Dear Folks,

It is now two months since we met in Atlanta, at AVIATION 2014, in the ASE Conference, and on the ASE/AFM/FT Invited Sessions on Managing Wake Vortex Encounter (MWVE). Thank you to all our presenters very much for your efforts, bringing, in many cases, your current research to the Sessions. As such, the papers presented contemporary research in the area of transport aviation wake vortex technology. Thank you to Dr Fred Proctor, NASA, for co-chairing the Sessions. Thank you to the AIAA for providing the Forum, and to the ASE, AFM and FT Technical Committees for supporting the Joint nature of the Sessions.

Following MWVE 2010 in AIAA Toronto, August 2010, I undertook the preparation and dissemination of a summary of the Sessions. Once again, I shall do this for MWVE 2014, since in the intervening four years have resulted in the initiation of a number of significant technology research projects in the realm of MWVE, and they were the subject of papers and presentations at MWVE 2014. In summarizing, some other presentations and/or work which were not presented within the MWVE Invited Sessions, rather in other AVIATION 2014 sessions, but which is relevant to the topic, are mentioned.

As before (2010), please feel free to discuss, correct, rejoin, disagree, or amplify, with your own views. I only ask that any such, responsive communication is circulated to the complete address list, contained herein. Concerning the address list, I have included our colleagues who considered an Invitation, but were unable to commit to, or join us in, Atlanta. Also, if you would like to add others, please feel free to do so, by adding them to the address list in any response email, or by forwarding. In particular, please forward to your co-authors.

Please also note that I am disseminating this to the AIAA, as some limited comments are relevant to their planning of the Conference Groupings.

AVIATION 2014 Conference Group

AVIATION 2014 was the consolidation of AIAA Summer Conferences – however not all Technical Committees opted to join the consolidation. In particular, GNC was not present at AVIATION 2014. GNC complements AFM (vital to the MWVE Topic) and MST, and their presence would have value-added the Conference Group in the MWVE topic (and in other technical areas, as the AFM/MST/GNC/FT Group is a 'natural'). However the Flight Test (FT) Conference was included in AVIATION 2014, and that was very valuable. I have watched the FT Conference grow, and it has been the forum for some very interesting papers – as it was, again this year.

To summarise, MWVE I and II were Joint AFM/ASE/FT Invited Sessions. MWVE I considered the AFM aspects (e.g. flight dynamics, flightpath disturbances, loads, avoidance systems including predictive avoidance, gust alleviation design); MWVE II, WV Transport & Decay, was in the ASE realm – it over-lapped, for example predictive avoidance. MWVE I drew some AFM and MSR audience participants, MWVE II drew an ASE audience, largely WV researchers. MWVE I & II were concurrent with ASE Icing Sessions.

Session Agenda

The Final Session Agenda appears as Appendix A, to the present summary document.

Managing Wake Vortex Encounter I

The WV Decision Support System of Thales demonstrates the emergence of comprehensive airport-based WV systems. Thales has progressively developed ground-based radar for the detection of wake vortices, including radar sensing developmental and demonstrational projects at Paris Orly and Charles de Gaulle in recent years. An ATM ground-based wake vortex location system for Terminal Areas might become a necessary element of Dynamic Pairs WV separation, and is being considered on a number of fronts. Thales integration of X-band radar with 1.5Γμm LIDAR and modeling (predictive WV) into an ATM system will be a comprehensive coverage of prevailing/developmental technology to the application. The paper reflects the primary thrust of Thales' research, namely addressing WV detection in all-weather – the X-band performance dominant in water droplet conditions, LIDAR in dry air conditions, with Thales seeking to expand radar performance to dryer air (by reducing beam width & increasing beam power) from the present sensitivity of -16 dB at 2 km in droplet number density equivalent to 0.004 mm/hr water. In collaboration with 12 others, Thales presently is conducting the UFO project (UntraFast wind sensOrs), which will advance the promising technologies further.

Away from the Runway, a ground-based WV model system could predict WV locations throughout the Enroute Airspace structure. The difficulty is actual meteorological data – winds, pressure, temperature, shear, vorticity, not just spot but horizontal and vertical distributions – without which the sigma of a model prediction might be large, to the point of nuisance alert dominance and subsequent intrusion into high-density enroute airspace tracks (even without any RNP, the tight tolerancing of the present US enroute track system was demonstrated to the NRC this year, in flying the T33 across the Continent from Ottawa, ON to Palmdale, CA). Possibly an airborne-based WV system could provide a better sigma. DLR Braunschweig is researching an air-based WV model location system, and has flown the system on the DLR A320 in 2013 and 2014: 2013 used a basic empirical WV location model, whilst, impressively in 2014, DLR flew a real-time P2P running at 2 Hz, with 1 Hz pilot-display update and ADS-B used for wake generator information. Now, sooner than later, it might be beneficial to quantify the sigma of the system, requiring many validation points – for this, one efficient methodology would be to use a third aeroplane to measure vortex position.

Nevertheless, this effort plus others, including that of IANS and TsAGI, are significant in the technical pursuit of utilizing pilot display systems for improving WV awareness and avoidance (the SAE G-10WV sub-committee, has been developing an ARP for pilot displays of such WVSS, in itself a parallel promotion of the technical issues involved and guidance thereupon). Research in this area will further reinforce technical guidance. Of relevance, but as an aside, SAE guidance on TCAS installation symbology (back 2 decades ago) called for chevron tags to aircraft targets. Instead, TCAS I used diamonds, thus carried through to present-day TCAS. Perhaps this was because of possible difficulties of direction-of-flight resolvability with TCAS I. The present-day ADS-B iPad displays from the ForeFlight/STRATUS combination use chevrons. Personally, I find the improvement in situational awareness (SA) immense – through research, the improvements from symbology advances could be quantified.

Such HMI research is a topic in the TU Braunschweig comprehensive plan to fly an airborne WV prediction plus sensing (scanning airborne WindTracer LIDAR) system, seen by TUBr as a necessary element for SESAR/NexGen procedures such as in-trail and self-separation. TUBr plans to fly the system, incrementally commencing 2015 and will be a substantive technical development. As commented above, statistical inflight measurement of actual WV locations compared with both predictive and sensed WV locations would provide a measure on computational and on sensor accuracies.

TU Berlin has been undertaken rigorous research into the flight dynamic and subsequent effects upon flightpath of WVE loads for several years. The latest TUB research investigates deformed vortex WVE probabilistically, for a swept-wing jet transport encounter aircraft. It is a comprehensive approach, the results of which have been cross-validated against the research analysis of Boeing, conducted *c.* one decade ago. These are analyses, using vortex and aerodynamic interaction models. Given that the TUB research uses Monte Carlo, in principle it could provide a mechanism for comparing with real-world (flight) data, a necessary comparison for such research analyses (also applicable to RCR and SHAPe, for example), if ever they will provide firm foundation for defining 'acceptable WVE', an objective of many, including TUB. 'A mechanism' is needed because of the likelihood of WVE being 'perturbed vortex' and, as strongly indicated by NRC flight data, of the huge difficulty of obtaining local pitch and yaw angles for the vortex segments' axes (and, vortex core states), at the point of WVE. Traditionally, WVE severity considers rolling motions; an expansive severity matrix is warranted – many WVE injuries are a result of negative normal-direction acceleration.

Takeshima *et al* of Tohoku Univ, Sendai, with DLR, JAXA, Tokyo Univ and Keio Univ collaborators and contributors, presented an intriguing paper on vortex multisensory identification from numerical analyses data; in particular, using haptic devices. Whilst the paper concludes with two priorities for further technical progress, namely speed of computation and expansion from 3 to 6DOF, I am fascinated with the potential for using such an approach for researching severity of WVE, by using a research flight simulator with back-driven flight control inceptors – essentially turning the simulator's flight control system into an aerodynamically reversible system, wherefore the driving is not simply control surface hinge moments, but rather WV applied moments, and, for any direct 'lift' flight control element, forces.

Brown presented NRC flight data, which demonstrates the potential for the extent of WVE loads alleviation which is possible using manual flight control inputs, in accordance with an experience-based strategy; in the case of the NRC T33, in round figures, a 50% reduction in loads – not only for 'full-geometry' WVE with contrail delineated vortices (condensate ice particles at core edges), wherefore visual anticipation is available for 2π steradians, but also for in-trail WVE, wherefore visual anticipation is available (even without condensate) from refraction for a small angle (approximately 0.1π steradians). A suitable digital FCS gust-alleviation system should have higher bandwidth, and achieve greater % reductions in loads, but system sensory perception of WV position is necessary.

Scanning LiDAR perception WV identification performance is central to the paper of Ehlers *et al*, DLR (not in the MWVE Sessions, due to AIAA limitations on session length). Particularly interesting in this work is the sensitivity analysis of the identification. Such analyses are important and useful in the assessments of required and/or available WV sensory preceptors. But arguably not for detailing the full range of specifications of such systems; rather, additional considerations include: the need to assess against a range of vortex profiles, such as those measured inflight, and of which researchers have been aware since the earliest days of FAA measurements of WV generated by aeroplane flight, in the late 60's; WV core profiles can also include axial velocity distributions, not generally considered in LiDAR WV perception; also, LES is useful for such studies, yet is not to the stage of being able to fully un-constrain vortex cores; LiDAR WV perception studies are limited to tangential velocity sensing

MWVE II, Including Wake Vortex Modelling

The topic of Nash'at Ahmad *et al*, NASA, Craig Technologies and Delft UofT, was cross-over between Sessions MWVE I and II, insofar as the topic of fast-time wake models and the integration of such with flight data. Amongst other applications, such a topic can address, predictively, the required wake vortex position element of a real-time WVSS. Ahmad *et al* consider the APA and TDP fast-time models, against the WV data from one particular flight of the 1995 and 1997 NASA AVSSP (C-130 generator and OV-10 WVE aeroplane), thus a demonstration of the long-lasting utility of rare WV data-sets. The work provides figure of merit comparisons between prediction and measurement of WV strength and location, for this particular flight (low turbulence, stable stratification). (Such comparisons are a vital part of the development and approval of WVSS.) For this the fast-time models were run deterministically at 1 Hz update (re-initialisation of generated WV). The paper also includes probabilistic solutions, to account for uncertainties in WV generation, and showed for the cases presented, that probabilistic-mean and deterministic solutions varied insignificantly, and that probabilistic-2σ generally covered WV position and strength (the latter, to $3t^*$ age). The paper also contains meteorological model (WRF) and measurement comparisons; likewise for WVE load parameters, using an aircraft Type-generalised WVE model (Bowles-Tatnall, 0% to 50% under-estimation for this presented data).

Delisi *et al*, NWRA and Coherent Research Group, presented first analyses from the recent collection of landing approach WV flight data at Memphis, from the viewpoints of interdependency between WV evolution and atmospheric conditions. More, after the following paragraph discusses the next paper.

The importance of meteorological data accuracy on WV predictions, whichever code is used, is generally appreciated. Prius *et al*, NWRA and Coherent Research Group, provided a detailed quantitative assessment of required accuracies, inherent actual atmospheric variability (temporal & spatial, of length scales relevant to transport, for fixed Earth-axes reference), small-scale, pursuant to the Memphis data-set collection, and atmospheric turbulence generation derivation from ground LIDAR. The paper points out the difficulty of measurement of realistic atmospheric variability, as well as the difficulty of assigning the effect of such variabilities upon WV computation, such as in the measurement and assignation of EDR effect. It could be argued that EDR (and N^*) are bulk quantities, and as such perhaps an incremental understanding is related to empiricism (which is interpolative not extrapolative, by nature), hence the importance of such data collection experiments as Memphis, and the wide range of instrumentation applied thereto. These too can also be archived, like flight data. For the long-sighted view is that, WV as a dynamic system, is more likely to be influenced by discrete rather than bulk parameters, with an understanding of the former evolving as an understanding of WV dynamics (such as that of cores) evolve.

The effects of atmospheric variabilities would appear to be thematic in the paper of Delisi *et al*, introduced above – for, the first data has includes plots of the variation and variability of the time to 'last LIDAR WV ID' with measured EDR, normalized by aircraft parameters. Whereas the median line comparison between A306 and MD11 is in agreement with the EDR normalization parameter group, the variability (σ) is large, times varying by factors of 4-5, at the one value of normalized EDR. The paper presents data on atmospheric vertical wind velocity variability, raising the question of potentially a factor in WV variability. Perhaps this approach is coincident with the comments of the above paragraph. In any case, such explorations can only be advantageous to fundamental WV research and understanding.

The paper of Proctor, NASA, also considers perhaps a relatively rare WV characteristic of behaviour, namely the very-long lived WV of asymmetric demise – some of which might be in the Memphis data presented by Delisi *et al*. Proctor considers long-life WV cases from JFK and Idaho Falls data-sets, and undertook detailed TASS LES analysis of the latter, and pointed-out that the details of which included the development of Taylor instability as a part of the asymmetric decay process, appearing as helical vortex elements around the vortex core. Some aircraft Types, more than others, appear to possess this type of secondary vorticity structure, enroute – the B777 series has this characteristic more striking than others, observed and measured by NRC. The TASS analyses of Proctor have highlighted interactions between asymmetric WV demise and first and second derivatives of the crosswind component of atmospheric wind, i.e. crosswind shear and shear gradient. Perhaps the second crosswind derivative, crosswind shear gradient, association with WV behaviour is particularly interesting – in any case, it is an example of detailed research diversifying the interdependency between WV behaviour and atmospheric parameters, beyond the fundamental characterizing parameters of EDR and N^*.

Holzaepfel *et al*, DLR and Tohoku Univ, presented their recent research on WV in ground proximity, emphases on WV generated at a height of $1b_o$, including a new hybrid simulation from roll-up to demise for landing approach WV. This applied research has impressively resulted in a provisional patent on 'plate lines', an array of ground plates, mounted vertically, a few hundred metres on approach from the runway threshold. The array is designed to promote interactions with the descending WV from the aeroplane on landing approach, thereby promoting earlier WV decay. The hybrid simulation consists of a RANS (TAU code) solution to the aeroplane flowfield forcing the LES solution. In spite of the detail, the paper reports the solution having an under-estimation of aeroplane-generated vorticity (embodied within free shear layers emanating from separating boundary layers) as the cause for generally under-estimating vortex decay rates. Future elaboration will thus include additional components of an aeroplane in the landing configuration, such as lowered landing gear. Nevertheless, the presented hybrid LES solution through to landing touchdown is impressive in the detail of ground-plane and plate line vorticity interactions, and highlights the disturbing effects of the DLR plate line. To further physical understanding, the work may benefit from clarity on the touchdown vortex end effects, which are not an immediate effect as cited in the paper, but emanate from a ramped reduction in wing-bound circulation (i.e. loss of lift); the ramped reduction can be aggressive, as upon the landing-gear squat switch-induced deployment of spoilers (a rapid configuration change, as evidenced in the cited video of the Virgin Australia E190 landing at Port Macquarie) or progressive, as upon pilot-induced de-rotation without *a priori* spoiler deployment. Oberpfaffenhofen measurements of plate line effects enhancing WV decay are presented as scatter plots, trajectory plots (including Γ) would also be enlightening. Once again, the paper highlights atmospheric variability effects.

Representation

MWVE 2014 was only a snapshot of some significant worldwide research in WV technology. Whilst representative, the Sessions were certainly not exhaustive – additional projects are being conducted by various organizations, groups and companies. Nevertheless, compared to MWVE 2010, the present Sessions have highlighted substantial WV technology projects researched, developed and/or conducted in the interim:- airport WV field campaigns with more meteorological sensors than previously, addressing the WV impact of atmospheric variability, the emergence of integrated , ground-based WV advisory systems, the flight of new airborne real-time predictive WV systems, initial assessments of fast WV predictive accuracy, greater understanding of WVE severity and demonstration of severity alleviation potential, patent of a ground system promoting IGE WV decay.

Where to Now?

This question was asked in the summary of MWVE 2010 at Toronto. Various WV technology steps were suggested, against an overall metric of maintaining the WV avoidance philosophy, whilst progressing to an acceptable level of WVE – always the latter is inherent in every set of wake turbulence separation standards. These steps mirroring an extension of the thrust of research work presented at that time:- (1) WVE Management Systems, (2) WVE Simulator Experiments, (3) remote-sensing, LIDAR, (4) WV behavior, and (5) flight data, in-situ.

Since that time, some wake turbulence separation standards have changed, e.g. RECAT, and dynamic-pairs flexible spacing is road-mapped. Considered against the numerated topic areas above, substantial progress is seen in some areas

(1) WVE Management Systems (WMS)

- ground-based (airport) systems, progress in synthesizing comprehensive systems
- airborne WVSS – additional prototype systems have flown, including real-time P2P, and guidance material for their design is being developed; using existing data-sets, efforts have addressed the accuracy of predictive computations; it may shortly be time for the accuracy of real-time prediction to be validated;
- the development of vortex-decay enhancing technology for the landing approach element of the airport environment;
- WVE computational simulations have been & are being used to provide deeper understanding of WVE dynamics & severity;

(2) Simulator Experiments

- in the pilot behavioural context, simulator experiments have been progressing, such as FAA research, but perhaps this research area is being more-prominently managed by probabilistic computational efforts at the moment;

(3) Remote-sensing LIDAR and RADAR (further developed)

- whether ground or airborne WMS, LIDAR remains an integral part of comprehensive avoidance & management systems, rather than relying on prediction alone, yet the research remains performance-simulation based;
- the future is likely to see developments in airborne LIDAR WV sensing technology; the work of JAXA is one example (http://www.youtube.com/watch?v=lxlSZ-SB1XQ);
- the future will see further developments in ground-based RADAR sensing of WV, technology that might eventually evolve to airborne RADAR sensing
- ground-based LIDAR at airport locations continues to serve, in obtaining data-sets elucidating WV behaviour and supporting the refinement of wake turbuelcne separation standards;

(4) WV behaviour, in temporal order

- LES computational analyses have continued to provide greater detail and progress the understanding of WV behaviour;
- when combined with measured data, research has highlighted the interaction of atmospheric variability, supported by evermore refined meteorological measurements; dynamic-coupling of atmospheric parameters with WV behaviour, beyond EDR & N*, are being considered & studied, such as crosswind shear gradients and vertical wind velocity;
- however, vortex core constraints and limited representation of core dynamics remain a limitation of CFD computation of WV behaviour; the significance of core dynamics remains an unknown;

(5) Flight data, *in-situ*

- airborne WVSS prototype flight campaigns;
- limited but important WVE severity flight data (also enlightens WV behaviuour)
- piggy-back WVE & WV behavioural flight data (NRC, on emissions).

WV RESEARCH would appear to be conducted primarily by research organizations *per se*; 10 papers of MWVE 2014 emanated from research organizations, 1 from industry. This might well reflect the TDL of WV technology; in particular, the 2010-2014 period does not seem to have been a period of R&D of aircraft WVE gust alleviation technology, rather, a limited amount of preparatory and developmental research appears to have considered this area (e.g., extraneous to the MWVE Sessions, JAXA's research, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6736312); in practice, WV alleviation might well be managed by general gust alleviation design, for starters, and perhaps this is achieved by some existing designs – the market value is the potential to achieve aircraft-Type specific reductions in Wake Turbulence Separation standards, and thus enhanced airport and enroute viability.

In addition to civil transport design, there would appear to be little progress towards achieving WVE alleviation design for tactical military aircraft, which have a potentially higher frequency of WVE (during tactical manoeuvring) – e.g., AVIATION 2014 saw the presentation of an excellent paper of F-35 developmental flight test, a rare gem, but neither WVE alleviation design requirements nor technology would not appear to be a visible element of the aeroplane's FCS.

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APPENDIA (over-page)
MWVE I & II 2014 AGENDA

Tuesday, 17 June 2014

91-ASE-5	Icing Physics					Hanover C
Chaired by: R. MOSER, AeroTex UK and K. AL-KHALIL, Cox & Company, Inc.						
0930 hrs AIAA-2014-2326 **An Experimental Study of Wind-Driven Water Film Flows over Roughness Array** K. Zhang, Y. Liu, A. Rothmayer, H. Hu, Iowa State University, Ames, IA	1000 hrs AIAA-2014-2327 **On the Numerical Solution of Three-Dimensional Condensed Layer Films** A. Rothmayer, H. Hu, Iowa State University, Ames, IA	1030 hrs AIAA-2014-2328 **Effects of Surface Characteristics and Droplet Diameter on the Freezing of Supercooled Water Droplets Impacting a Cooled Substrate** J. Blake, D. Thompson, Mississippi State University, Mississippi State, MS; D. Raps, Eurocopter Deutschland, Donauworth, Germany; T. Strobl, EADS, Munich, Germany; E. Bonaccurso, Airbus Group Innovations, Munich, Germany	1100 hrs AIAA-2014-2329 **Time-Resolved Temperature Distribution of Icing Process of Supercooled Water in Microscopic Scale** M. Tanaka, Kanagawa Institute of Technology, Kanagawa, Japan; M. Katuaki, Japan Aerospace Exploration Agency (JAXA), Tokyo, Japan; S. Kimura, Kanagawa Institute of Technology, Kanagawa, Japan; H. Sakaue, Japan Aerospace Exploration Agency (JAXA), Tokyo, Japan	1130 hrs AIAA-2014-2330 **Ice Roughness in Short Duration SLD Icing Events** S. McClain, D. Reed, Baylor University, Waco, TX; M. Vargas, R. Kreeger, NASA Glenn Research Center, Cleveland, OH; J. Tsao, Ohio Aerospace Institute, Cleveland, OH	1200 hrs AIAA-2014-2331 **A Thermal Analysis of a Hot-Wire Probe for Icing Applications** P. Struk, NASA Glenn Research Center, Cleveland, OH; D. Rigby, Vantage Partners LLC, Cleveland, OH; K. Venkataraman, University of Texas, Austin, Austin, TX	

Tuesday, 17 June 2014

92-ASE-6/AFM-6/FT-2	Managing Wake Vortex Encounter I					Hanover D
Chaired by: A. BROWN, National Research Council Canada and F. PROCTOR, NASA Langley Research Center						
0930 hrs AIAA-2014-2332 **ATM Decision Support Tool for Wake Vortex Hazard Management Combining Sensors and Modeling** L. Mutuel, Thales Group, Seattle, WA; F. Barbaresco, P. Juge, M. Klein, D. Canal, Y. Ricci, Thales Group, Limours, France; et al.	1000 hrs AIAA-2014-2333 **In-Flight Wake Encounter Prediction with the Wake Encounter Avoidance and Advisory System** T. Bauer, D. Vechtel, F. Abdelmoula, T. Immisch, German Aerospace Center (DLR), Braunschweig, Germany	1030 hrs AIAA-2014-2334 **Investigation of Encounters with Deformed Wake Vortices using a Monte-Carlo Simulation Methodology** D. Bieniek, R. Luckner, Technical University of Berlin, Berlin, Germany	1100 hrs AIAA-2014-2335 **Topological Approach to Multisensory Realization of Wake Turbulence** Y. Takeshima, T. Misaka, S. Obayashi, Tohoku University, Sendai, Japan; H. Kato, Japan Aerospace Exploration Agency (JAXA), Chofu, Japan; S. Takahashi, University of Tokyo, Kashiwa, Japan; I. Fujishiro, Keio University, Yokohama, Japan	1130 hrs AIAA-2014-2336 **In-Flight Testing of Airborne LIDAR for Wake Vortex Detection, Characterization and Tracking** M. Steen, M. Stanisak, T. Feuerle, P. Hecker, Technical University of Braunschweig, Braunschweig, Germany	1200 hrs AIAA-2014-2337 **The Alleviation of Wake Vortex Encounter Loads, A Study of Flight Research Data** A. Brown, National Research Council Canada, Ottawa, Canada	

Tuesday, 17 June 2014

93-AA-4	Jet Noise Near Field I					Hanover E
Chaired by: S. REDONNET, ONERA						
0930 hrs AIAA-2014-2338 **On the Scaling of Jet Noise with Helmholtz Number Close to the Jet Axis** U. Michel, CFD Software GmbH, Berlin, Germany; K. Ahuja, Georgia Institute of Technology, Atlanta, GA	1000 hrs AIAA-2014-2339 **On Coherence of Jet Noise** K. Ahuja, Georgia Institute of Technology, Atlanta, GA; D. Nance, Jacobs, Huntsville, AL; J. Carrigan, Georgia Institute of Technology, Atlanta, GA	1030 hrs AIAA-2014-2340 **Time-dependent prediction of the unsteady pressure near-field from an under-expanded jet** A. Rona, D. Di Stefano, A. Mancini, E. Hall, University of Leicester, Leicester, United Kingdom	1100 hrs AIAA-2014-2341 **The Prediction of Noise due to Jet Turbulence Convecting past Flight Vehicle Trailing Edges** S. Miller, NASA Langley Research Center, Hampton, VA	1130 hrs AIAA-2014-2342 **Decomposition of the Near-field Pressure in a Forced Subsonic Jet** M. Crawley, M. Samimy, Ohio State University, Columbus, OH		

123-AA-6	CAA Sound Generation I					Hanover A
Chaired by: E. BRAMBLEY, University of Cambridge						
1400 hrs AIAA-2014-2451 **The Fast Random Particle Method for Combustion Noise Prediction** F. Grimm, German Aerospace Center (DLR), Stuttgart, Germany; R. Ewert, J. Dierke, German Aerospace Center (DLR), Braunschweig, Germany; B. Noll, M. Aigner, German Aerospace Center (DLR), Stuttgart, Germany	1430 hrs AIAA-2014-2452 **Internal noise suppression for DNS of a turbulent jet-pipe configuration** R. Sandberg, B. Tester, S. Olivetti, University of Southampton, Southampton, United Kingdom	1500 hrs AIAA-2014-2453 **Numerical Predictions of Turbulence-Cascade Interaction Noise Using CAA with a Stochastic Model** V. Clair, C. Polacsek, T. Le Garrec, ONERA, Châtillon, France; M. Jacob, École Centrale de Lyon, Ecully, France	1530 hrs AIAA-2014-2454 **Exploration of temperature effects on the far-field acoustic radiation from a supersonic jet** H. Hafsteinsson, L. Eriksson, N. Andersson, Chalmers University of Technology, Göteborg, Sweden; P. Mora Sanchez, E. Gutmark, University of Cincinnati, Cincinnati, OH; E. Prisell, FMV, Stockholm, Sweden	1600 hrs AIAA-2014-2455 **Direct aeroacoustics simulation of automotive engine cooling fan system: effect of upstream geometry on broadband noise** M. Piellard, B. Coutty, Delphi Thermal Systems, Bascharage, Luxembourg; V. Le Goff, V. Vidal, Euraxo, Paris La Défense, France; F. Perot, Exa Corporation, Brisbane, CA	1630 hrs AIAA-2014-2456 **Integrating CFD source predictions with time-domain CAA for intake fan noise prediction** Z. Rarata, G. Gabard, R. Sugimoto, J. Coupland, R. Astley, University of Southampton, Southampton, United Kingdom; H. Namgoong, Rolls-Royce Group plc, Derby, United Kingdom; et al.	

Tuesday, 17 June 2014

124-AA-7	Fluid Acoustic Phenomena I					Hanover B
Chaired by: Y. GUO, Boeing Defense, Space & Security and M. ROGER, Ecole Centrale de Lyon						
1400 hrs AIAA-2014-2457 **Aero-Structural Acoustics of Uneven Surfaces Part 1: A General Model Approach to Radiated Sound** W. Blake, University of Notre Dame, Notre Dame, IN; J. Anderson, Naval Surface Warfare Center, West Bethesda, MD	1430 hrs AIAA-2014-2458 **Aero-Structural Acoustics of Uneven Surfaces Part 2: A Specific Forcing by a Rough Wall Boundary Layer** J. Anderson, Naval Surface Warfare Center, West Bethesda, MD; W. Blake, University of Notre Dame, Notre Dame, IN	1500 hrs AIAA-2014-2459 **Acoustic scattering by finite poroelastic plates** A. Cavalieri, Technological Institute of Aeronautics (ITA), São José dos Campos, Brazil; W. Wolf, University of Campinas, Campinas, Brazil; J. Jaworski, Lehigh University, Bethlehem, PA	1530 hrs AIAA-2014-2460 **The Noise From Separated Flow** S. Glegg, B. Bryan, Florida Atlantic University, Boca Raton, FL; W. Devenport, M. Awasthi, Virginia Polytechnic Institute and State University, Blacksburg, VA	1600 hrs AIAA-2014-2461 **Aeroacoustics of 2D and 3D Surface Discontinuities** M. Awasthi, W. Devenport, T. Meyers, W. Alexander, Virginia Polytechnic Institute and State University, Blacksburg, VA; S. Glegg, Florida Atlantic University, Boca Raton, FL	1630 hrs AIAA-2014-2462 **Effect of Step Rounding on Noise from Forward-Facing Steps** J. Hao, M. Wang, University of Notre Dame, Notre Dame, IN	

Tuesday, 17 June 2014

125-ASE-7	Ice Roughness Effects on Heat Transfer and Transition					Hanover C
Chaired by: M. VARGAS, NASA Glenn Research Center and P. VILLEDIEU						
1400 hrs AIAA-2014-2463 **Convection from Ice Roughness with Varying Flux Boundary Conditions** C. Walker, S. McClain, Baylor University, Waco, TX	1430 hrs AIAA-2014-2464 **Transient Heat Transfer Measurements of Surface Roughness due to Ice Accretion** Y. Han, J. Palacios, Pennsylvania State University, University Park, PA	1500 hrs AIAA-2014-2465 **Infrared and Hot-Wire Investigations of Ice Roughness Induced Transition** S. McClain, C. Walker, L. Tecson, Baylor University, Waco, TX	1530 hrs Oral Presentation **Boundary layer and heat transfer characterization on surface with academic roughness (Invited)** P. Reulet, D. Donjat, F. Micheli, B. Aupoix, ONERA, Toulouse, France	1600 hrs Oral Presentation **How Roughness Research can Improve LEWICE (Invited)** W. Wright, Vantage Partners, LLC, Cleveland, OH; C. Bidwell, NASA Glenn Research Center, Cleveland, OH	1630 hrs Open Discussion	

Tuesday, 17 June 2014

126-ASE-8/AFM-9/FT-3	Managing Wake Vortex Encounter II: Including Wake Vortex Modelling					Hanover D
Chaired by: A. BROWN, National Research Council Canada and F. PROCTOR, NASA Langley Research Center						
1400 hrs AIAA-2014-2466 **Evaluation of Fast-Time Wake Vortex Models using Wake Encounter Flight Test Data** N. Ahmad, R. VanValkenburg, R. Bowles, NASA Langley Research Center, Hampton, VA; F. Limon Duparcmeur, Craig Technologies, Inc., Hampton, VA	1430 hrs AIAA-2014-2467 **First Results from the NASA Wake Vortex Measurements at the Memphis International Airport** D. Delisi, M. Pruis, NorthWest Research Associates, Redmond, WA; D. Jacob, Coherent Research Group, LLC, Ormond Beach, FL; D. Lai, NorthWest Research Associates, Redmond, WA	1500 hrs AIAA-2014-2468 **Observations of Small-scale Atmospheric Variability and the Importance of Accurate Weather Information in Deterministic and Probabilistic Fast-time Wake Vortex Modeling** M. Pruis, D. Delisi, NorthWest Research Associates, Redmond, WA	1530 hrs AIAA-2014-2469 **Numerical Study of a Long-Lived, Isolated Wake Vortex in Ground Effect** F. Proctor, NASA Langley Research Center, Hampton, VA	1600 hrs AIAA-2014-2470 **Impact of Wind and Obstacles on Wake Vortex Evolution in Ground Proximity** F. Holzäpfel, A. Stephan, N. Tchipev, T. Heel, S. Körner, German Aerospace Center (DLR), Oberpfaffenhofen, Germany; T. Misaka, Tohoku University, Sendai, Japan		