Gapman® Gen3 replaces feeler gauges in Aircraft Shimming Process

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Robert Foster and Bryan Manning Capacitec

Over the past few years the Aircraft Assembly Manufacturers challenges have amplified extensively. Customers such as Airlines, Leasing Companies and Freight Companies as well as passengers are looking for improved safety, lower cost, reduced time and better comfort.

The responses are new versions of 777X, A350, 787 and new smaller models from Embraer and Bombardier.

Their most evident approaches are reducing production cost and lead-time. Capacitec has embraced the industry's wants and needs by responding to requirements such as increased speed, accuracy and ability to measure difficult sizes, shapes and hidden gaps.

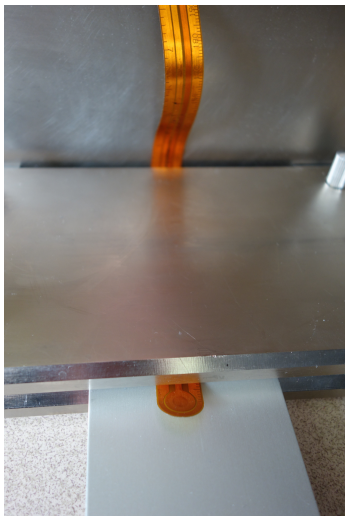

Figure 1: Impossible access achieved with flexible wands

Traditional gap measurement methods, such as feeler gauges (see Figure 2) and plastic shims cannot meet today's quality methods and specs for accuracy and repeatability. In addition, automatically recording and storing error-free data can result with headaches for Quality and Manufacturing.

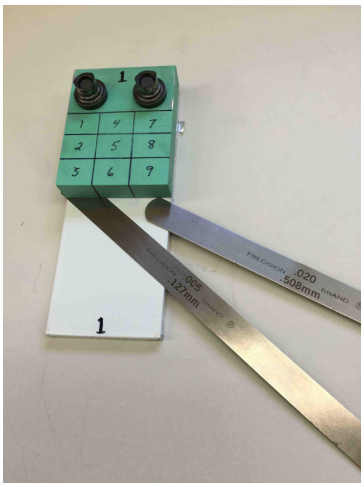

Figure 2: Traditional Feeler gauges

New requirements for carbon composite aircraft platforms such as the A350-100, the 787 Dreamliner and the newest 777X assembly techniques has been challenging. In cases of inboard hidden gaps where the gap dimensions expand to a larger value the feeler gauges cannot measure gap value at all.

Released in 2011, the Gapman **Gen3**® is a portable battery operated, non-contact gap measurement system. It includes two capacitive sensors – one looking up and the other looking down installed at the end of a flexible Kapton® wand. The sensors are connected to the Gapman **Gen3** electronics and use a separate conductive ground lead being attached to the target surfaces. The sensor pair acts as one plate of a capacitor. The grounded targets act as the other plate of the capacitive return. The gap between each sensor face to the grounded target is linearly calibrated to digital engineering units. The results can be recorded into internal Gapman **Gen3** memory or sent by USB or Bluetooth to a laptop computer.

Historically the Capacitec Gapman® portable non-contact electronic gap measurement system has been used for aircraft shimming applications since 1996. It has replaced feeler gauges and other mechanical contact methods at all major commercial aircraft manufacturers with a non-contact "electronic feeler gauge". See Figure 3.

Figure 3. Gapman Gen3 with flexible wand with dual capacitive non-contact sensors

Another advantage of the Gapman Gen3 is the flexibility of the wands inserted into gaps with difficult access as seen in the 90-degree angle in the photo below (Figure 4).

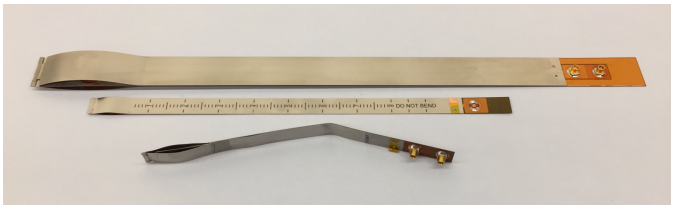

Figure 4: GapmanGen3 contact and non-contact flexible and rigid wands for measurement of hard to access hidden gaps

Over the past few years Capacitec has met the challenge of providing higher volumes of GapmanGen3 to match the increased production volume of the A320 and 737 aircraft rising to 2 to 4 planes per day. The Gapman's value is saving significant labor cost compared with the past feeler gauges methods and helps with lowering aircraft production lead times.

Capacitec consistently develops new Gapman Gen3 wand models to solve aircraft assemblers' pain such as measuring gaps in hard to access gap locations, non-conductive targets (one or both), and painted target surfaces.

One of the examples is the 777X. The wing configurations and materials are different from the older 777 versions. The new wings use composite skins attached to metal ribs versus the older version of metal to metal. This larger structure and higher loads also requires larger shims to fill the voids. *There was also high pain due*

to the tolerance fit in 3 axis and more??. Engineers were required to profile large gap areas so they contacted Capacitec for a solution. The new Gapmaster design now enables aircraft builders to profile large gap areas reaching into gaps along 500mm while mapping every 25mm.

Attaching skins on the new very large rib pads was also a challenge. Such large wing surfaces requires thousands of gap measurement to see if they are needed to insert shims (liquid and solid) to fill the voids. In some cases, measured inside the fuel tanks requiring a custom angled probe due to the limited access or operator convenience.

These new methods may also be used for the new A350-1000. It is the biggest variant of the Airbus A350 family featuring a 7-meter longer fuselage, modified wing trailing edges.

Additional new aircraft models are in the process of development worldwide. Examples are the Airbus/Bombardier 210, longer term Boeing/Embraer new models along with developing military fixed wing and rotary aircraft

Development of the Capacitec Gapman$_{Gen4}$

Larger shims in applications such as fuselage joins, wing assemblies and elevator and engine pylon joins are driving aircraft builders to look for new gap measurement systems with the ability to measure higher volumes of gaps with one electronic systems. To meet these challenges, Capacitec is in the development of the new Capacitec Gapman$_{Gen4.}$ This will be a multi-channel measurement system (8 to 16 gaps) to map out the dimensions/contours of larger and very large shims required in critical join locations.

Figure 5: Spring contact wand for gap measurement of non-conductive targets

Robert Foster is President of Capacitec and Bryan Manning is Commercial Director of Capacitec Europe.