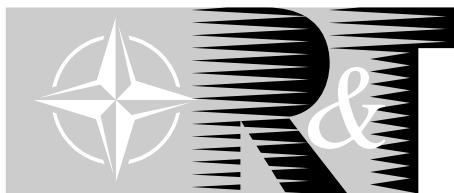


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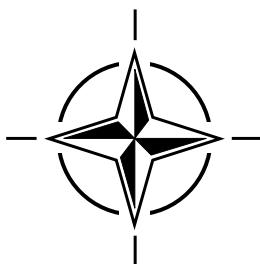
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Flight Test Techniques Series – Volume 21

Flying Qualities Flight Testing of Digital Flight Control Systems

(les Essais en vol des performances des systèmes de commande de vol numériques)

This AGARDograph has been sponsored by the SCI-055 Task Group, the Flight Test Technology Team of the Systems Concepts and Integration Panel (SCI) of RTO.



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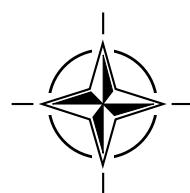
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Flying Qualities Flight Testing of Digital Flight Control Systems

(les Essais en vol des performances des systèmes de commande de vol numériques)

by
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(Air Force Flight Test Center – Edwards AFB)
and
T.D. Smith
(BAE Systems)

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RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective coordination with other NATO bodies involved in R&T activities.

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- AVT Applied Vehicle Technology Panel
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- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS Studies, Analysis and Simulation Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

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Flying Qualities Flight Testing of Digital Flight Control Systems

(RTO AG-300 Vol. 21 / SCI-034)

Executive Summary

This document covers a wide range of subjects which are applicable to the flying qualities flight testing of Digital Flight Control Systems (DFCS). By necessity, the technical depth and disciplines involved in testing such systems cover a wide range of specialties. The job of flight testing a DFCS is really that of a systems development and integration problem. The DFCS depends on many other aircraft characteristics, systems, and subsystems in order to operate properly and perform its intended mission. Each must perform adequately in order for the entire DFCS to properly operate.

This report covers specific areas deemed especially important by the author, specifically the test preparation and data analyses sections. Proper preparation and data analyses are cornerstones of any successful flight test program, and as such have been given broad attention in this report. In addition, the consequences of potential mistakes while testing a DFCS can be disastrous, leading to loss of aircraft or life. Since this type of flight testing is often hazardous, it is incumbent on the test team to carefully plan and execute the program. The test team must be knowledgeable about what the aircraft is predicted to do, what it is doing, and the reasons for both. Armed with this knowledge, the DFCS flight test team can make the appropriate decisions required during the execution of the test program. Without minimizing the other areas involved, the author believes that preparation and data analyses are the two most important aspects of testing hence the emphasis on these areas.

Lastly, the procedures and practices presented in this report are a compilation of best practices as learned over the years by the test community. They certainly are neither exhaustive nor all-inclusive, but simply a list of perhaps the most commonly used practices. There never has been, nor will there ever likely be, a test program where it is possible or practical to employ all of the practices discussed in this report. However, it is hoped that the reader will find many of the practices applicable to their test programs and be able to improve both test efficiency and safety as a result.

les Essais en vol des performances des systèmes de commande de vol numériques

(RTO AG-300 Vol. 21 / SCI-034)

Synthèse

Ce document couvre un grand éventail de sujets se rapportant aux évaluations en vol des performances des systèmes de commande de vol numériques (DFCS). C'est la conséquence logique du fait que la complexité technique et les disciplines associées aux essais de tels systèmes impliquent un grand éventail de spécialités. La réalisation des essais en vol d'un DFCS n'est rien moins qu'un problème de développement et d'intégration de systèmes. Le DFCS dépend de nombreux autres systèmes, sous-systèmes et caractéristiques aéronautiques pour pouvoir fonctionner et exécuter sa mission. Chacun de ces éléments doit fonctionner correctement afin que l'ensemble du DFCS puisse remplir ses fonctions.

Ce rapport couvre des domaines spécifiques considérés par l'auteur comme particulièrement importants, et en particulier ceux de la préparation des essais et de l'analyse des données. La réussite d'un programme d'essais en vol passe en effet par une préparation et une analyse de données adéquates, ce qui explique la large place accordée à ces sujets dans le rapport. En outre, les conséquences d'éventuelles erreurs lors des essais des DFCS peuvent être catastrophiques, entraînant la perte de vies et de matériel. Puisque ce type d'essais en vol est souvent risqué, il incombe à l'équipe d'essais de préparer et d'exécuter le programme avec le plus grand soin. L'équipe d'essais doit bien appréhender le comportement prévu de l'aéronef, son comportement réel, ainsi que les raisons de ces deux comportements. Forte de ces connaissances, elle sera en mesure de prendre les bonnes décisions lors de l'exécution du programme d'essais. Sans vouloir réduire l'importance des autres éléments concernés, l'auteur est de l'avis que la préparation et l'analyse des données sont les deux aspects les plus importants des essais, ce qui explique l'importance qu'il leur accorde.

Enfin, il est à noter que les procédures et les pratiques présentées dans ce rapport sont la synthèse des meilleures pratiques telles qu'élaborées au fil des années par les spécialistes du domaine. Elles ne sont ni exhaustives, ni complètes mais représentent simplement une liste des pratiques les plus courantes. Pour des raisons pratiques, il n'y a jamais eu, et il n'y aura probablement jamais, de programme d'essais capable d'incorporer l'ensemble des pratiques examinées dans ce rapport. Cependant, il est à espérer que le lecteur pourra appliquer un certain nombre de ces pratiques à ses programmes d'essais et améliorer ainsi leur efficacité et leur sécurité.

Note de traduction : l'auteur insiste lourdement dans le 2ème paragraphe sur la préparation des essais et l'analyse des données. Je n'ai pas modifié le texte mais je suggère de supprimer la 2ème phrase du paragraphe : « La réussite d'un programme d'essais en vol passe en effet par une préparation et une analyse de données adéquates, ce qui explique la large place accordée à ces sujets dans le rapport ».

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Preface

AGARDograph Series 160 and 300

The Systems Concepts and Integration (SCI) Panel has a mission to distribute knowledge concerning advanced systems, concepts, integration, engineering techniques, and technologies across the spectrum of platforms and operating environments to assure cost-effective mission area capabilities. Integrated defence systems, including air, land, sea, and space systems (manned and unmanned) and associated weapon and countermeasure integration are covered. Panel activities focus on NATO and national mid- to long-term system level operational needs. The scope of the Panel covers a multidisciplinary range of theoretical concepts, design, development, and evaluation methods applied to integrated defence systems.

One of the technical teams formed under the SCI Panel is dedicated to Flight Test Technology. Its mission is to disseminate information through publication of monographs on flight test technology derived from best practices which support the development of concepts and systems critical to maintaining NATO's technological and operational superiority. It also serves as the focal point for flight test subjects and issues within the SCI Panel and ensures continued vitality of the network of flight test experts within NATO.

These tasks were recognized and addressed by the former AGARD organization of NATO in the form of two AGARDograph series. The team continues this important activity by adding to the series described below.

In 1968, as a result of developments in the field of flight test instrumentation, it was decided that monographs should be published to document best practices in the NATO community. The monographs in this series are being published as individually numbered volumes of the AGARDograph 160 Flight Test Instrumentation Series.

In 1981, it was further decided that specialist monographs should be published covering aspects of Volume 1 and 2 of the original Flight Test Manual, including the flight testing of aircraft systems. The monographs in this series (with the exception of AG 237, which was separately numbered) are being published as individually numbered volumes of the AGARDograph 300 Flight Test Techniques Series.

At the end of each AGARDograph 160 Flight Test Instrumentation Series and AGARDograph 300 Flight Test Techniques Series volume is an annex listing all of the monographs published in both series.

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Flight tests	Wind tunnel tests																						
14. Abstract	<p>This document covers the basics of flying qualities flight testing for digital flight control systems. Most of the techniques and subjects discussed also apply to analog systems as well. The techniques discussed are by no means the only techniques available, nor are they necessarily applicable to every flight test program. Rather, they are a collection of best practices from organizations across NATO, which practice the subject matter. The author hopes that the contents of this text will provide a comprehensive overview of the subject appropriate for experienced engineers, as well as provide a learning source for those new to the subject matter.</p>																						

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