Chapter 36 – SUMMARY OF THE SYNERGISTIC EFFECTS OBTAINED BY THE PRESENT STUDY OF VORTICAL FLOWS

by

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36.1 SUMMARY

This chapter identifies the benefits that occurred to the AVT-113 task group members and the resulting progress made to two separate vortical flow proposals for task group status being combined into one. Both of these proposals dealt with multiple-vortices, and though they shared different focuses, the general topic, as well as the specific features of this flow, made it of great interest to each sub-task or facet member. The joint meetings increased our overall understanding of vortical flow and the synergistic benefits are summarized in terms of experimental and computational data, virtual laboratory usage, dissemination of results, and career development.

36.2 INTRODUCTION

This chapter identifies the benefits that occurred to members of the AVT-113 task group as a result of two separate vortical flow proposals for task group status – contained in [36-1], [36-2] – being combined into one. Though these proposals had different focuses, the general topic, as well as the specific features of the flow, made our joint meetings of great interest to each sub-task or facet member; moreover, these gatherings increased our overall understanding of the grand variety of multiple vortices that can occur over a wing. Each meeting was a seminar in itself and the official ten meetings, plus those held in advance under the Exploratory Team AVT/ ET-026, provided directions for the next steps. Highlights of the synergy that took place are given next.

36.3 SYNERGY

The synergistic benefits are a direct result of sharing together at semi-annual official, as well as unofficial, meetings, and by e-mail or telephone, plus jointly working common problems and writing up the results. They are separated for discussion below into the general categories dealing with data, its communication, and the careers influenced.

36.3.1 Experimental and Computational Data

Data presentations and the following discussions by participating members gave an early insight of the novel vortical flow features that were measured or predicted for the F-16XL aircraft or the 65° delta-wing model at a variety of test conditions.

However, before we could get to the point of discussing the data, there was a need to share geometry/grids data or a wind-tunnel model among the international participants. This need led to a sharing of the process learned by one facet with the other. In particular, since the experimental data existed for the CAWAPI facet, the immediate focus for this facet was on securing a suitable geometry and grids that could be used by the members and to work the ITAR agreements with the European participating organizations. In the VFE-2 facet

the geometry of the delta-wing model was not subject to ITAR restrictions, as it was analytically described, and therefore new wind tunnel models could be fabricated quite easily. However, the immediate focus of the VFE-2 facet was the transfer of a NASA model to the DLR for use in an upcoming wind-tunnel campaign, and this transfer required again international agreements similar to those in the CAWAPI facet.

Another part of the task-group synergy is that some members of the CAWAPI facet ended up contributing solutions to the VFE-2 facet as well, along with those who only generated solutions for the VFE-2 facet. In particular, O.J. Boelens, primarily a CAWAPI member, located an existing structured-grid solution at the NLR for the 65° sharp-edged delta-wing configuration and this was one of the first utilized by that facet [36-3].

Also, W. Fritz, initially only a CAWAPI facet member, played an important role within the VFE-2 facet. He supported the DLR-Goettingen PIV wind-tunnel tests of the VFE-2 facet with an initial CFD flow solution [36-4]. This guided the experimentalists to investigate the details of the primary vortex separation in the appropriate region of the flow field, where two co-rotating vortices, an inner and an outer one, have been found. This success was the origin of a close cooperation between the experimental and the numerical part of VFE-2 [36-5].

Another task group synergy took place in the opposite direction. In the CAWAPI facet the flow around the F-16XL aircraft turned out to be very complex, and a large number of vortical flow regions have been found in the numerical solutions. During the final interpretation of the results the expertise of members of the VFE-2 facet was very helpful.

36.3.2 Virtual Laboratory Usage

Chapter 2 of this report details the planned and actual usage of a virtual laboratory (VL) to speed the information being generated by members and to facilitate comparisons. Since the details are already given, the synergistic effect to note is that the CAWAPI facet hardware and software system, being developed and in place, was also in the process of being adapted/modified for use by the VFE-2 facet.

36.3.3 Dissemination of Results

Dissemination of the AVT-113 results was always key to what this task group would do and even early on, as well as stated in the TAP, plans were laid for communicating what was being learned through various venues.

36.3.3.1 Conferences

Since the CAWAPI facet did not need to generate new experimental data to commence its work, this facet was able to conclude its limited CFD scope on the order of a year earlier than that of the VFE-2 facet. As a result, the CAWAPI facet was able to report out its results at two special sessions of the AIAA Aerospace Sciences Meeting (ASM) in January 2007, and the session chairmen came from the VFE-2 facet. Similarly, the VFE-2 facet reported out its results at two special sessions of the ASM in January 2008 and used CAWAPI facet members as session chairmen.

36.3.3.2 Journal Articles

The thirteen papers presented by the CAWAPI facet members at the AIAA ASM have been combined into six articles, plus one editorial, for publication in the AIAA Journal of Aircraft as a Special Section. Publication is expected in late 2008 or early 2009. The fifteen papers presented by VFE-2 facet members at the AIAA ASM

are targeted for publication in the AIAA Journal at some future date. They chose the AIAA Journal because it was better suited to their more fundamental topic. This journal would also allow them to discuss the topic without having to combine or shorten articles and could even be published in one or more issue, depending on the amount of information selected.

36.3.4 Career Development

Task group participation by doctoral students from the University of Glasgow (GBR), the Royal Institute of Technology (KTH) in Stockholm (SWE), the Technical Universities of Braunschweig and Munich (DEU) not only greatly assisted the work of the group but also provided these young engineers with opportunities to be exposed to senior people and prospective employers on a regular basis. Consequently, the results are that:

- Six doctoral theses by members/regular-invited-guests have utilized all or a portion of their task-group work as a basis and some of them have already been published (S. Goertz [36-6], A. Jirasek [36-7], L. Schiavetta [36-8] and S. Crippa [36-9]).
- Two National Research Council post-doctoral fellowship at USAFA were awarded (S. Goertz [2005] and A. Jirasek [2008]).
- Two permanent careers started (S. Goertz [2006] and S. Crippa [2008]).

In addition, task group members already employed by USAFA and DLR-Braunschweig have participated in reciprocal sabbaticals for their mutual benefit and career enhancement.

36.4 CONCLUDING REMARKS

This task group succeeded in accomplishing its assigned tasks and benefited by the combined strength of two differently focused groups of people, one in a difficult CFD application to a complex airplane and the other more fundamental. The energy, determination of each sub-group or facet, and the reported progress at the semi-annual meetings/seminars were examples of cooperation as each facet encouraged the other. Moreover, the cooperation between the AVT-113 co-chairmen was especially cordial and helpful. The results of synergy within the group were particularly noted in the handling of the experimental and computational data, virtual laboratory usage, dissemination of results, and career development.

36.5 REFERENCES

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