DPW-8 & AePW-4

Static Deformation Working Group

June 21, 2024

dpwaiaa@gmail.com
(working group specific email TBD)

SHAPING THE FUTURE OF AEROSPACE

Static Deformation Working Group Leadership

- Stefan Keye, DLR
- Garrett McHugh, NASA Langley
- Ben Rider, The Boeing Company

Administrative Information

- **Meeting schedule modified**
  - Third Friday of every month
  - 10:00 Eastern Time (will be adjusted with US Daylight Saving Time)
- **For questions about the working group, please email** dpwaiaa@gmail.com
- **Website updates**
  - Static Deformation Working Group website https://aiaa-dpw.larc.nasa.gov
  - Geometry website https://aiaa-dpw.larc.nasa.gov/geometry.html
  - Grid website (in work) https://aiaa-dpw.larc.nasa.gov/grids.html
  - Postprocessing website (in work) https://aiaa-dpw.larc.nasa.gov/postprocessing.html

Two Joint Working Groups

Static Aeroelastic Deformation

1. Collaborative effort with both communities
2. Compute fluid/structure interactions in linear regime

Stefan Keye, Garrett McHugh, Ben Rider

Unsteady Aerodynamics and Buffet

1. Collaborative effort with both communities
2. Compute unsteady flowfield (fixed geometry)
3. Compute fluid/structure interactions in linear regime and past pitchup

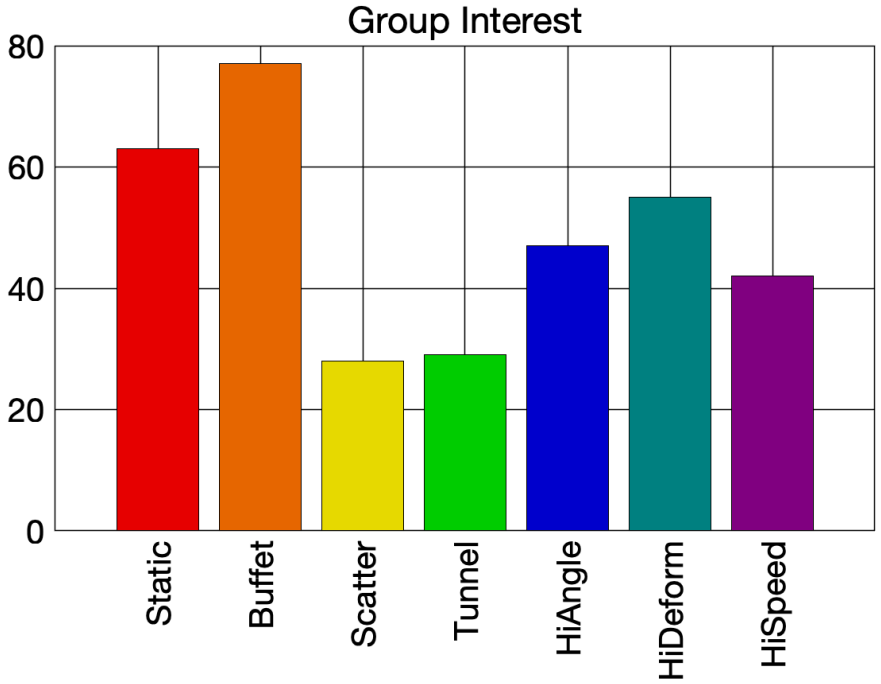
Hadar Ben-Gida, Brent Pomeroy, Daniella Raveh, Andrea Sansica, and Bret Stanford

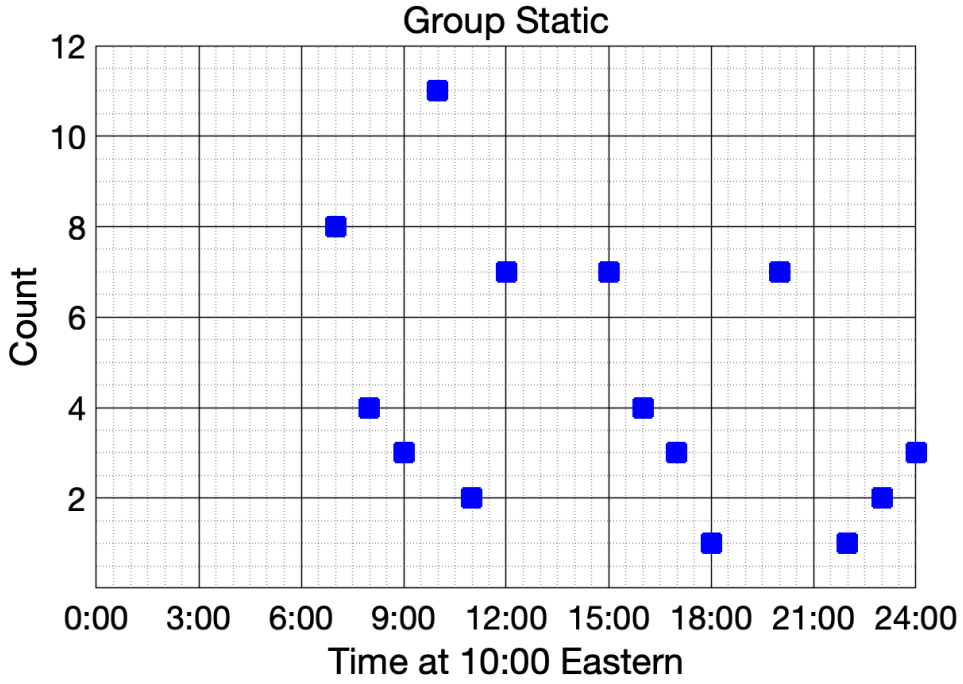
Vision

- **Leverage knowledge from both fields to advance state of the art**
  - Increase understanding within each field, individually
  - Synthesize methods to increase understanding of static deformation predictions
- **Determine practices that accurately model fluid structure interaction to predict accurate deformations and resulting aerodynamics**
- **To provide an impartial forum for evaluating the effectiveness of existing tools and methods**
- **Provide guidance for simulations while relying upon users to implement his/her code's best practices**
- **Establish workshop model for future multidisciplinary communities**

Participant Summary

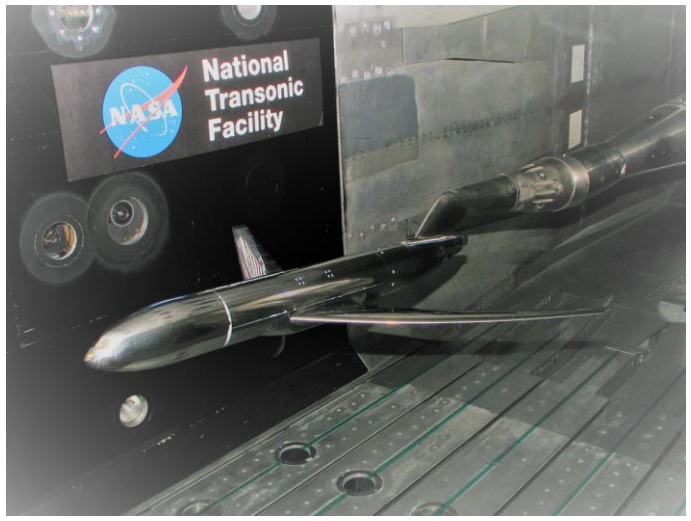
- **127 workshop respondents to date**
  - Represent five continents
  - Most individuals are interested in multiple working groups
- **77 signed up for Buffet Working Group meeting series**
- **63 signed up for Static Deformation Working Group meeting series**

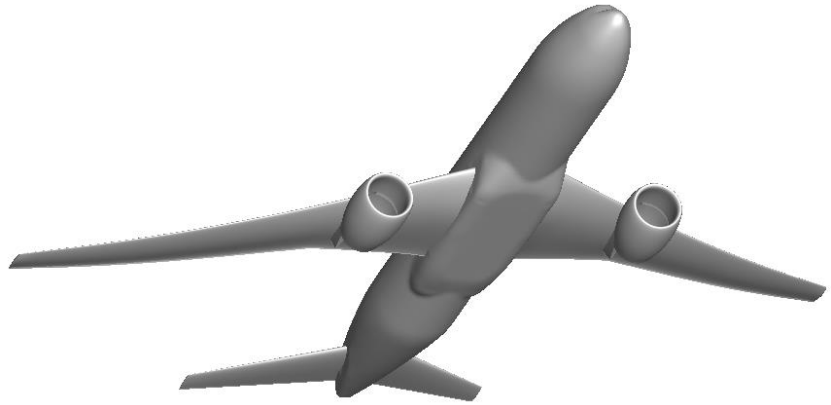




DPW-8 and AePW-4 Configurations

- **NASA/Boeing Common Research Model**
  - Well studied and tested
  - Provides good comparison to other workshops
  - Rich legacy of NASA, ETW, ONERA, and JAXA experimental data sets
  - Finite element model available for NASA and JAXA models
- **Components**
  - Different working groups require various geometries
  - Will include: wing/body and wing/body/nacelle/pylon





Grids

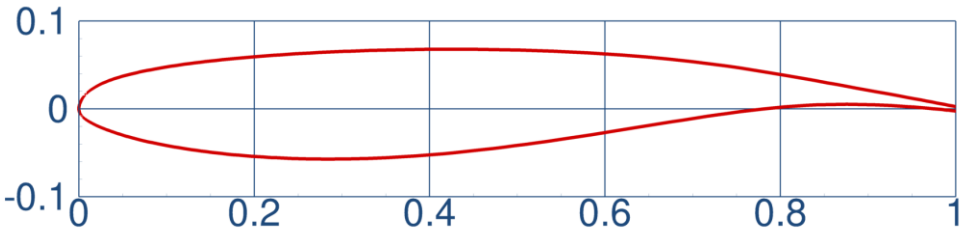
- **Geometry**
  - High-quality CAD is being created or already exists, much from DPW-7
  - Available for download from the DPW website and JAXA website (link coming)
- **Common grids are being generated**
  - Strongly encourage use of committee-supplied grids
  - Cadence/Pointwise, Helden Aerospace, NASA Ames (and you???)
  - User's best practices for solvers may require alternate grids
  - Submission to the workshop strongly desires any custom grids to be provided for posting on the website
- **Proposed topologies**
  - Mixed-element unstructured
  - All-tet unstructured
  - Hex dominant unstructured
  - Structured overset

Grids

- **Committee-supplied grids will be provided (stay tuned for an email)**
- **Geometry**
  - High-quality CAD for the ONERA OAT15A is on the website
  - https://aiaa-dpw.larc.nasa.gov/geometry.html
  - Various spans
- **Common grids are being generated**
  - Strongly encourage use of committee-supplied grids
  - Cadence/Pointwise and Helden Aerospace
  - User's best practices for solvers may require alternate grids
  - Submission to the workshop strongly desires any custom grids to be provided for posting on the website

Test Case 1a: Workshop-Wide Validation

- **Validation of steady CFD analysis, required**
- **Users are encouraged to employ best practices for selected CFD codes**



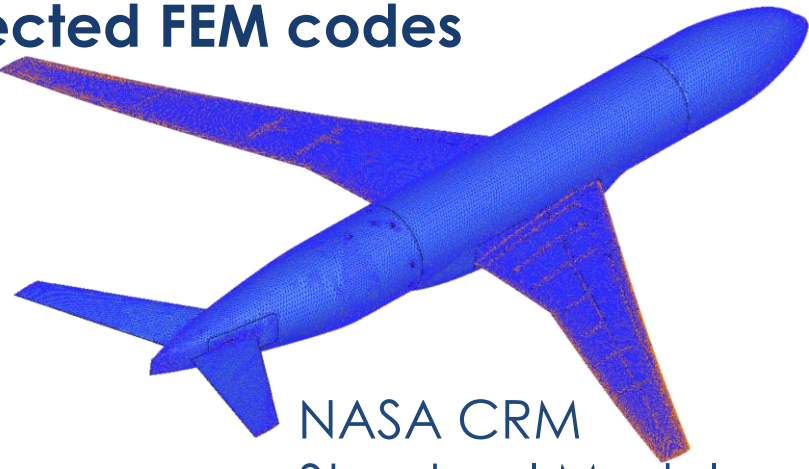
ONERA OAT15A Transonic Airfoil

- **Settings**
  - Steady CFD (e.g., RANS)
  - Prefer some version of SA, multiple turbulence models can be submitted
- **Grids**
  - Six-member grid family; four are required, six are desirable
  - Encourage use of committee-supplied grids; user-generated grids are acceptable
  - Three committee-supplied grid options: one cell wide, span=0.1 chord, and 230mm chord with 780mm span (users can contribute one or multiple geometries)
- **Conditions**
  - Mach 0.73, Re_c=3m (based on chord length), T_{static}= 300K (540 R, 80.33 F)
  - Alpha: 1.36, 1.50, 2.50, 3.00, 3.10

Jaquin, et al. "Experimental Study of Shock Oscillation over a Transonic Supercritical Profiles." AIAA Journal, Vol. 47, No. 9, 2009. Pages 1985-1994.

Test Case 1b: FEM Validation

- **Validation of Structural Model for NASA CRM**
  - Tap Test planned for comparison to normal mode solutions of FEM models
  - Static Loads Tests will be conducted to compare deflection measurements (and maybe twist) to Linear Static FEM solutions
- **Users are encouraged to employ best practices for selected FEM codes**
- **Settings**
  - Linear Eigenvalue Analysis (e.g. NASTRAN® SOL103)
- **Conditions**
  - Rigid suspension at sting
- **Grid**
  - MSC NASTRAN® solid 4-node tetrahedral finite-element structural model
  - Model consists of $6.8 \cdot 10^6$ elements, $4.1 \cdot 10^6$ degrees-of-freedom
  - Supplied by NASA Langley's Configuration Aerodynamics Branch
  - Wind tunnel sting will be added as beam model (date ???)



NASA CRM
Structural Model

Test Case 2a: Wing/Body Deformation (1 condition)

- **CFD/FEM start from unloaded (wind-off) geometry/grid**
- **CRM Wing/Body**
  - Reynolds numbers: 5M (LoQ) [Available: 5M(LoQ),20M(LoQ),20M(HiQ),30M(HiQ)]
  - Mach Number: 0.85 [Available: 0.70, 0.85, 0.87]
  - Angle of Attack: 3.00 deg [Available: -3.0 – 12.0 deg]
- **Committee-supplied**
  - NASA CRM geometry in jig/unloaded condition
    - Trip location, if tested (optional to use)
  - MSC NASTRAN® finite-element model of the NASA CRM
  - Grid Family (L1:**T**iny/L2:**C**oarse/L3:**M**edium/L4:**F**ine/L5:e**X**tra-fine/L6:**U**ltra-fine)
- **Comparison metrics**
  - Forces / Moments
  - Sectional Twist / Deformation
  - Sectional C_P distribution

Test Case 2b: Wing/Body Deformation (polar)

- **CFD/FEM start from unloaded (wind-off) geometry/grid**
- **CRM Wing/Body**
  - Available Reynolds numbers: 5M (LoQ), 20M (LoQ), 20M (HiQ), 30M (HiQ)
  - Range of Mach numbers: 0.70, 0.85, 0.87 (Mcruise = 0.85)
  - Range of Angles of attack: -3.0 – 12.0 deg (AOAcruise ~ 2.75-3.00 deg)
- **Committee-supplied**
  - NASA CRM geometry in jig/unloaded condition
    - Trip location, if tested (optional to use)
  - MSC NASTRAN® finite-element model of the NASA CRM
  - Grid Family (L1:**T**iny/L2:**C**oarse/L3:**M**edium/L4:**F**ine/L5:e**X**tra-fine/L6:**U**ltra-fine)
- **Comparison metrics**
  - Forces / Moments
  - Sectional Twist / Deformation
  - Sectional C_P distribution

Test Case 3: Wing/Body/Nacelle/Pylon Deformation

- **CFD/FEM start from unloaded (wind-off) geometry/grid**
- **CRM Wing/Body/Nacelle /Pylon**
  - Available Reynolds numbers: 5M (LoQ)
  - Range of Mach numbers: 0.70, 0.85, 0.87 (Mcruise = 0.85)
  - Range of Angles of attack: -3.0 – 12.0 deg (AOAcruise ~ 2.75-3.00 deg)
- **Committee-supplied**
  - NASA CRM geometry in jig/unloaded condition
    - Trip location, if tested (optional to use)
  - MSC NASTRAN® finite-element model of the NASA CRM
  - Grid Family (L1:**T**iny/L2:**C**oarse/L3:**M**edium/L4:**F**ine/L5:e**X**tra-fine/L6:**U**ltra-fine)
- **Comparison metrics**
  - Forces / Moments
  - Sectional Twist / Deformation
  - Sectional C_P distribution

Nominal Schedule

- **June, 2024**
  - First Working Group Meeting ✔
  - ONERA OAT15A geometry release ✔
- **July, 2024**
  - ONERA OAT15A grids released
- **August, 2024**
  - AVIATION in-person meeting
- **August, 2024**
  - First look of Test Case 2/3 grids
- **Winter, 2024 (?)**
  - Mini Workshop 1
- **January, 2025**
  - SciTech in-person meeting
- **July, 2025**
  - AVIATION in-person meeting
- **Summer/Fall, 2025 (?)**
  - Mini Workshop 2
- **January, 2026**
  - SciTech in-person meeting
- **February, 2026**
  - Delivery of final data set (perhaps alternate submissions prior to this date)
- **June, 2026**
  - Workshop in San Diego, CA

Working Group Meeting Cadence

- **Currently set up for 10:00 Eastern time on third Friday of each month**
  - A suitable meeting time is very difficult for global participants
  - Recurring meeting invite sent

- **Next meeting: July 19th**

- **Workshop-wide meeting at AIAA AVIATION (July 30 @ 7pm)**

dpwaiaa@gmail.com

Data Submission for ONERA OAT15A

- **Please carefully follow filename and auxiliary data information on the website**
- **Case 1a**
  - Required data
    - F&M (**`DPW8-AePW4_ForceMomentAveraged_v1.dat`**)
    - C_P cut (**`DPW8-AePW4_SectionalCutsAveraged_v1.dat`**)
  - Optional data set supplement
    - Boundary layer profile data (**`DPW8-AePW4_BoundaryLayerAveraged_v1.dat`**)

NASA NTF Deformation Data

- **NTF 197**

Configuration	Re#=5M	Re#=19.8M LoQ	Re#=19.8M HiQ	Re#=30M
WB			X	X
WBT(0)	X	X	X	X
WBPN	X			

- **NTF 215**

Configuration	Re#=5M	Re#=19.8M LoQ	Re#=19.8M HiQ	Re#=30M
WB	X	X	X	X
WBT(0)	X	X	X	
WBPN	X			

ETW Deformation Data

- **ETW ESWI^{RP}**

Configuration	Re#=5M	Re#=19.8M LoQ	Re#=19.8M HiQ	Re#=30M
WB				
WBT(0)	X	X	X	X
WBPN				

Data made available through the Research Project ESWI^{RP} (**E**uropean **S**trategic **Wi**nd Tunnels **I**mproved **R**esearch **P**otential) funded through the European Union 7th Framework Programme under grant agreement n° 227816.