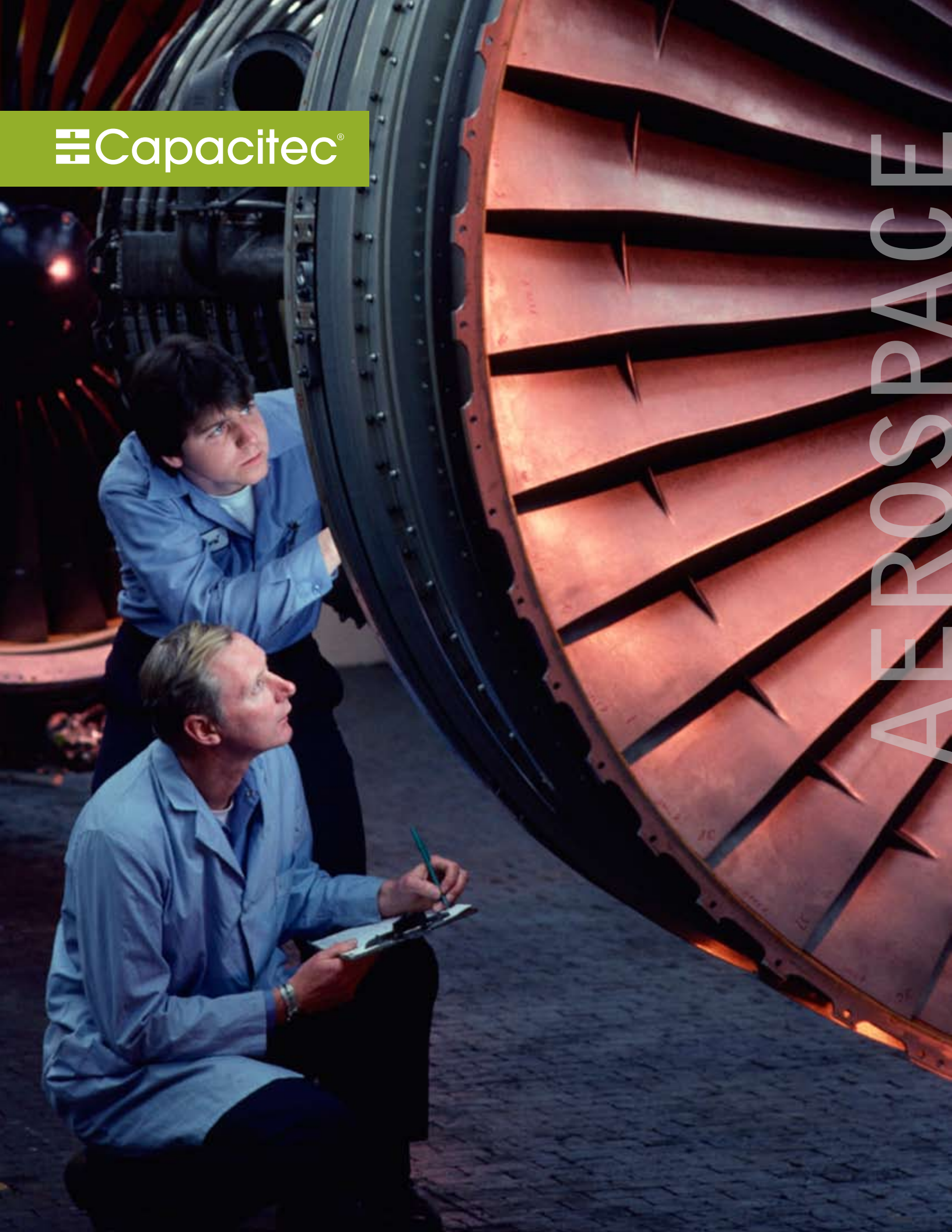
Capacitec®

AEROSPACE


Capacitec®
AEROSPACE

Aerospace is a major market for Capacitec's non-contact displacement, gap and hole mapping sensors and systems. Our customers build/rebuild commercial and military aircraft and engines. For 25+ years we have worked closely with manufacturing and quality engineers as well as R&D to enhance their product designs and production and quality control methods. Often we have replaced mechanical measurement tools such as feeler gauges and go/no gauges with electronic alternatives.

FOR EXAMPLE:

- The GAPMAN® "electronic feeler gage" provides a high accuracy non-contact equivalent with a built-in data logger, the only way to comply with SPC/Six Sigma product improvements.
- The LiniGage engine eccentricity tool improves rebuild centering of aircraft engines while completely assembled.
- The CMS/CHP capacitive hole profiler offers a 48 sensor complete hole mapping probe in a portable system.

These solutions provide you with compelling time/cost reductions and quality enhancements that easily support very rapid payback on your investment.

Major applications include:

AIRCRAFT ENGINES

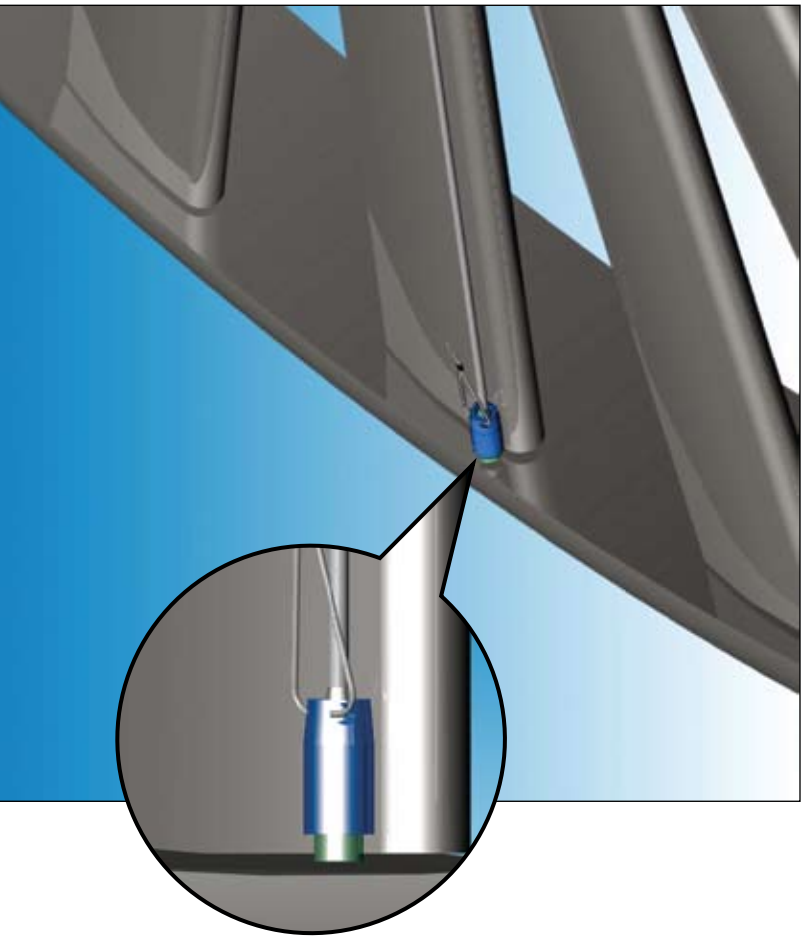
- HPC/HPT rebuild eccentricity for CFM56, CF34-10 and others
- Fan blade length and blade tip gap measurement for GE90, GENx, CF6, RR Trent and others
- High temperature runout and thermal expansion for P&W 4000 & F135 (JSF) and MTU engines
- "Mapping" bore diameter dimensions for P&W turbofans

AEROSPACE STRUCTURES

- Gap measurement for shim selection for:
  - + Wing tie plates, skin to frame and frame gaps
  - + Gaps in airframe between subsections and mating surfaces
  - + Tail section tie plates and horizontal stabilizer gaps
  - + For Boeing 737, 747, 777, 787 and the Airbus family
- "Mapping" bore diameter dimensions on wing tie plates for Airbus A318, A319, A320 and A340, Boeing 737 and 777
- Outer skins/frame fastening for Delta IV launch vehicles

LiniGage

Aircraft Engine Rotor Eccentricity Realignment



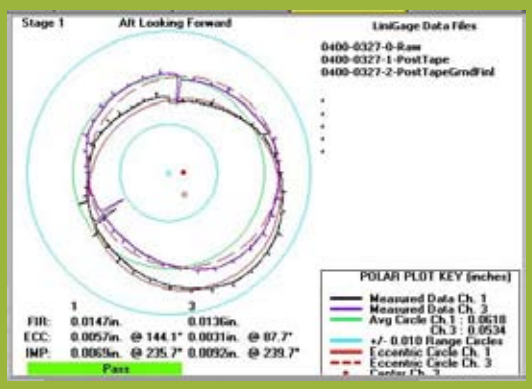
The Capacitec LiniGage is an Aircraft Engine Rotor Eccentricity Realignment System that is used to set the concentricity of engine rotor assemblies such as in the HPC and HPT sections. An 8mm non-contact displacement sensor is temporarily attached to the tip of one of the blades with a lead typically exiting the engine enclosure through a borescope hole. The rotor is rotated 360° allowing the sensor to measure the gap between the blade tip and the housing inside circumference. The LiniGage custom software takes displacement values, polar plots the circumferential blade gap and calculates the eccentricity magnitude with its resultant angle. An out-of-spec eccentricity plot then allows the engine rebuild technician to easily identify where to make adjustments by re-torqueing case segments into specification simultaneously creating a permanent quality record.

A new recently introduced LGWAS version supports the CFM and GE families of engines in rebuild centers and during their design. This is a custom version of the LiniGage to help support continued quality initiatives for these aircraft engines.

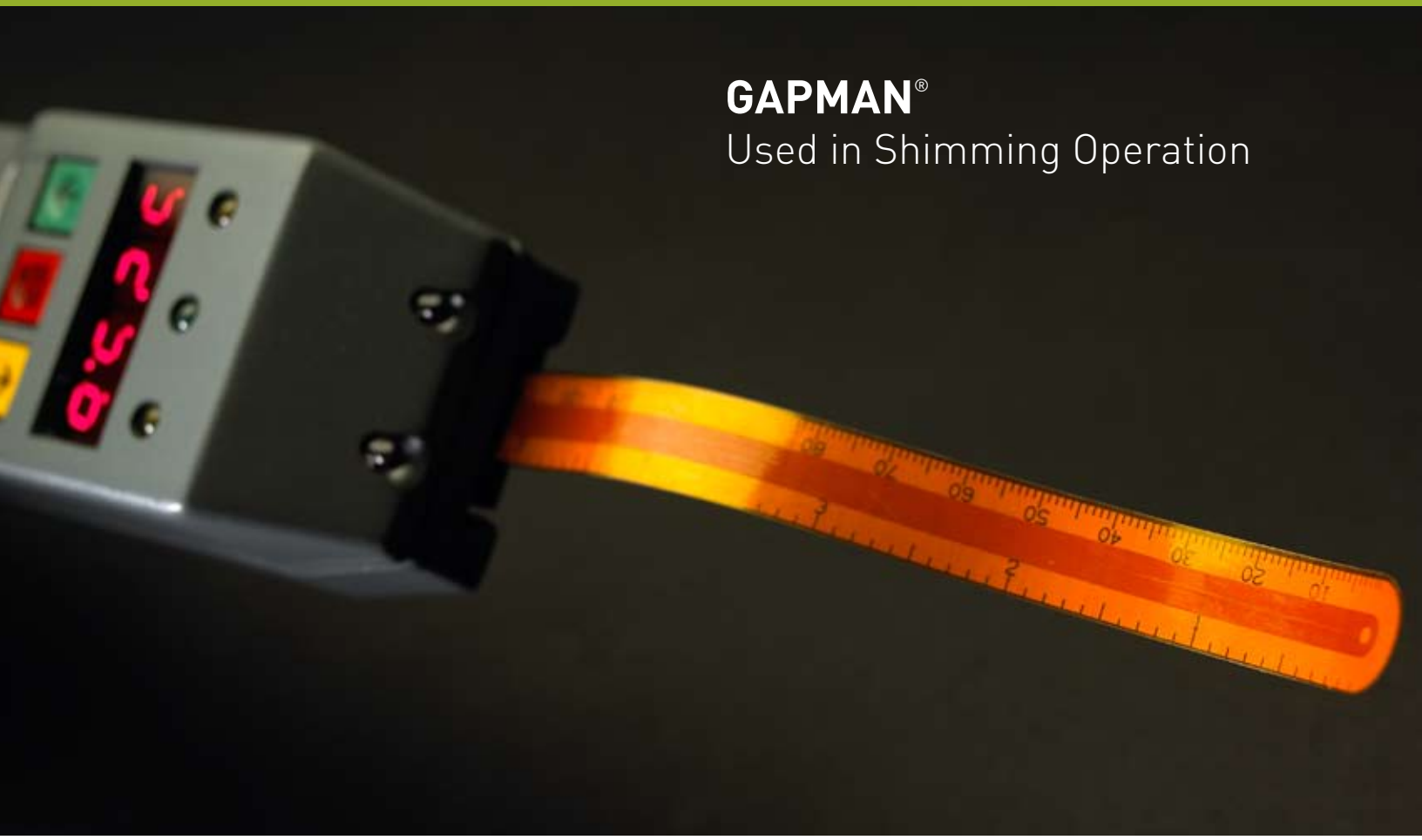
The original LGDAS system was introduced in the late 1980s and there are more than 100 systems currently in operation worldwide at engine manufacturers and rebuild centers.

The new LiniGage running on Windows XP® offers even more benefits to engine manufacturers and users due to the following features:

Features	Benefits
Single rotor and custom multi-rotor, multi-engine HPC/HPT gap measurements	Simultaneous gap, eccentricity and FIR measurement using one system can be easily programmed for any new engine style
Windows XP (Vista) ® software platform	Very easy user interface, PDF and exportable data files to standard software packages
Multiple ID grinds	Compensation for multiple internal grinds w/o affecting FIR (full indicated runnout)
Measure engine in vertical or horizontal positions	Mathematical compensation for gravity "droop" in horizontal position
Higher resolution encoder	Better data fidelity
ISO9001 certified calibration method	Measurements traceable to worldwide standards



Polar Plot showing two engine stages simultaneously



GAPMAN®
Used in Shimming Operation

GAPMAN® is the world's first high precision, non-contact, portable electronic gap measurement gage. It features a dual capacitive sensor for position-compensated measurement and easy insertion into very narrow gaps down to 0.004" (105 microns) in a wide range of aerospace applications.

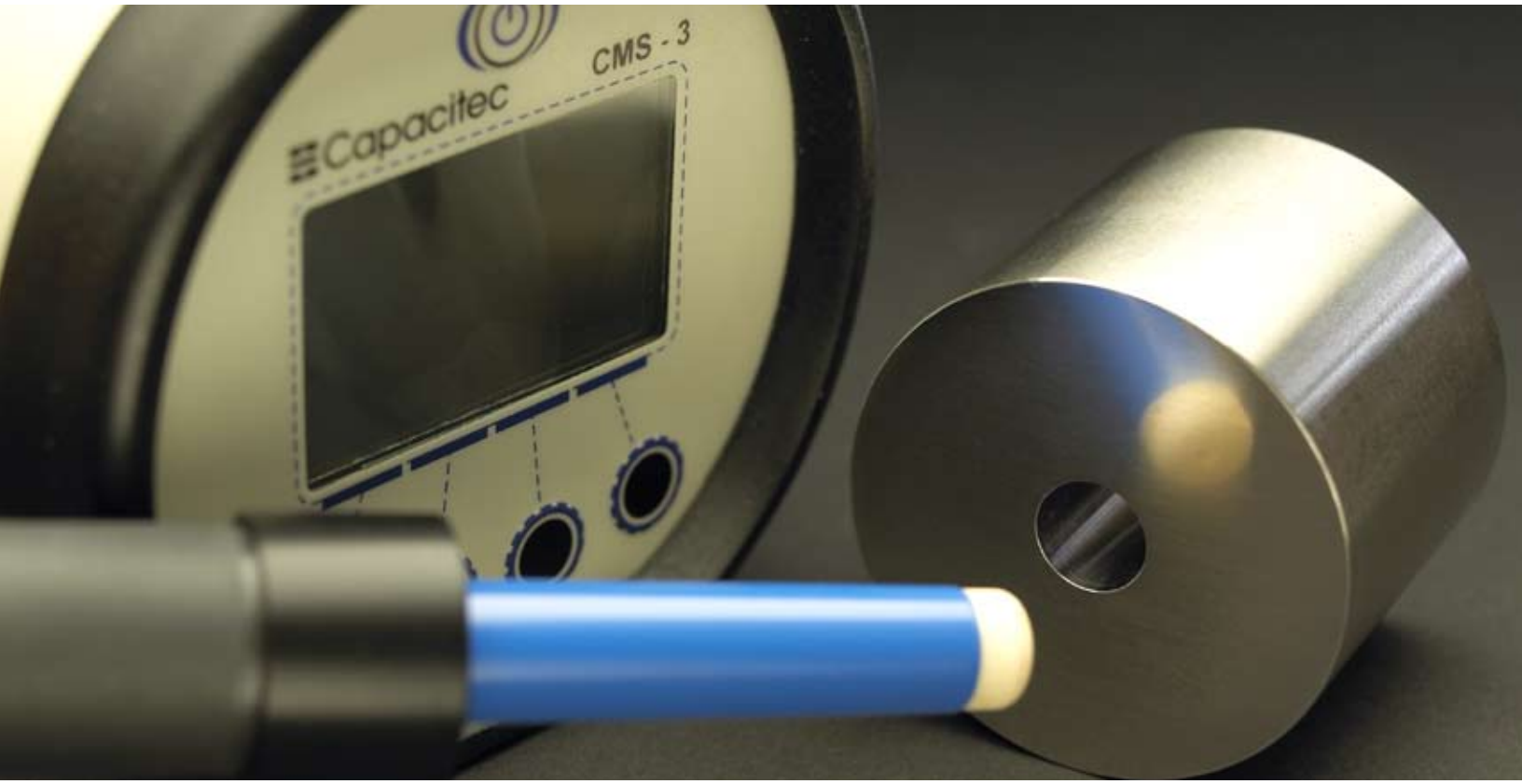
The most popular aerospace application for the GAPMAN® is the assembly of Commercial and Military aircraft and in particular its use in the shimming process. It has been documented that the use of the GAPMAN® has reduced the time required for shimming by 5X over the previous method using feeler gauges. Hundreds of units have been in use over the past 10+ years and the robust units are holding up well in this tough shop floor environment.

Key Features Include:

- Measures gaps between all metal and composite surfaces
- Microprocessor based and application software driven
- Records and stores up to 1,000 data points for easy transfer to SPC and other quality systems via RS232
- Typical accuracy is +/- 0.0005 (12.7 microns) or better with resolution of 0.0001 (2.54 microns)
- Battery operated and lightweight (approx. 1lb/454 grams)

CMS™ (Capacitance Measurement System)

Hole Diameter Mapping System



Airframe and other demanding structures require thousands of fastener hole inspections to ensure compliance to exacting design specifications. The CMS3™ and Capacitive Hole Probe (CHP) combine to form a system that reduces operator influence. The non-contact displacement sensor probe contains 48 sensors that allow the system to inspect 24 inside diameter locations of a fastener hole in one insertion in less than 3 seconds.

Additional Features:

- High-speed, high-precision measurement of straight, tapered, or countersink fastener holes
- Min, max, and average hole diameter are displayed with the option of having Pass/Fail limits
- The CMS3™ interfaces with industry standard data collectors for in-process trend analysis
- Dramatically increases measurement throughput while minimizing operator induced errors
- Rigid probe design provides a unique centerline data reference
- Wireless options available

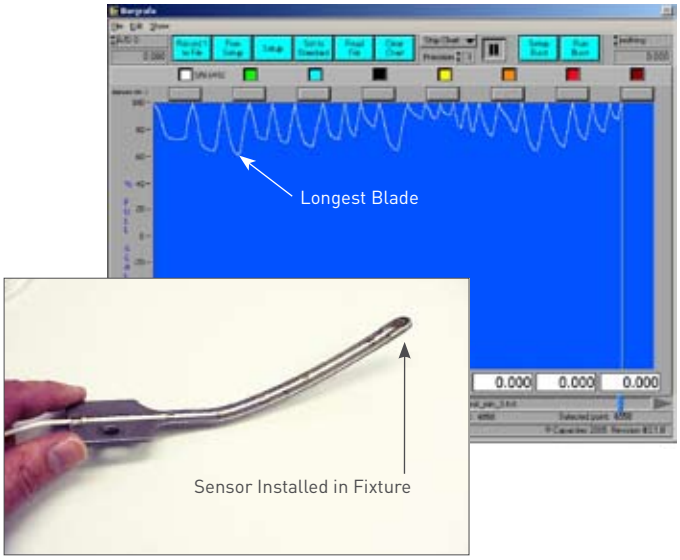
Engine Fan Blade Length Measurement

Non-Contact and Contact Methods

FIXED POSITION NON-CONTACT METHOD

To enhance efficiency and safety, aircraft manufacturers need to know the fan blade lengths during initial assembly and after engine rebuild. Current mechanical gap measurement methods, such as step gauges and shims, cannot meet the latest quality requirements such as Six Sigma since they fail to pass Gauge R&R. In response, Capacitec has developed a special "electronic blade length gage" that operates as follows:

- An HPB-150 non-contact displacement sensor is installed in a custom fixture that precisely positions the sensor onto the engine cowling interior with the sensor facing up under the fan blades.
- The fan blades are rotated 360º with each blade passing over the sensor. (Two sensors can be installed in the fixture if leading and trailing edge measurements are required.)
- A single channel electronics package including a Bargrafx peak read software application interrogates each sensor signal and displays the blade length while recording the results on a laptop.



PORTABLE CONTACT WAND METHOD

The portable "contact wand" blade length measurement system is used to measure gaps between fan blades and the engine cowling. The advantage of this system is that it does not require grounding of the target and the hand-held wand and electronics can easily access any of the fan blade gaps without the need to rotate the blades.

It Operates As Follows:

- A double-sided GPD4 non-contact displacement sensor is installed onto a metal wand with two flexible leaf springs placed on top to provide the target.
- When the wand is introduced into the gap, the leaf springs bend inward toward the sensors giving a precise reading of the gap.
- The sensor wand can either be integrated into a portable GAPMAN® unit or alternatively into a Gapmaster3® electronics package with a remote wand option.

Capacitec®

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