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Prediction of F-16XL Flight-Flow Physics

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THIS special section is the result of fruitful endeavors by an international group of researchers in industry, government laboratories, and university-led efforts to improve the technology readiness level of their CFD solvers through comparisons with flight data collected on the F-16XL-1 aircraft at a variety of test conditions. These 1996 flight data were documented in [1] and detailed the flight-flow physics of this aircraft through surface tufts, pressures, boundary-layer rakes, and skin-friction measurements. The flight project was called the Cranked-Arrow Wing Aerodynamics Project (CAWAP), due to its leading-edge sweep crank (70 deg inboard, 50 deg outboard), and served as a basis for the international comparisons to be made, called CAWAPI. This highly focused effort was one of two vortical flow studies facilitated by the NATO Research and Technology Organization (RTO) through its Applied Vehicle Technology (AVT) Panel with a title of "Understanding and Modeling Vortical Flows to Improve the Technology Readiness Level for Military Aircraft." It was given a task group number of AVT-113 and had an official start date of spring 2003. The companion part of this task group dealt with fundamentals of vortical flow from both an experimental and numerical perspective on an analytically describable delta-wing model, for which much surface pressure data had already been measured at NASA Langley Research Center at a variety of Mach and Reynolds numbers, and is called the "Vortex Flow Experiment–2" (VFE-2) as proposed in [2]. These two parts or facets helped one another in understanding the predictions and data that had been or were being collected.

The CAWAPI facet had the distinction of using actual aircraft geometry, which is subject to the ITAR controls, and required much cooperation between NASA Langley Research Center, NASA Headquarters, and the leadership of the various NATO or Partners-for-Peace participating organizations in establishing how the geometry and grids could be shared. This and other background information is contained in the first paper that follows. The second paper discusses how the supplied geometry was processed into acceptable computational grids for both the structured and unstructured solver communities, papers three to five detail the comparisons of three classes of grid solutions with the flight data, and the last paper provides what has been learned from CAWAPI.

The author is extremely proud of the many outstanding researchers and organizations that have had a part in the CAWAPI facet. These RTO task groups do not come with funded support, so each participating organization had to anticipate that the benefit it accrues would be greater than the expense encountered. The participating researchers accommodated the work often on their own time under the benevolent eye of their employers who saw this work to be of importance and provided an opportunity for their staff to make a novel contribution, as well as to test their own solvers. We have also benefited from significant graduate student involvement; in particular, CAWAPI has lasted long enough for some to complete their advanced degrees and to be part of the coauthorship of two of the following papers.

The author also wishes to thank the AIAA for providing a means of rapid dissemination of results obtained during CAWAPI through two special sessions at the 45th AIAA Aerospace Sciences Meeting and Exhibit (January 2007), and now through the *Journal of Aircraft*. In particular, Professor Frank Coton (University of Glasgow) and the Applied Aerodynamics Technical Committee are thanked for advocating and facilitating these special sessions at the general meeting in which results from nine organizations were reported in 13 papers. The themes of these papers are carried over as articles in this special section, either individually or in combination. The *Journal of Aircraft* editors, editorial staff, and reviewers are also thanked for the many helpful suggestions made during the publication process.

References

[1] Lamar, J. E., Obara, C. J., Fisher, B. D., and Fisher, D. F., "Flight, Wind-Tunnel, and a Computational Fluid Dynamics Comparison for Cranked Arrow Wing (F-16XL-1) at Subsonic and Transonic Speeds," NASA TP-2001-210629, Feb. 2001.

[2] Hummel, D., and Redeker, G., "A New Vortex Flow Experiment for Computer Code Validation," *RTO AVT Symposium on Advanced Flow Management; Part A—Vortex Flow and High Angle of Attack*, Paper 8, 7–11 May 2001.

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