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Spatial Disorientation: Towards International Standardization

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Summary

Spatial Disorientation (SD) remains an important source of attrition in both military flying and general aviation. Several recent symposia and technical meetings have recommended various initiatives to control this hazard such as improvements in training and the standardization of mishap and incident data. In the first area, improved and standardized methodologies of training with appropriate training objectives for aircrew training in SD are intended to produce curricula that will provide international air forces with the ability to ensure that aircrew have a common training base. In the second area, the development of a standardized method of data collection, terminology and reporting for SD related topics would enable a common accident database from which factors involved in the SD accident or incident can be determined. Similarly, a standardized format for data collection from surveys of aircrew experience of SD would be extremely useful for comparative and education purposes. Ultimately, research into SD and the application of training countermeasures can be better coordinated, and more effectively and economically applied. Such enhancements are already being progressed in the military forum through the Air Standardization Coordinating Committee (ASCC). Other international services and organizations (NATO in particular) could readily adopt many, if not all, these initiatives. This paper summarizes the achievements to date and outlines the way in which other organizations can both benefit from the work already achieved, and also contribute to the anticipated improvement in mission effectiveness and flight safety.

INTRODUCTION

Spatial Disorientation (SD) is not a new problem to aviation but judging from the concerns expressed in the open literature there is evidence that the phenomenon continues to be a most important source of attrition in all air forces. SD contributes to between 15 and 30 percent of aircraft accidents, and SD incidents reduce operational effectiveness [1].

There is encouraging evidence that operators are beginning to realize that this hazard, which is primarily due to the limitations of man's orientation senses in flight, is worthy of attention and the application of countermeasures. However, the research and development resources to address the issues have been severely restricted over recent years.

Prevention of SD is the ultimate aim and standardization of many issues is likely to contribute significantly to this aim. It was with these ultimate goals in mind that in 1996 a proposal was made to the Air Standardization Coordinating Committee (ASCC) to form a project to address SD [2]. The following year, a Project Group (PG 117) was formed in Working Party (WP) 61 of the ASCC and the work produced so far is encouraging.

THE FUNCTION OF ASCC AND WP 61

NATO members and PfP nations may not be familiar with the function of ASCC and so the following summary is provided [3]. The ASCC nations are Australia, Canada, New Zealand, United Kingdom and the United States.

The **mission** of the ASCC is to ensure that member nations are able to fight side by side as airmen in joint and combined operations. Interoperability is the ability of coalition forces to train, exercise, and operate effectively together, in the execution of assigned missions and tasks. Within available resources, the ASCC mission of interoperability is achieved through standardization, validation, economizing the use of resources, and information exchange.

- **Standardization.** Standardization is not an end in itself, but is a tool for increasing the operational effectiveness of coalition military forces. Its primary purpose is to achieve operational standardization requirements; however it may also be used to promote economy in the use of resources. International standardization agreements are implemented through national documents. There are three levels of standardization.
 - **Compatibility.** The suitability of products, processes or services for use together under specific conditions to fulfil relevant requirements without causing unacceptable interactions.
 - **Interchangeability.** The ability of one product, process or service to be used in place of another to fulfil the same requirements.
 - **Commonality.** The state achieved when the same doctrine, procedures, or equipment are used.
- **Validation.** Validation assesses the extent to which ASCC member nations have achieved the operational standardization requirements and focus on assessing the capability for combined air operations. Validation is conducted through the following activities:
 - Analyzing the lessons identified/learned during operations and exercises.
 - Assessing the relevance, adequacy and effectiveness of existing standards.
 - Confirming that national implementing documents reflect ratified Air Standards.
 - Testing interoperability during exercises or operations.
- **Economical Use of Resources.** The ASCC provides opportunities for both formal and informal collaboration on issues of common interest to air forces, thereby sharing successes and avoiding duplication of effort. The following activities may be conducted where they improve national or coalition capabilities, while reducing overall costs:
 - The loan of equipment through the Test Project Agreement programme.
 - Collaborative activities not covered by other organizations.
 - Standardization of equipment or procedures not directly related to combat operations, where this is expected to result in significant savings and/or improvements to flight safety.
- **Exchange of Information.** Formal and informal exchanges of information improve the operational effectiveness of national forces, which in turn improve the capability of coalition forces. They also contribute toward ASCC goals by:
 - Enhancing interoperability, where standardization is inappropriate or where individual national requirements preclude standardization.
 - Determining the viability of proposed standardization projects.
 - Assisting in the development of subsequent Air Standards.

PUBLICATIONS

There are three levels of publication that support the standardization initiative. In hierarchical order, they are as follows:

- **AIR STANDARD (AIR STD).** An ASCC AIR STD is a formally documented agreement between ASCC members to standardize specific military doctrine, procedures and/or material to enhance their ability to conduct joint and combined operations.
- **ADVISORY PUBLICATION (ADV PUB).** An ASCC ADV PUB is developed where agreement to standardize is either impracticable or inappropriate yet there remains a requirement for nations to be advised of the procedures and materiel being used by other ASCC nations.
- **INFORMATION PUBLICATION (INFO PUB).** An INFO PUB is an ASCC document for the formal exchange of information between nations which does not meet the requirements of AIR STDs or ADV PUBs.

Publications may be authorised for release. Requests for further release within ASCC nations should be addressed to the national Assistant for Standardization (A/Stand); other requests should be addressed to the ASCC Management Committee (Email: asccad01@pentagon.af.mil). All requests should state the purpose for which release is requested. Contact details are available on the ASCC Website at <http://www.xo.hq.af.mil/xor/xorg-iso/ascc/>

Within ASCC, Working Party 61 is responsible for addressing Aerospace Medicine, Life Support and Aircrew Systems and Project Group 117 specifically deals with SD issues.

PROJECT GROUP 117

The **objective** of Project Group 117 is to standardize concepts, doctrines, procedures, equipment and designs to enhance aircrew effectiveness by minimizing the impact of SD in order to maintain the specified coalition capability requirements. The Project Group's **scope** is to develop AIR STDs, ADV PUBS and INFO PUBS concerned with SD in the flight environment in the following areas:

- Training and operational issues.
- Standardization of terminology and epidemiological data.
- Methods and equipment to enhance, maintain and regain spatial orientation in flight, and other countermeasures to SD.

Co-operative investigations are coordinated and liaison is maintained with appropriate Project Groups, Working Parties and other agencies.

The aim of these publications is to improve the effectiveness of ASCC forces in joint training and combined operations by minimizing the impact of SD through the reduction of loss of lives and money. The capability of joint operations will be enhanced by ensuring commonality in the presentation of orientation information and procedures to prevent and overcome SD.

The Project Group has two primary projects and several information exchange items. These are summarised below and the progress in each area is described.

PROJECT: CONTROLLING THE HAZARD OF SPATIAL DISORIENTATION FOR COMBINED JOINT AIR OPERATIONS THROUGH ENHANCED TRAINING.

Objective: To develop standardized curricula with appropriate training objectives for aircrew training in SD.

Scope: Project Officers will exchange data and information to enhance interoperability in order to develop standardized objectives in both ground-based and in-flight demonstration and training in SD. The goal is to produce standardized curricula that will provide ASCC nations with the ability to ensure that aircrew have a common training base.

AIR STD 61/117/1: Aviation Medicine/Physiological Training of Aircrew in Spatial Disorientation.

The intent of this standard is to define the minimum aviation medicine/physiology training in SD of aircrew of each ASCC member nation. Training which meets the requirements of this AIR STD will be acceptable to all ASCC member nations for the purpose of allowing trained aircrew from any ASCC nation to operate that nation's aircraft. The AIR STD provides a standardized academic definition for SD, specifies details of the required (and agreed) classroom curriculum and makes general recommendations about ground-based and in-flight demonstration and training. It is a very useful document that has already provided the basis for further publications on standardization. AIR STD 61/117/1 has been ratified and is fully releasable to other agencies.

Draft AIR STD: Ground-based demonstration in Spatial Disorientation.

The objective of this AIR STD is to define a standardized curriculum and practice for the ground-based demonstration of the limitations of the orientation senses and SD. From information provided by Project Officers, it is clear that a variety of devices are being used and, although **general** training objectives in SD are available, **specific** objectives for the ground-based demonstrations are not used. Although it is not possible to provide commonality of experience with the variety of devices currently in use, it has been agreed that **common** training objectives would be valuable. These training objectives should reflect best practice and will not be written with specific devices in mind. The agreed objectives could then be used to define the future performance criteria of SD demonstration devices. This AIR STD is in early draft form but progress is being made and the publication will be progressed.

Draft AIR STD: In-Flight Demonstration of the Limitations of the Orientation Senses and Spatial Disorientation in Rotary-Wing Aircraft.

The objective of this AIR STD is to define a standardized curriculum and practice for the demonstration of the limitations of the orientation senses and SD during an in-flight rotary-wing demonstration. An additional intent is to standardize the method of training those who are to conduct the demonstration (training the trainers). The AIR STD also serves as a reference document for trainers. It is therefore comprehensive in its approach. The publication is based upon the successful programme that has been conducted by the British Army for over 20 years [4]. Although the publication has yet to be ratified and so is not yet releasable, this is anticipated for later in 2002. Nevertheless, the demonstrations and their efficacy are described in the open literature [5,6].

Draft AIR STD: In-Flight Demonstration of the Limitations of the Orientation Senses and Spatial Disorientation in High Performance Fixed Wing Aircraft

The objective of this AIR STD is to define a standardized curriculum and practice for the demonstration of the limitations of the orientation senses and SD during an in-flight high performance fixed wing demonstration. The AIR STD also serves as a reference document for trainers. It is therefore comprehensive in its approach. The procedures have been recently developed in the UK on the Hawk T Mk 1 training aircraft of the Royal Air Force but are also being assessed by other air forces. Although the publication has yet to be ratified and so is not yet releasable, this is anticipated for later in 2002.

Draft AIR STD: In-Flight Training in Spatial Disorientation.

The objective of this AIR STD is to standardize the in-flight training of SD in both fixed and rotary-wing aircraft. Most air forces already incorporate some training of this sort but standardization of the training objectives will be of great benefit in providing a common training base for aircrew on joint and combined operations, the goal being a commonality in experience and expertise. The AIR STD specifies that training is to be conducted during both elementary and advanced (including operational conversion) flight training, and also during conversion to each specific aircraft type. An assessment of skills should also be made during revalidation of an instrument flying rating. Although the publication has yet to be ratified and so is not yet releasable, this is anticipated for later in 2002.

PROJECT: IMPROVING UNDERSTANDING OF SPATIAL DISORIENTATION THROUGH COMMONALITY OF TERMINOLOGY, REPORTING PROCEDURES, AND RESEARCH METHODOLOGIES.

Objective: To develop a standardized method of data collection, research methodologies, terminology and reporting for SD-related topics.

Scope: Project Officers will exchange data and information to achieve commonality in SD-related topics. The goals are to produce:

- An accident database from which factors involved in the SD accident or incident can be determined.
- A standardized format for data collection from surveys of aircrew experience of SD.
- Standardized approaches to research methodologies.

These products will provide ASCC nations with the ability to compare data, and in turn, target future research efforts in order to minimize the impact of SD in joint and combined air operations.

Draft AIR STD: The Contribution of Spatial Disorientation to Accidents and Incidents.

The objective of this AIR STD is to define the data to be collected for accidents and incidents in which SD is implicated. Once data collection is standardized between ASCC nations and services, this research tool will enable data to be compared and contrasted between services and nations and thus enhance the collective effort towards controlling the SD hazard. The aims of this data collection are summarized as follows:

- To gather information on the incidence of various factors that affect the generation of the SD accident or incident.
- Identify aircrew member, aircraft and mission factors that contribute to the SD accident or incident.
- Identify controls that could be applied to prevent or overcome SD, e.g. training, technology, ergonomics, etc.

Accident investigation techniques are not standard between ASCC nations and are constantly evolving. Therefore, rather than attempt to re-categorize all accidents, a standard format provided as an annex for data collection specifically concerning the accident or incident in which SD is implicated is provided in addition to existing accident analysis methods. The annex will be completed by aeromedical professionals (e.g. flight surgeon, physiologist, psychologist or researcher) preferably at the time of the accident or incident. If this is not possible, it will be completed once the proceedings of the investigation have been finalized. At “worst” it will be a valuable research tool for the retrospective analysis of accidents. Data analysis will be a national responsibility unless a collaborative agreement is established. When data are exchanged between services and nations, the originating service or nation’s regulations on confidentiality and security will be applied. This is a very useful document that has already provided a valuable means of data collection. The AIR STD is still subject to the ratification process and should be releasable to other agencies in the near future.

INFO PUB 61/117/5: SD Survey Postal Questionnaire

The objective of this INFO PUB is to ensure that each member nation can record aircrew SD survey data in a standard format. It has been decided that 2 formats should be developed; a postal questionnaire that could be sent to a large number of pilots, and an administered questionnaire that could be used to obtain more detailed information from a smaller number of participants. Information obtained from use of these questionnaires will be made available to member nations to enhance understanding of SD problems faced by aircrew. This information will be of value in developing future standards for the protection of aircrew. Nations agree to exchange information derived from use of this postal questionnaire with other member nations and identify enhancements to the questionnaire that could improve its utility in future. UK and USAF have already successfully used the questionnaire and their initial experiences are recorded elsewhere in these proceedings [7,8]. INFO PUB 61/117/5 has been agreed by the national Coordinating Members and is fully releasable to other agencies.

INFORMATION EXCHANGE: MINIMUM REQUIREMENTS FOR CONTINUOUS PRESENTATION OF ORIENTATION INFORMATION.

Objective: To specify the minimum requirements for continuous presentation of orientation information to aircrew in head-up and helmet-mounted displays particularly when the field of regard is off bore sight

Scope: The goal is to conduct a literature search and collate information on the state of current and projected technology. Once this is achieved, progress towards standardization can be made in the equipment (including display symbology, etc) and procedures both to maintain and regain spatial orientation.

This Information Exchange is in early draft form but progress is being made and the publication will be progressed.

INFORMATION EXCHANGE: MEDICAL FACTORS PREDISPOSING TO SPATIAL DISORIENTATION.

Objective: To identify those medical factors which predispose aircrew to SD.

Scope: Traditional teaching emphasises the relevance of various physiological, psychological, pathological and pharmacological factors to an increased incidence of SD. However, the source of this information is poorly coordinated. This Information Exchange will catalogue these factors under a single cover in order to enhance the control of SD in joint operations. An INFO PUB should be ready by late 2002.

THE WAY FORWARD

This paper has provided details of the important ways in which standardization of various aspects of SD can be achieved in an international forum (ASCC). The primacy of effort of work of Project Group 117 has been directed towards the identification of aspects of SD that are amenable to standardization. Nevertheless, some significant progress has been made in a short time and the initiatives have provided valuable tools in the areas of training and data collection. The following points are stressed:

Training. Common practices between nations should be based on the BEST practise. If this can be achieved, we will know that each other has aircrew that are “safer” to fly through our own airspace or on joint operations. In particular, standardization of the training objectives will be of enormous benefit in providing a common training base for aircrew on joint and combined operations, the goal being a commonality in experience and expertise.

Data collection. Many nations have very small air forces or services. By pooling our data in a common format we can increase the power of our observations. In particular, the smaller organizations can gain from the experience of the bigger ones who in turn will gain from this approach as it may provide a fresh look at the challenges. The ultimate aim is of course to provide the EVIDENCE BASE upon which to build our cases for recommendations to enhance mission effectiveness and flight safety.

Some of the ASCC experiences in SD have been submitted to the NATO National Agency for Standardization for incorporation in STANAGS (particularly STANAG 3114: Aeromedical Training of Flight Personnel, and STANAG 3318: Aeromedical Aspects of Aircraft Accident/Incident Investigation) but there would be distinct advantages if broader liaison were established so that NATO and PfP nations can benefit.

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