Safety Science 109 (2018) 36–45

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Understanding teamwork errors in royal air force air traffic control

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ARTICLE INFO

Keywords:
Teamwork
TRM
ATC

ABSTRACT

Despite the success of Crew Resource Management (CRM) training in aviation and the development and implementation of Team Resource Management (TRM) in civil Air Traffic Management (ATM), the Royal Air Force (RAF) is yet to embrace a dedicated, Air Traffic Control (ATC)-specific TRM training programme for its controllers. In order to ascertain the extent to which teamwork-related errors are contributing to RAF ATM incidents, the first part of this study involved analysis of data from incident reports. Using the outputs from the first study, the second part of the study involved interviews with current controllers at Terminal Units in order to understand their perceptions of team, teamwork and teamwork errors in ATC and identify any deficiencies. Both co-located and geographically dislocated teams were considered. The findings showed that controllers have a strong sense of team cohesion and understand the behaviours required for successful teamwork, but have limited appreciation for the cognitive aspects of teamwork, which is where errors are manifesting in incidents. This improved understanding of deficiencies will provide a foundation for future RAF ATC TRM training development.

1. Introduction

Air Traffic Control (ATC) systems that combine human operators and their equipment, are increasingly reliable, therefore when an incident occurs there is usually an element of human error involved (Kirwan et al., 1999). It was suggested by Eurocontrol (2002) that human error contributes to up to 75% of ATC incidents. Operator errors can include errors of attention, judgement or communication by the Controllers or their Supervisors, or, as in the case of mode or display confusion, can due to poor design or insufficient training. These errors have been studied in terms of individual cognition and the control of one's own actions (Isaac et al., 2002; Pounds and Isaac, 2002) but in order to ensure safe separation of aircraft, an air traffic controller must coordinate activity with other airspace users. An extensive literature review into human error in Air Traffic Management (ATM) (Isaac, 2002) found several error-prone activities, but identified no specific research into ATC team error. Similarly, although there has been research into military teamwork (Salas et al., 1998; Prince and Salas, 1993; Bowers et al., 1994), it has concentrated on aircrew teams. Since then, further research has focused on development of tools for identifying, analysing and classifying errors, as shown in Table 1. This change in research direction was driven by the need for safety assessments and quantification of risk in ATM (Kirwan et al., 2008).

Although the RAF does not generally incur the same *commercial* pressures as civil ATC, there are nonetheless operational pressures associated with meeting military flying training and currency targets that require ATC output to be optimised. There are also distinct differences in the nature of the traffic in each environment; Civil ATC typically has to deal with steady, continuous, predictable streams of air traffic flow, whereas RAF ATC has to typically deal with more sporadic but dynamic and unpredictable air traffic flow, which has its own challenges. Additionally, the initiation of Programme MARSHALL, in 2015, saw the start of a 22-year contract to upgrade ATM equipment that is rapidly approaching obsolescence, such as surveillance radars, navigation aids and radios (RAF, 2014), along with the provision of long-term technical support services. This will provide the RAF with an ATM infrastructure that remains both compliant, available and benefitting from commonly accepted efficiency and safety tools. With this also comes a partial restructuring, ranging from each airfield having its own ATC Tower, with resident controllers providing both visual and radar services, to implementation of a 'hub-and-satellite' model, where four ATM hubs will provide radar services for up to three satellite airfields each. This will have two effects significant to this study: if controllers are designated to operate only at satellite airfields providing visual services or only at hubs providing radar services, they will, first, not have experience of each other's professional roles and responsibilities. Second, they will have reduced familiarity with each other on a personal level. The impact of both aspects is discussed later. More geographically isolated

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https://doi.org/10.1016/j.ssci.2018.04.030
Received 17 January 2017; Received in revised form 13 March 2018; Accepted 30 April 2018

Table 1
ATM error analysis tools.

Technique	Description	Authors
TRACEr	Technique for the retrospective and predictive analysis of cognitive errors in air traffic control	Shorrock and Kirwan (2002)
HFACS	Human factors analysis and classification system	Wiegman and Shappell (2003)
HERA - JANUS	Human error in ATM – conceptual framework and taxonomy	Isaac et al. (2002, 2003)

units will continue to operate standalone with combined Air Traffic Services (ATS) (Aquila, 2014). The centralisation of services and equipment modernisation are intended to provide a future military terminal ATC capability that is safer and more efficient as part of project MARSHALL (RAF, 2014). However it would be wise to consider any possible implications of moving from majority co-located to more dispersed ATC teams.

The aim of this research is to identify which areas of TRM training could be utilised to improve ATC team performance, thus creating a safer and more efficient operating environment. In order to do so, the following objectives are established:

- To investigate the extent to which team errors are contributing to incidents and identify the main circumstances in which team errors are being made.
- To increase knowledge and understanding of controllers' perceptions of teamwork, team error and its contribution to incidents.
- To identify differences between team error in co-located and geographically dislocated teams.

The insights gained in this research will enable better understanding of teamwork and team error in RAF ATC, taking into account the characteristics that are specific to RAF terminal ATC teams, therefore allowing deficiencies to be targeted both through training and through consideration of team interactions during task design. By including a current dislocated ATC team (visual and radar services to the same airfield provided from different locations) in the research, the issues associated with working with team members who are geographically dispersed can be considered in order to better manage the transition to 'hub-and-satellite'. The combined effects are intended to ultimately reduce the impact of team errors in RAF terminal ATC.

2. Background

2.1. RAF ATC teams

Although RAF controllers work in accordance with the same rules and regulations as their civilian counterparts, there are specific differences in the way they operate that make it inappropriate to directly transfer research obtained in a civil En-route ATM environment. RAF controllers can be employed in Area Radar, the equivalent of civil En-route Control, but this study concentrates on the traditional Terminal environment, with the Towers located on their respective airfields. Towers are typically composed of two domains, the Visual Control Room (VCR) (Fig. 1) and the Approach Control Room (ACR) (Fig. 2). The VCR is where personnel work collectively to ensure the safety of aircraft during take-off, landing and when operating in the visual circuit, as well as coordinating the deconfliction of aircraft on the ground from vehicles and pedestrians. The ACR, situated beneath the VCR, is where the radar controllers use radar derived information displayed on screens to provide Air Traffic Services (ATS) to aircraft departing from, arriving at and transiting within 40 nautical miles (NM) of the airfield. More information about individuals' roles and responsibilities is contained in Table 2 and their physical positions in Figs. 1 and 2.

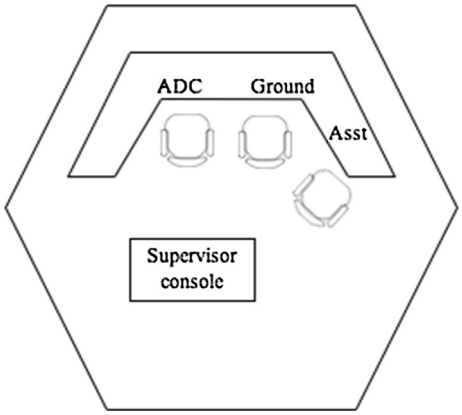

Fig. 1. Typical VCR layout.

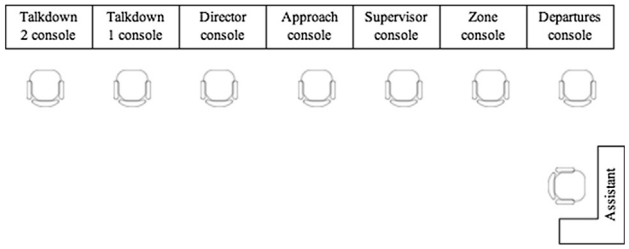

Fig. 2. Typical ACR layout.

Table 2
Terminal ATC roles and responsibilities.

Role	Abbreviation	Responsibilities*
VCR		
Tower	ADC	VCR management Control of aircraft taking off, landing and in the visual circuit
Ground	Grd	Control of aircraft on the ground
Local Assistant	Asst	Control of vehicles and pedestrians on the airfield
Caravan**	TRC	Last-look safety checks on aircraft taking off and landing Control of aircraft through red and green flares
ACR		
Supervisor***	Sup	Tactical management of daily flying programme and Watch personnel Monitoring and intervention
Approach	RA	ACR management Control of aircraft arriving and departing
Director	Dir	Control of aircraft making radar approaches
Zone		Control of aircraft transiting through local airspace
Departures	Deps	Control of aircraft departing
Talkdown	TD	Control of aircraft on final approach (radar based)
Switchboard Assistant	Swb	Updating weather and flying programme informationAnswering / filtering general calls to ATC

* Simplified. Actual responsibilities more extensive and can vary by airfield.
** Based in a mobile caravan at the runway edge. Not found at all airfields.
*** Usually based in the ACR but can move freely between the ACR and VCR as required, with the ability to 'plug in' and listen into any frequency in use in either domain.

Controllers are trained and expected to achieve endorsement in all available roles within the Tower in order to provide maximum manning flexibility, which can be beneficial to the development of shared mental models (Paris et al., 2000). Another difference when compared to En-