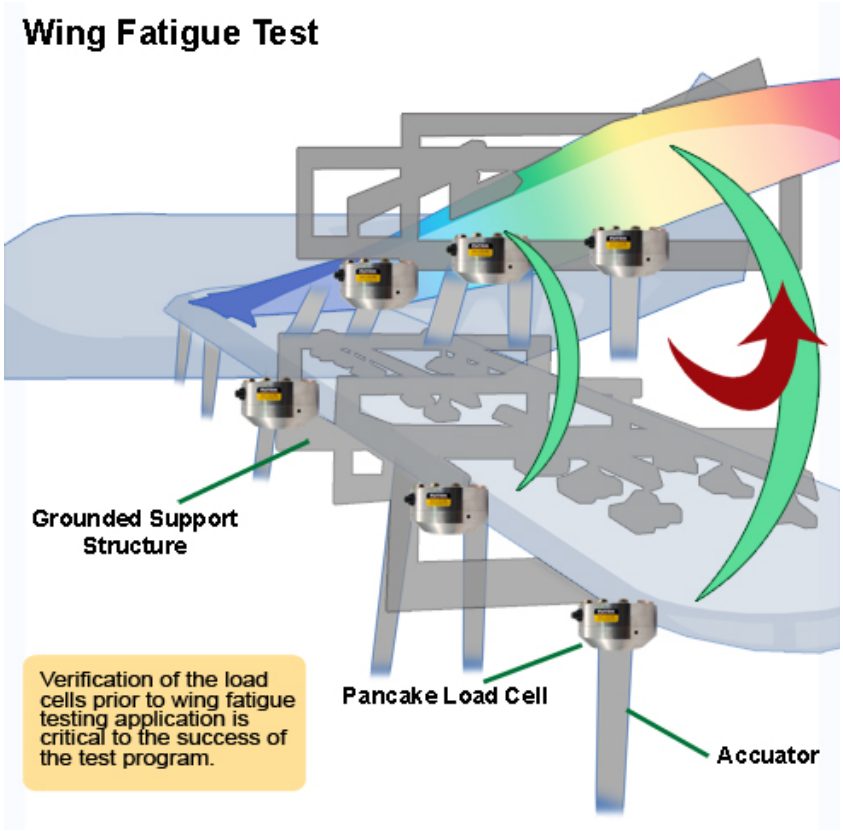


**Fig. 2**. Fatigue tests were carried out on wings with specific force being applied at 150 locations.

Quality Control: A major aircraft supplier with multiple global divisions faced the challenge of how to control and specify damage due to mishandling of a wide variety of sensors used for various applications across the divisions. An alliance exchange program was installed across the facilities. By installing a common verification system at each division and recording a signature test upon arrival and departure of every sensor, all problems due to sensor damage were eliminated.

## 3. Portable Verification Systems

The latest in verification technology has enabled FUTEK to offer a portable system that is designed for on-site verification, quick check, and calibration of load cells, torque, force, and pressure sensors. All of the required testing needed for any sensor is integral to the unit itself. The main advantage of this type of portable verification and calibration system is that it supports the load cells, pressure and torque sensors of all manufacturers, and any sensors with output of +/-4.5mV/V range, +/-15VDC range, 0-20mA and any sensor with RS232 or USB interface.

With integral software, storage capability and USB interface, data can be saved to the unit itself, in any computer or on a dedicated server via the Internet. Users can create multiple curves in different ranges for one sensor. For example a 5,000 lbs capacity reference load cell can be provided with a curve of 0-5,000 lbs in comp, a separate curve for 0-5,000 lbs in tension and a different curve for 0-500 lbs. Depending on the test requirement, the curve closer to the required load cell capacity can be selected. Systems also support TEDS (Transducer Electronic Data Sheet) per IEEE1451.4 standard for auto recognition of the sensor in use or smart sensor.

Verification and calibration software programs support linearity, hysteresis, and repeatability testing with user defined testing parameters. Manual entry of recorded test data from a previously calibrated reference sensor or test sensors is standard. Units provide overload and over-range warnings, and even provide users with customizable or standard certificates.

A portable sensor verification system can become an essential tool that complements any quality program where sensors are used for control in manufacturing or during critical testing. Verifying sensors at regular intervals can help prevent costly product test failures or worse, failures in the field due to sensors or test systems that were out of calibration in production. Being able to measure the severity of abused, mishandled or overloaded sensors after verification and developing a signature analysis provides system stability and repeatability in the long term.

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# Guide for Contributors

## Aims and Scope

*Sensors & Transducers Journal (ISSN 1726- 5479)* provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because it is an open access, peer review international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per annual by International Frequency Association (IFSA). In additional, some special sponsored and conference issues published annually.

## Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

## Submission of papers

Articles should be written in English. Authors are invited to submit by e-mail editor@sensorsportal.com 4-12 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: http://www.sensorsportal.com/HTML/DIGEST/Submition.htm Authors must follow the instructions strictly when submitting their manuscripts.

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