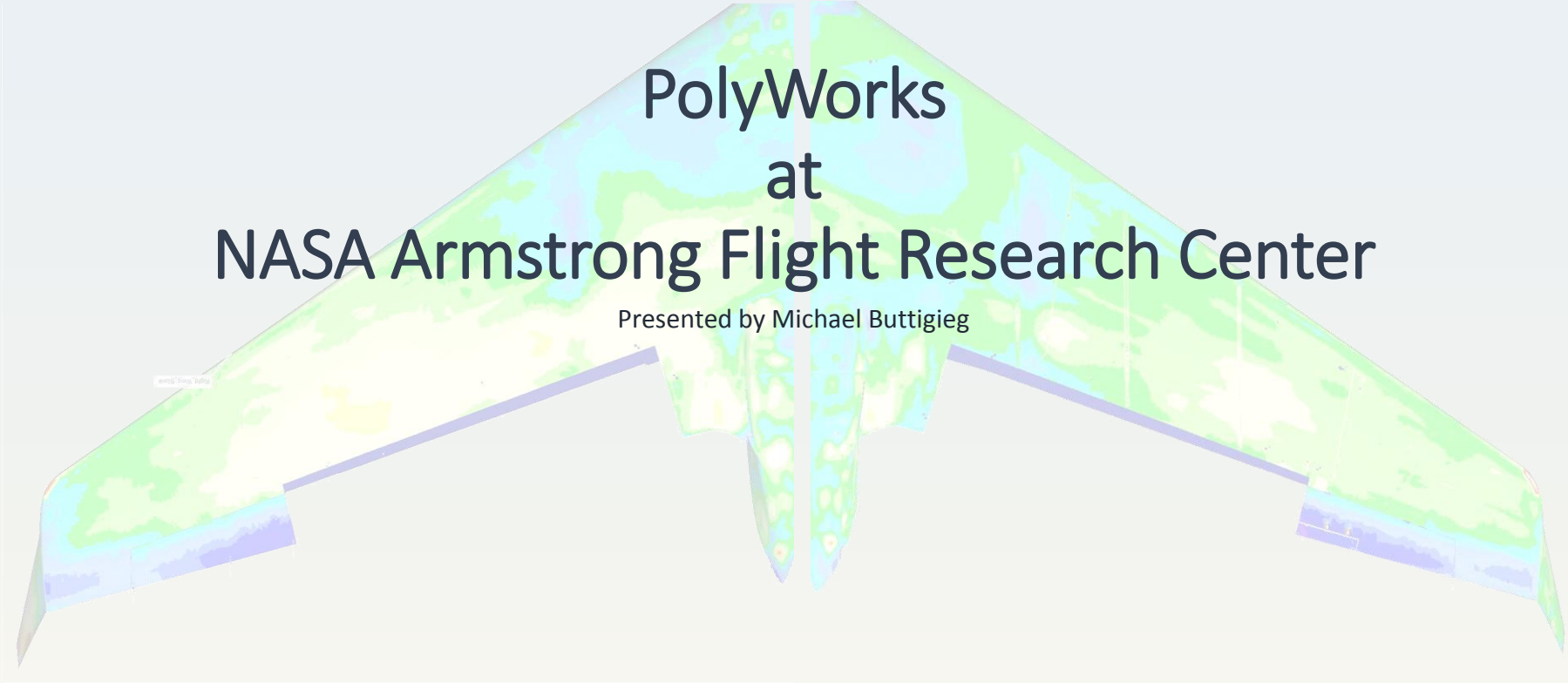
PolyWorks
at
NASA Armstrong Flight Research Center

Presented by Michael Buttigieg



Agenda

- Metrology Tools
- *Case Studies*
  - Virtual Fit-Checking
  - CFD Model Creation
  - Instrumentation Locating
  - Surface Deviations & Comparisons
- Conclusion

Metrology Tools

Romer Infinite 2 Portable CMM

Surphaser HSX100 Spherical Scanner

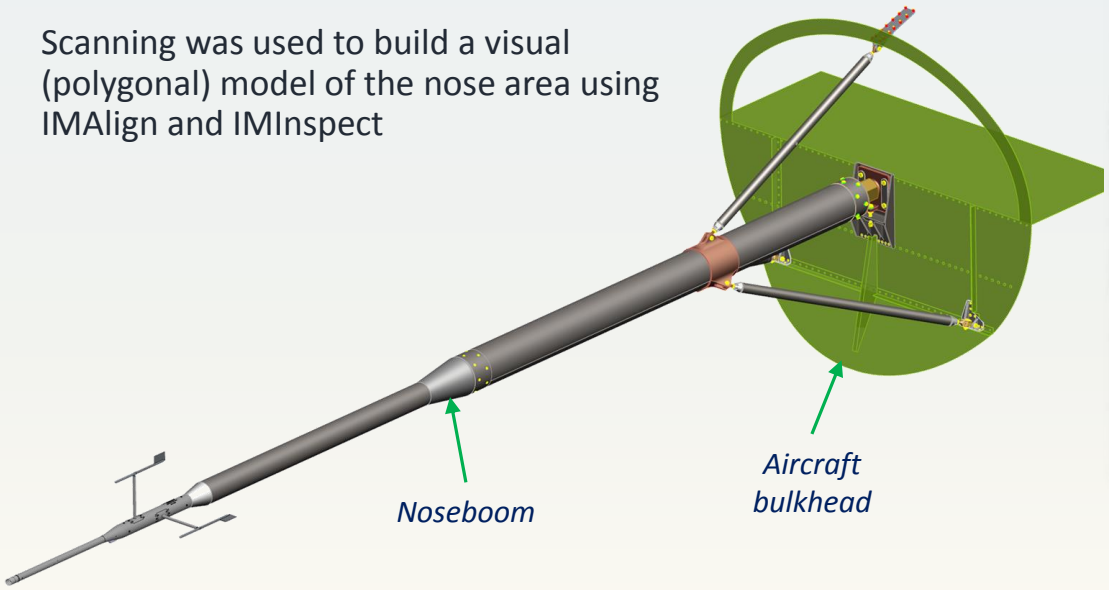
ScanShark V4 Laser Scanning Attachment

Mitutoyo Bright-M CMM (retrofitted for Polyworks use 2016)

Virtual Fit-Checking

A Noseboom for a Gulfstream III

- A newly designed noseboom for our Gulfstream III testbed utilized the capabilities of the Romer Arm and Surphaser peripherals
- Probing was used to identify existing hole locations for the new mounts
- Scanning was used to build a visual (polygonal) model of the nose area using IMAlign and IMInspect

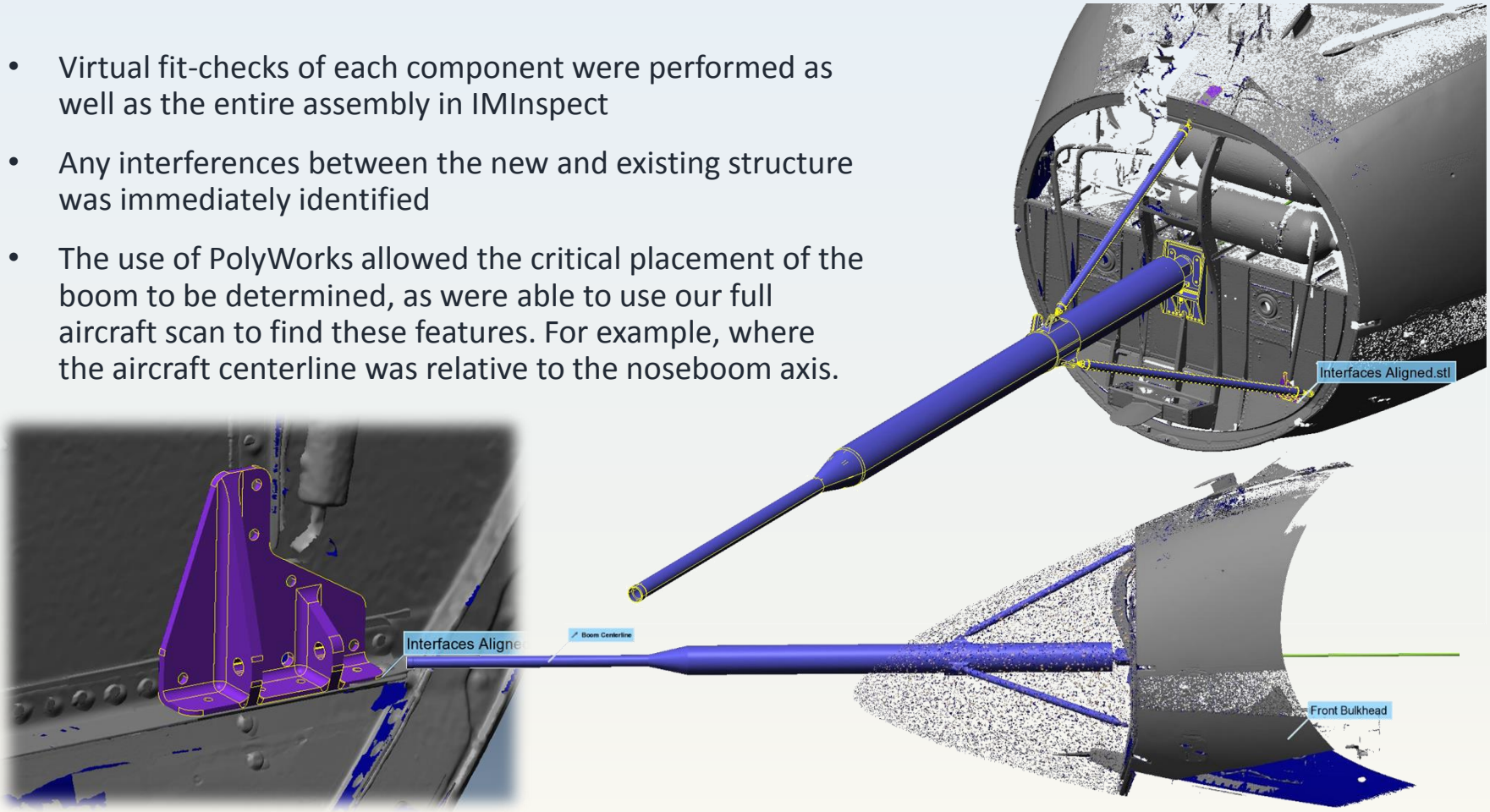


Probing setup

Virtual Fit-Checking

A Noseboom for a Gulfstream III

- Virtual fit-checks of each component were performed as well as the entire assembly in IMInspect
- Any interferences between the new and existing structure was immediately identified
- The use of PolyWorks allowed the critical placement of the boom to be determined, as were able to use our full aircraft scan to find these features. For example, where the aircraft centerline was relative to the noseboom axis.



CFD Model Creation

Variable Pitch Airplane Propeller

- A variable pitch propeller was selected to be used on an upcoming aircraft propulsion project
- Like many other projects we are involved in, computational fluid dynamics (CFD) analysis was needed to provide thrust characteristics

Mfg. CAD model

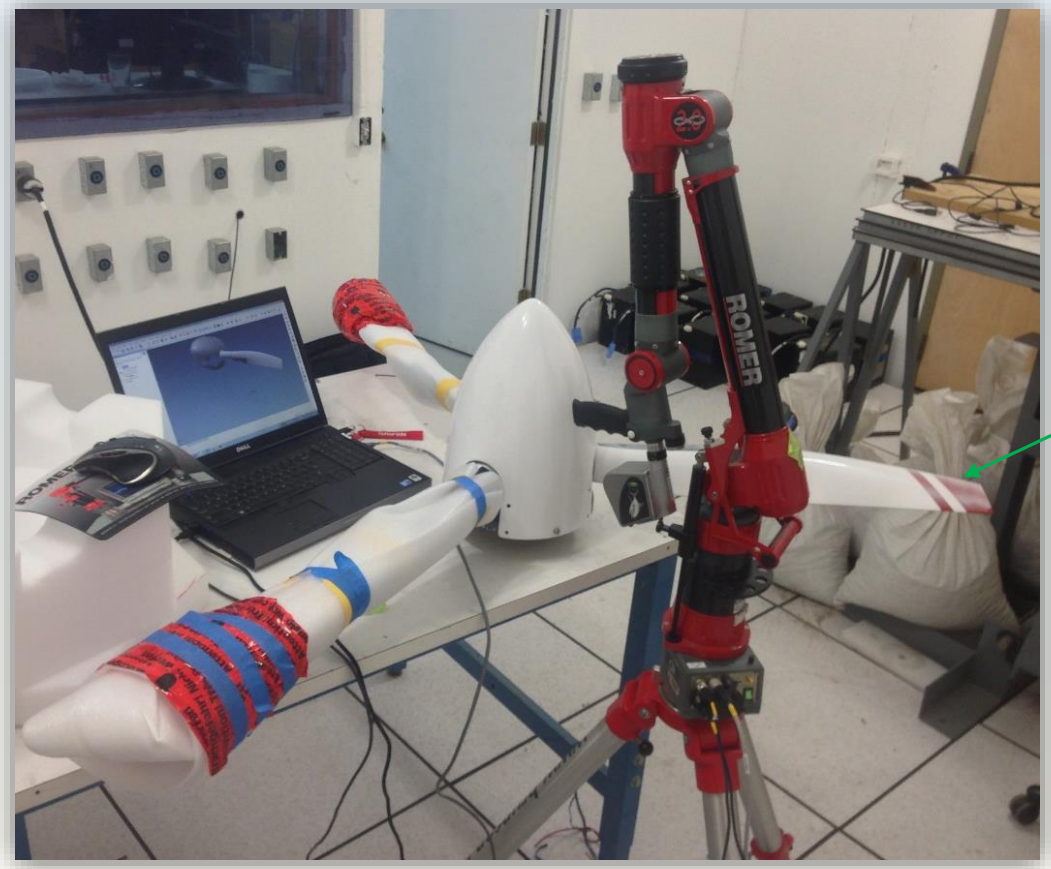
- Manufacture provided CAD model proved to be an inaccurate model of the actual propeller, and a more refined model was needed

MTV-7 Propeller photo (slightly larger model shown)

CFD Model Creation

Variable Pitch Airplane Propeller

- Both IMAlign and IMInspect were used to collect data
- The propeller coordinate system and hub mounting points were taken with IMInspect
- After setting the coordinate system, IMAlign was used for the blade surface data
- The data sets were then combined to create the NURBS model using IMEdit

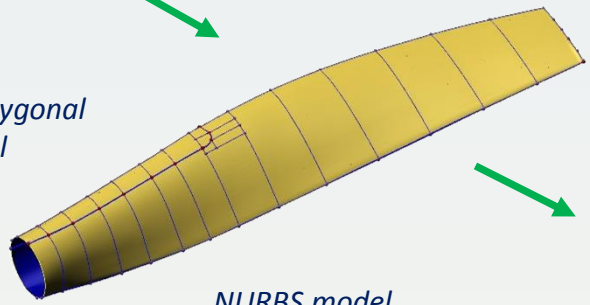


Scanning Test Setup

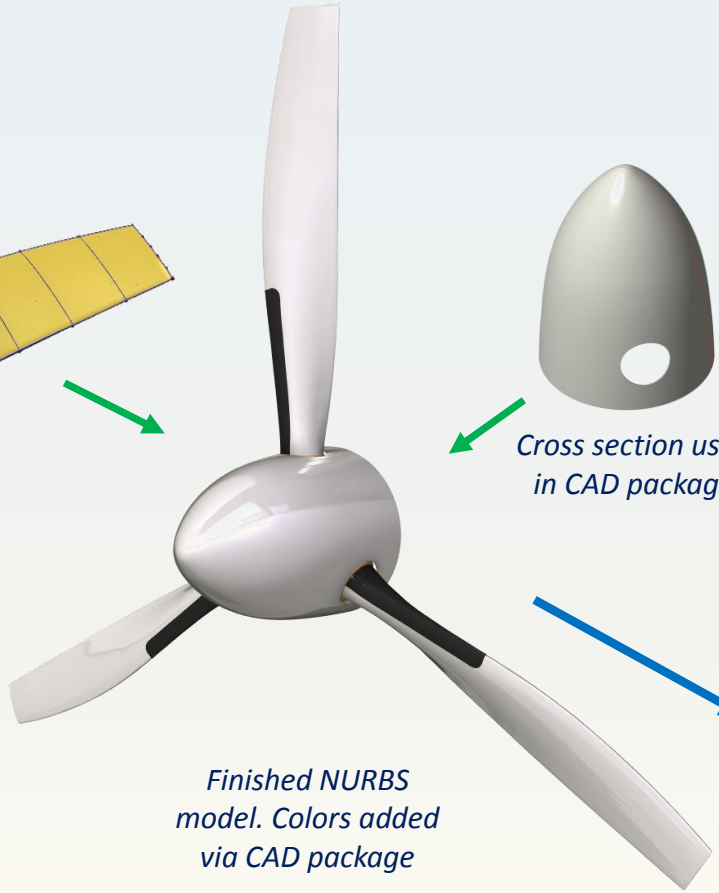
CFD Model Creation

Variable Pitch Airplane Propeller

Cleaned polygonal model



NURBS model



Finished NURBS model. Colors added via CAD package

Cross section used in CAD package

Polygonal model- Cross section extracted

CFD
(in work)

Instrumentation Locating

MQ-9 (Reaper) Wing Sensors

Challenge: How to determine the locations of sensors after they've been installed on a surface

Sensors include strain gauges, electronic tufts, fiber-optic gauges, pressure ports, and so forth

These sensors routinely are numbered in the hundreds

A better solution was needed…

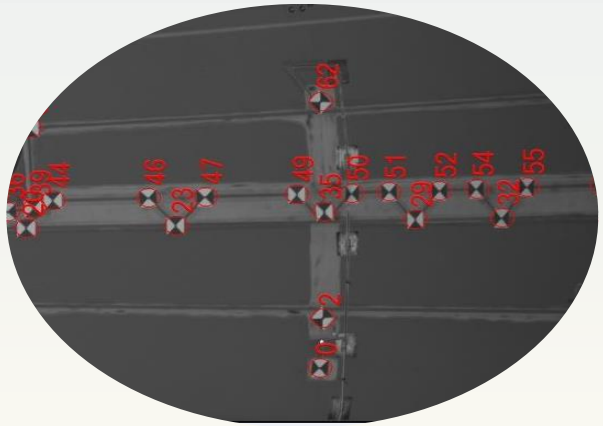
Instrumentation Locating

MQ-9 (Reaper) Wing Sensors

Solution!

- Use the Surphaser scanner to locate “reference” points positioned directly over the sensors
- Import reference points into IMAlign with Surphaser macro key

Targets have sight hole



SurphExpress screenshot- Auto target detection

Instrumentation Locating

MQ-9 (Reaper) Wing Strain Sensors

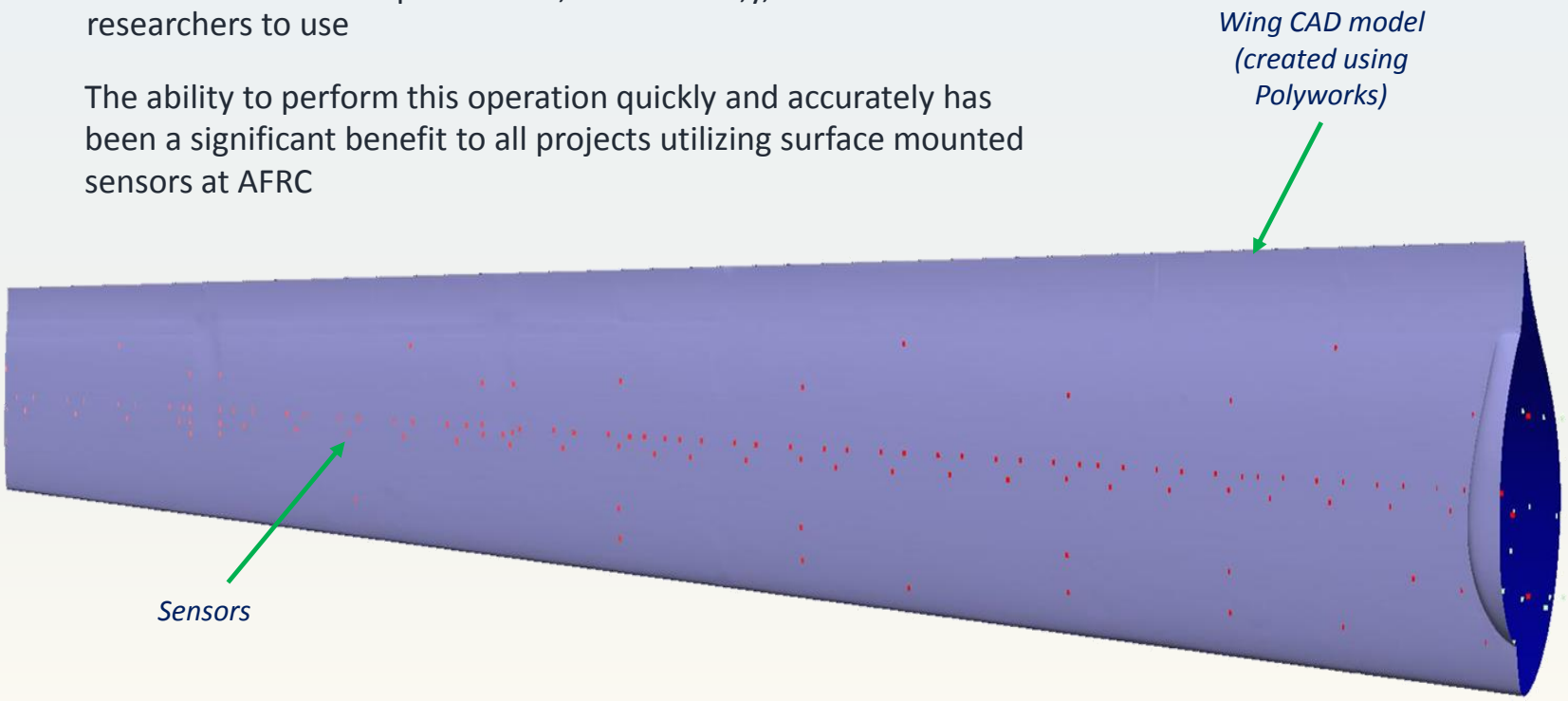
Test Setup in Armstrong's Flight Loads Lab (FLL)

Instrumentation Locating

MQ-9 (Reaper) Wing Strain Sensors

- Once the sensor point cloud has been created, it is aligned to the pre-existing CAD surface (in this case, also created using PolyWorks) using alignment targets
- The result is a sensor point cloud, each with x,y,z coordinates for researchers to use

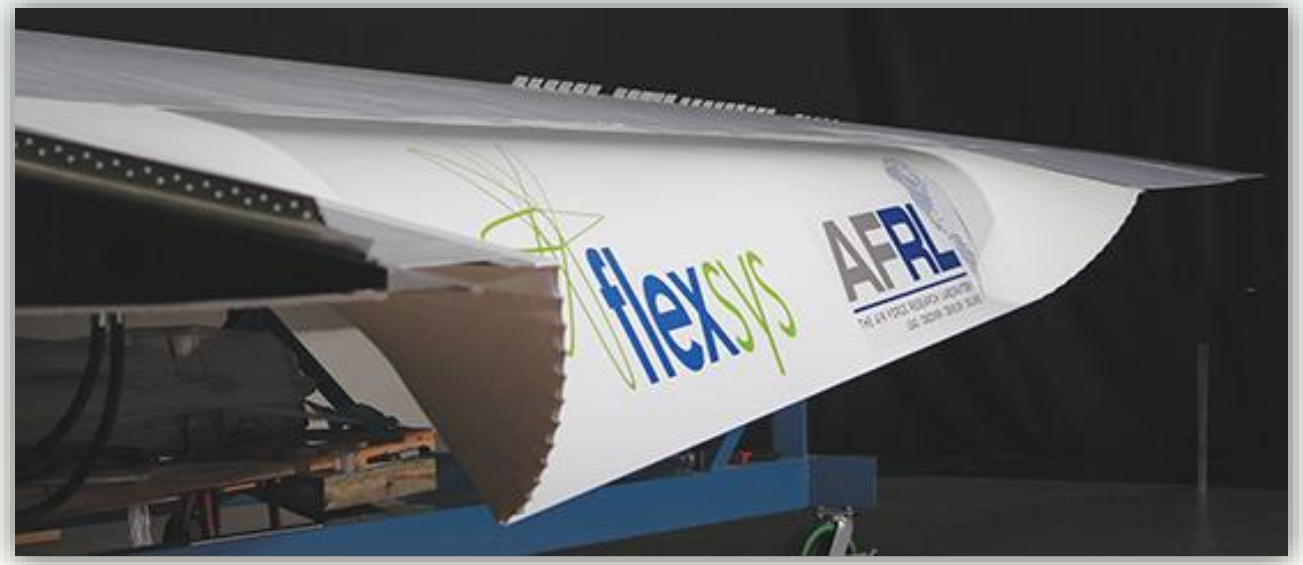
The ability to perform this operation quickly and accurately has been a significant benefit to all projects utilizing surface mounted sensors at AFRC



Surface Deviations & Comparisons

Flexible Flap Shape Verification

In 2014, NASA Armstrong (AFRC) was tasked with flight testing a new flexible flap (shown below). Prior to flight testing, it was critical that the shape of the flaps were known and within spec to previously created CAD models. These verifications were to be performed for many degrees of flap deflection. Verifications included: flap to wing alignment, shape to CAD models, asymmetry (left/right wings), and maintaining shape after flight

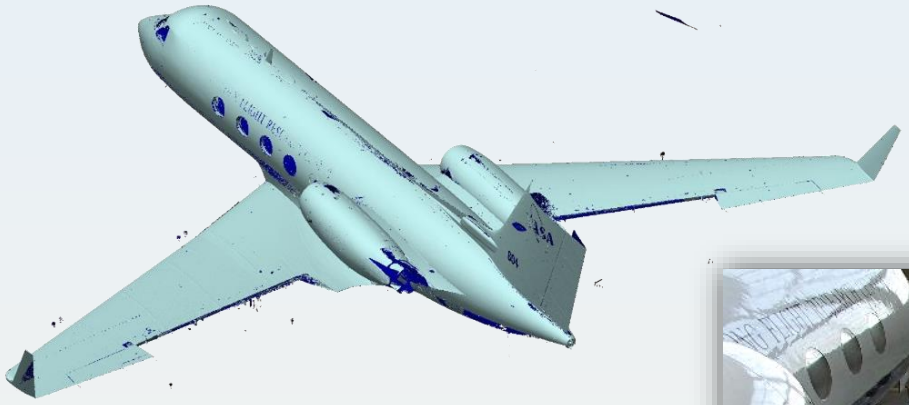


Flexible Flaps- Designed and built by FlexSys, Inc with funding provided by the Air Force Research Laboratory (AFRL)

Photo: FlexSys, Inc.

Surface Deviations & Comparisons

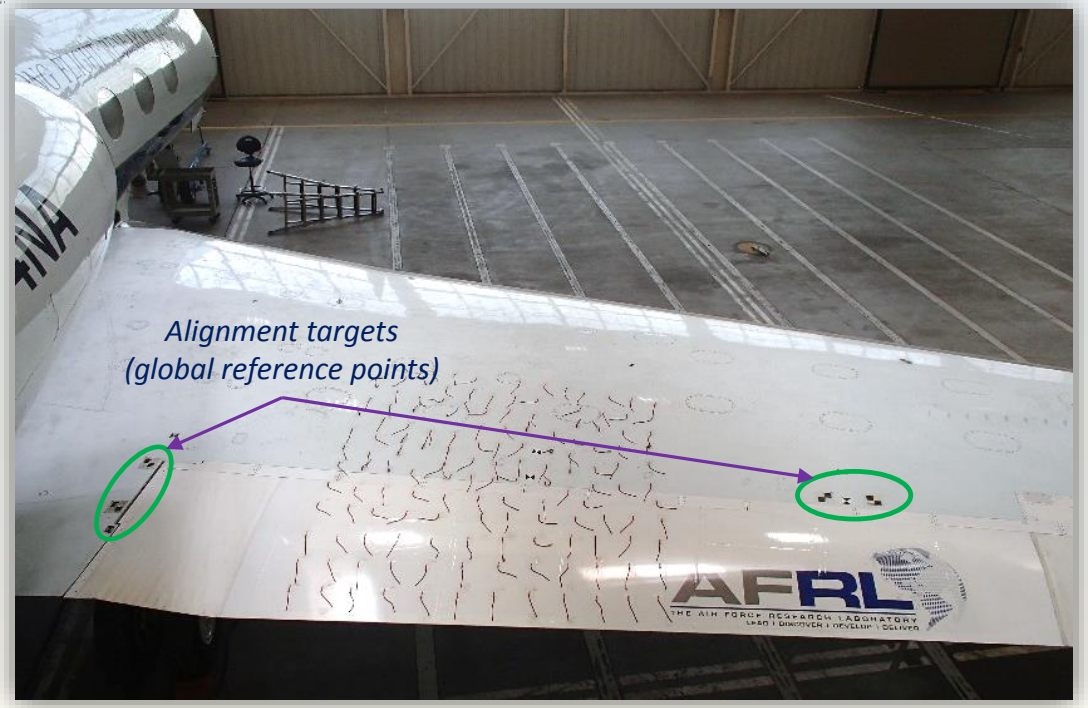
Flexible Flap Shape Verification



Polygonal model of aircraft

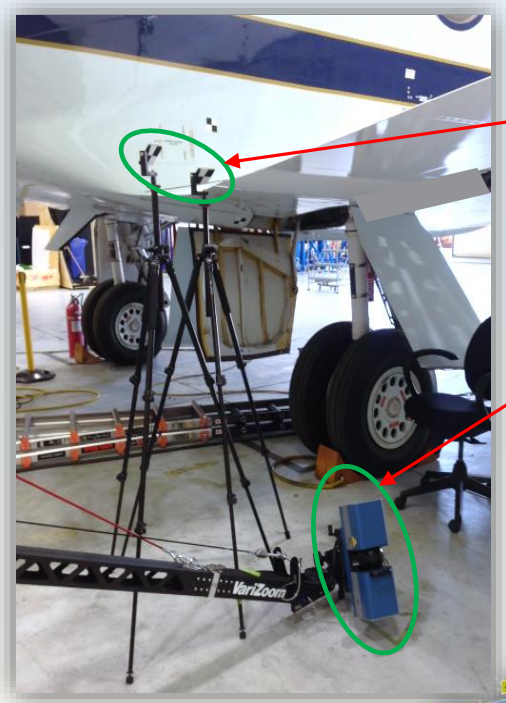
In order to align the scans of the flap to the CAD models, the whole aircraft was first scanned and a polygonal model created

- Hundreds of scans were to be performed, so a fast yet precise alignment method was crucial
- Targets placed on the wing during the scan of the entire aircraft allowed the flap scans to be attached precisely to the rest of the wing

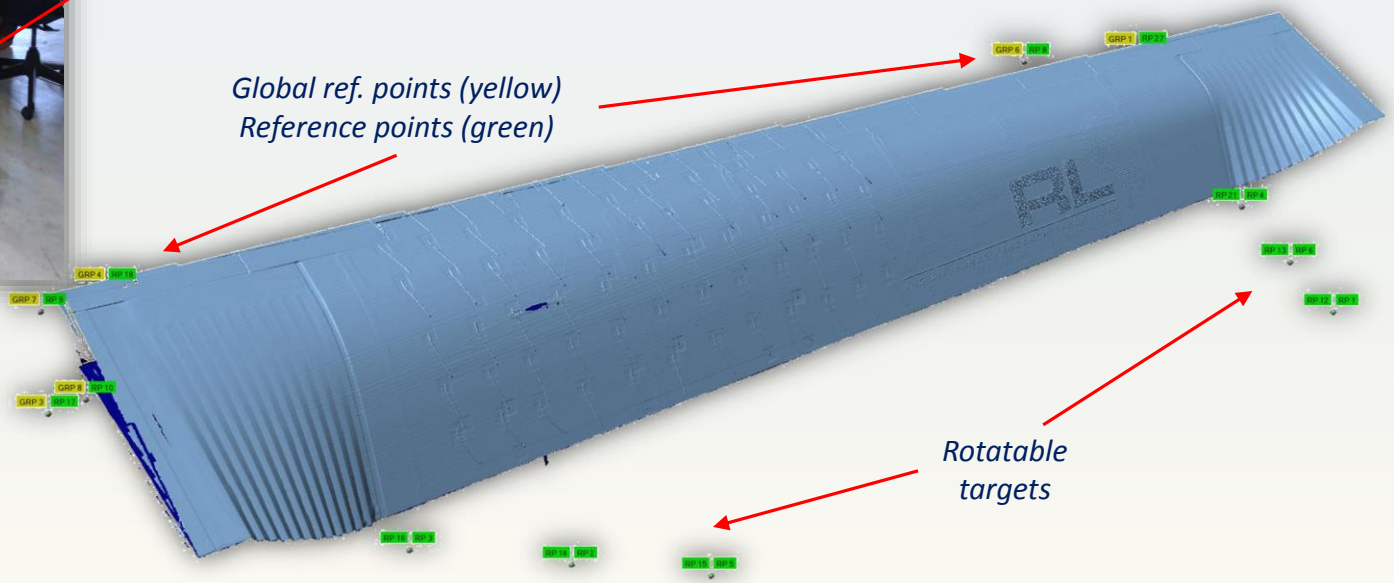


Surface Deviations & Comparisons

Flexible Flap Shape Verification



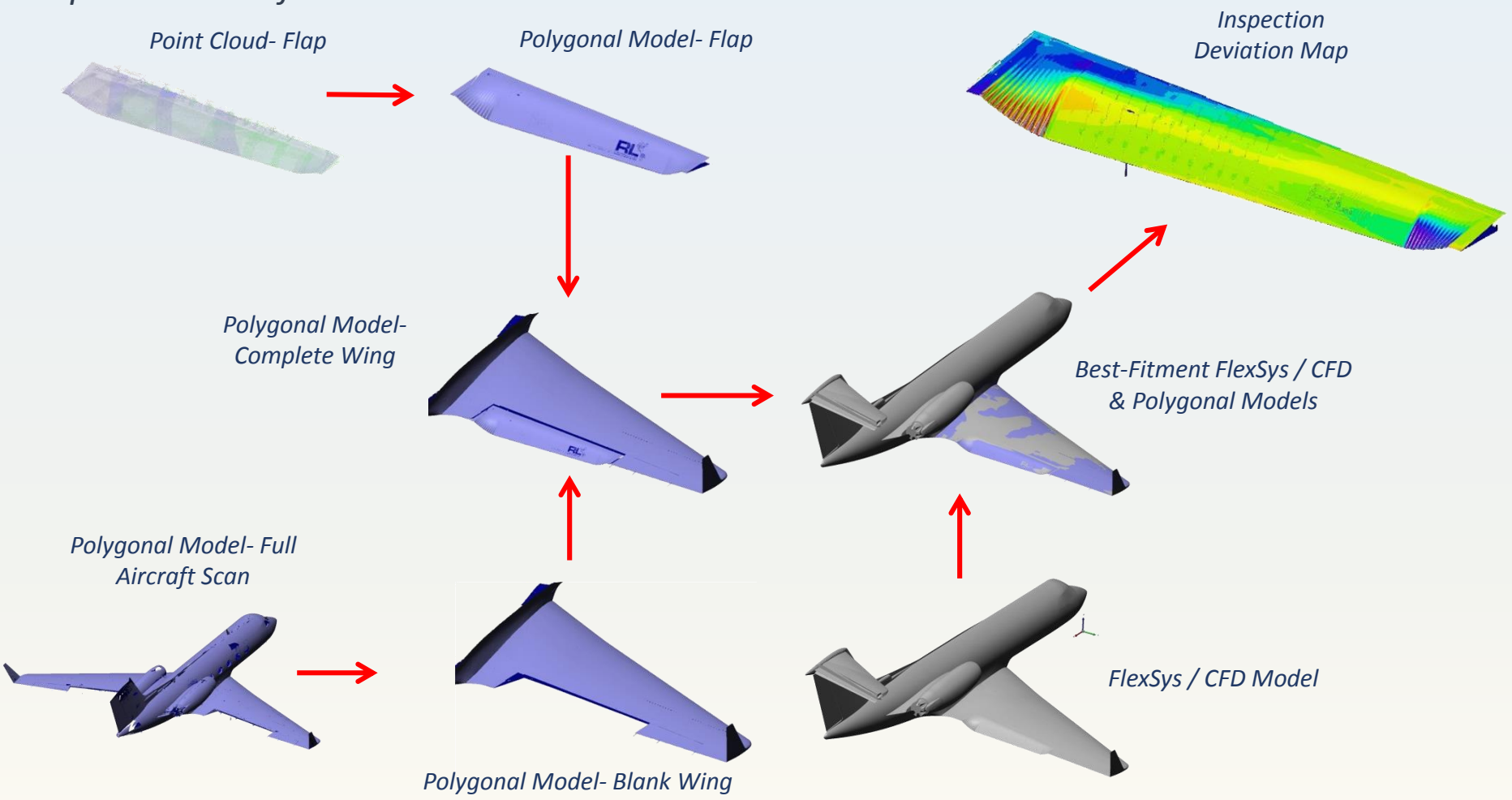
- Targets mounted on a rotatable platform provided target visibility when changing scanning positions from the top to bottom of the wings. Target center is maintained
- Alignment deviations from the flap to the wing could be checked via “Match reports” in IMAlign



Surface Deviations & Comparisons

Flexible Flap Shape Verification

Inspection Workflow



Conclusion

In short, PolyWorks combined with probing and scanning peripherals has been a tremendous asset to the Center. We look forward to applying the technology to even more areas associated with flight research

What's next?

We are in the process of changing processes in our fabrication shops to one that uses PolyWorks as the primary means of inspection. Secondly, we expanding our in-house user base to help cope with increased demands for metrology solutions

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