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Assessing Professional Cultural Differences Between Airline Pilots and Air Traffic Controllers

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Abstract. Past studies have found that values and attitudes influenced by national culture remain detectable in airline pilots, even after equalisation by training and organisational exposure. There is however insufficient research to ascertain if this relative strength of nationally-determined traits is because national culture is in itself change-resistant, or if it is because professional pilot training and international airline environments lack the power to impel shifts in cultural behaviour. Using a survey with items imported from the Flight Management Attitudes Questionnaire and the ATC Safety Questionnaires, this study compares the non-technical values and attitudes of pilots (n=21) and air traffic controllers (n=13) from the same national cultural background to examine whether the dissimilar pilot and ATC professional and organisational experiences bring about detectable changes in nationally-determined traits. It was discovered that professional and organisational exposure affected hierarchical relations between superiors and subordinates, levels of concern towards automation usage, and the desire for high earnings and career advancement. An understanding of how certain non-technical skills are changed by professional and organisational exposure has the potential to change training, influence equipment designs, and highlight issues in cross-cultural and cross-profession communications.

Keywords: Cultural Behaviours, Training, Aviation Training.

1 Introduction

1.1 The Relative Influence of Different Cultures

Individuals' attitudes and behaviours at work are influenced by the three cultural concepts of *national, organisational,* and *professional* cultures [1, 2]. *National culture* is "developed during adolescence when a person's sensibilities to rules and conceptions, interpersonal relations, and moral and religious ideals are formed" [3]. *Organisational culture*, often known as 'company culture', is determined by conventions of 'the way things are done' within a work environment. *Professional culture* involves the values and attitudes shared amongst people of functionally similar occupations through socialisation and occupational training [2].

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Studies conducted in multi-cultural airlines have demonstrated that traits of national culture, which are deeply ingrained in individuals' personalities as its values and attitudes are established during adolescence [4], remain detectable in airline pilots' values and attitudes on the flight deck even after equalisation by common pilot training and company culture [3]. There however remains insufficient conclusions as to whether this observed precedence of national culture over organisational and professional impacts is because national culture is change-resistant, or if on the contrary it is because pilot training and air crew recruitment selection processes which are globally similar [2] do not provide enough impetus for a significant cultural-shift in nationally moulded values and attitudes.

Humans function more effectively when operating within acquainted cultural contexts as they provide social constructs for individuals to know what to expect of others, and of what others expect of them [5]. In the pilot-air traffic control (ATC) interactive environment, a mismatch between the different players' expectations can lead to a failure to understand and comprehend what has been communicated. The Tenerife accident involving the collision of two Boeing 747s in 1977 provides a relevant example of cross-cultural, cross-context communicative issues. First, the flight crew misunderstood a *route clearance* of a "right turn after take-off", as provided by ATC, as an immediate *take-off clearance* and inappropriately initiated their acceleration for take-off. This was compounded when the flight crew's radio transmission of "we are now at take-off" (as in currently accelerating on the *take-off roll*) was misunderstood by the air traffic controller as that the aircraft was holding in position at the *take-off initiation point*. This series of events eventually caused the aircraft to catastrophically collide with another B747 aircraft that was also on the runway [6].

Contemporary studies confirm that pilot-ATC communicative issues remain unresolved. In a 2018 study, *pilot-ATC communications*, as an explanatory factor, was found to be responsible for 17% of safety performance indicator events in an European air navigation service provider [7]. Further investigation of how cultural traits are affected by professional and organisational training can provide opportunities to improve pilot-ATC mental model sharing by providing indications of both parties' contextual expectations and how these are influenced by occupational exposure.

1.2 Comparing Airline Pilots and Air Traffic Controllers

In this study, a consistent methodology is used to assess and compare the non-technical values and attitudes of airline pilots and air traffic control officers (ATCOs) from an identical national cultural background (East Asian).

Pilots and controllers are a good match for comparative assessment of organisational and professional influences. The two groups operate in the same environment and share functionally similar non-technical skills which are directly influenced by cultural traits [8, 9]. Safety management systems (SMS) and safety culture concepts also apply to both airline pilots and air traffic controllers [10], with Team Resource Management (TRM) and Normal Oversight Safety Survey (NOSS) principles used by ATC directly derived from airline based Crew Resource Management (CRM) and Line Operations Safety Audit (LOSA) techniques [11].

The anticipated outcome of this project is to identify particular traits and non-technical skills which are influenced by professional and organisational exposure. For training design, the identification of content areas where values and attitudes have been discovered to be amenable by organisational and professional cultures provides clues for which content areas to focus on to enable efficient and cost effective training transfer, and which non-technical skill deficiencies (the ones that are not amenable by training) are better catered for through other systemic changes. In relation to human-systems integration, the results can assist in the strategic application of adaptive equipment and procedure designs to compensate for cross-cultural teamwork.

2 Method

2.1 Participants

Thirty-four responses were included in this analysis, of which 21 were from pilots and 13 from air traffic controllers (ATCOs). Participants were recruited with the assistance of the Hong Kong Airline Pilots' Association and Hong Kong Air Traffic Control Association, who distributed through email to their own members and associated groups in the East Asian region a hyperlink to a survey which was hosted online.

2.2 Instrument

The survey distributed to airline pilot participants consists of relevant items imported from the established Flight Management Attitudes Questionnaire (FMAQ) [9], which measures respondents' work values, as well as their attitudes towards *command, communications, stress*, and *automation*. ATC data was collected using questions drawn from the Air Traffic Control Safety Questionnaire (ATCSQ) [11]. As the ATCSQ was developed by adapting FMAQ items with ATC terminologies and for the ATC work environment, the items in the two surveys are conceptually equivalent. Responses were rated on a 5-point Likert scale, with higher scores representing stronger agreement and greater desire for the item statement.

2.3 Research Design

Responses included in this analysis were collected over two time periods. The air pilot data was collected over an eight-month period from April to December 2018, whilst ATC data was collected over a four-month period from August to December 2019.

The survey was digitally hosted on the Jisc *Online Surveys* (pilot dataset) and *Qualtrics* (ATC dataset) platforms. Relevant groups were sent an email containing a hyperlink which redirected the participants onto a web-based interface through which the survey was completed online.

Ethical approval was provided by the Cranfield University Research Ethics System (CURES/9367/2019). Participation was voluntary with no identifying information collected.

Results were analysed using Microsoft Excel. Negatively worded items were reverse coded to ensure directionality, and survey items were consolidated into corresponding composite scales representing different content areas, following FMAQ and ATCSQ groupings, to generate content area scores (see Table 1). One-way Analyses of Variance (ANOVAs) were run for these content area scales to statistically establish whether there were significant differences between air pilot and ATC groups.

3 Results and Discussion

Survey items were compiled into composite scales representing various work values and attitudinal content areas. The results for content areas where significant differences were found between pilots and ATCOs are presented in Table 1. On a 5-point scale, higher scores represent an inclination for autocratic command, greater awareness of automation induced communications effects and higher concern for automation, and greater desire for work values items.

Table 1. Significant Results by Content Area and Profession

Content Area	ATCOs		Pilots		Effect Size for Differences
	Mean	SD	Mean	SD	(*small; **moderate; ***large)
Command	2.84	1.63	2.41	1.41	0.018*
Recognition of Communications Effects When Using Automation	2.85	1.39	4.05	0.91	0.171***
Automation Concern	4.00	0.95	3.32	1.27	0.083**
Work Values - Rewards	3.70	0.66	4.29	0.67	0.104**

3.1 Hierarchical Behaviour

Significant differences between pilots and ATCOs were found on the scale assessing attitudes toward *command* ($F(1,236)=4.24$, $p<0.05$, $\eta 2=0.02$, see table 2). Indicative of the effect of hierarchy and command gradients between superiors and subordinates, the results show that ATCOs (M=2.84, SD=1.63) had a preference for steeper, more hierarchical command gradients in comparison to pilots (M=2.41, SD=1.41). As the subjects tested in both airline pilot and ATC groups were of the same national cultural background, and hence the 'starting point' should be the same, the finding of significant differences between the two groups provides evidence to show that that attitudes toward command and hierarchy are feasibly shaped by organisational and professional exposure.

Table 2. Items Assessing Attitudes Toward Command

Survey Version	Items
ATCOs	1. The executive controller should always take control in an emergency. 2. Controllers should not disagree with their supervisors except when flight safety is threatened. 3. Leadership of the team comes from the sector supervisor. 4. Trainees should not question senior team members' decisions. 5. In abnormal situations, I rely on my superiors to tell me what to do. 6. Supervisors who encourage suggestions from team members are ineffective. 7. In your work environment, subordinates are afraid to express disagreement with their superiors.
Pilots	1. The Captain should take physical control and fly the aircraft in emergency and non-standard situations. 2. Crew members should not question the decisions or actions of the Captain except when they threaten the safety of the flight. 3. Successful flight deck management is primarily a function of the Captain's flying proficiency. 4. Junior crew members should not question the Captain's or senior crew members' decisions. 5. In abnormal situations, I rely on my superiors to tell me what to do. 6. Captains who encourage suggestions from crew members are weak leaders. 7. In your work environment, subordinates are afraid to express disagreement with their superiors.

3.2 Attitudes Toward Automation

In relation to the usage of automation, there were significant differences between pilots and ATCOs on the content areas of *recognition of communication effects* when using automation ($F(1,60)=16.55$, $p<0.01$, $\eta 2=0.22$, see fig. 1) and *automation concern* ($F(1,91)=6.86$, $p<0.05$, $\eta 2=0.07$, see fig. 1). Pilots (M=4.05, SD=0.91) were of greater agreement that the use of automation generates a requirement for more communications between team members than ATCOs (M=2.85, SD=1.39), whilst air traffic controllers (M=4.00, SD=0.95) were more concerned about the negative impacts of automation than pilots (M=3.32, SD=1.27).

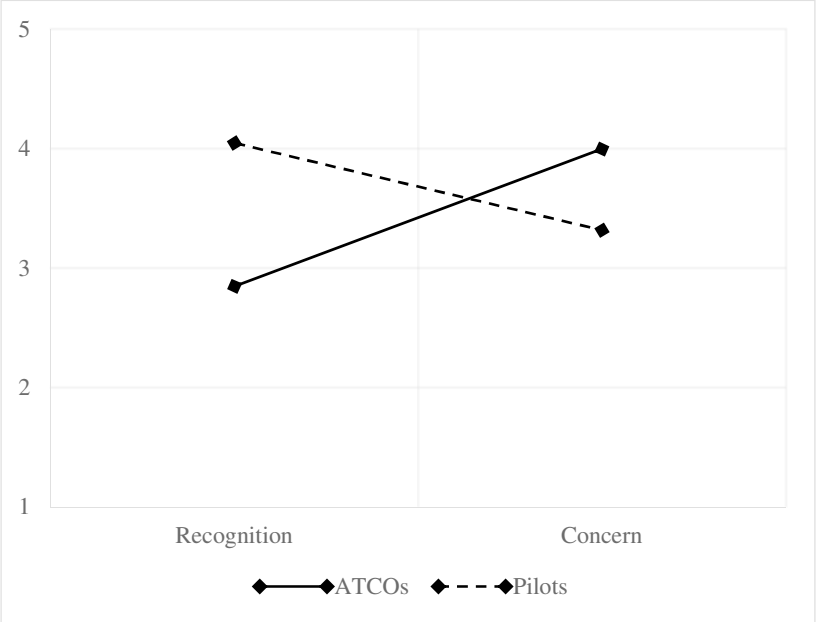

Fig. 1. *Recognition of communications effects when using automation*, and *automation concern* content area scores for ATCOs (solid line) and pilots (dashed line). Notice that the two content areas produced contrasting results.

The opposing findings of respondents' attitudes in the two content areas is possibly reflective of risk mitigation strategies acquired through organisational and professional training. Automation in ATC generally do not require nor permit direct human participation [12], whereas the use of automation on the flight deck heightens the importance of intra-crew communication as pilot-computer interactions need to be coordinated between crew members [13]. This may explain the finding of pilots' greater awareness of the importance of communication when using automation. Greater awareness leads to heightened communications on the flight deck, and as communication is a criterion for safe flight [13], it provides an explanation for the finding of pilots' significantly lower level of concern in relation to the negative impacts of automation.

The aforementioned finding of ATCOs' more hierarchical attitudes toward command may also explain the findings of automation attitudes. High scores on the command scale reflect less team communication and more unquestioned reliance on the person in charge. With modern automation technologies often considered as an additional crew member [14], it is therefore probable in consequence that ATC controllers will be less recognisant for communications requirements when interacting with this "silent crew-member", and be more concerned about its ability and possible negative impacts.

3.3 Rewards

ATCOs and pilots differed significantly on the work values scale of *rewards*, which consists of items assessing respondents' desire for high earnings and opportunities for advancement to higher-level jobs ($F(1,60)=10.42$, $p<0.01$, $\eta 2=0.15$). Pilots were found to be more reward driven ($M=4.29$, $SD=0.67$) than ATCOs ($M=3.70$, $SD=0.66$).

The differences between the two groups in this content area are highly likely to be due to influences of both professional and organisational cultures. Professional influences are reflected by the stereotypical "pilot persona [of] boats, cars, motorcycles, big watches, etc." [2]. Organisational factors, on the other hand, are best understood by considering the different work environments. As pilots work in aircraft and are therefore predominantly isolated from the corporate office environment, they are less exposed to symbolic communication and shared experiences (e.g. seasonal parties, award ceremonies, etc.) [2]. In contrast, ATCOs who work in fixed locations would be more exposed to the communication of organisational cultures and hence may be more susceptible to resulting behavioural changes.

4 Further Research

Although the results provide probable deduction of specific behaviours and attitudes which may be influenced by organisational and professional cultures, they are in no way conclusive. When determining changes in nationally-determined traits, it is difficult to separate the effects of industry-wide training syllabi which are similar for both pilots and ATCOs (such as CRM and Team Resource Management), with the effects of a wider range of organisational and professional factors that, to the contrary, are occupationally varied. The use of national cultural background as a control variable in this study may also fail to capture intra-culture discrepancies, such as participants' previous education, employment, or cross-cultural experiences.

Nevertheless, the interaction between national, organisational, and professional cultures and how it affects behavioural changes in CRM dependent industries merits further investigation. For example, longitudinal studies based on training evaluations can paint a clearer picture of how individuals' values and attitudes, from a known starting point, changes through professional training and exposure to organisational, company cultures. The use of objective measures of individual traits (such as cognitive attention [15]) to categorise respondent groups can also enhance future studies by taking into account and providing an objective control for intra-culture variations in values and attitudes.

5 Conclusion

Previous research on the effect of national cultural traits on air pilots' values and attitudes are insufficient in revealing whether detected cultural differences between pilots of different cultural backgrounds are due to relative strengths in their nationally-

determined traits, or if it is because organisational and professional exposure, such as pilot training, are ineffective in creating behavioural changes. By complementing air pilot data with equivalent data from air traffic controllers, survey results from pilots and controllers from the same national background were compared to assess how exposure to different organisational and professional cultures can affect individuals' non-technical values and attitudes.

Pilots and ATCOs differed in hierarchical behaviours of individualism and command, as well as in attitudes toward automation, suggesting that these content areas can be influenced by organisational and professional cultures. Professional motivations and organisational environments have also been discussed as a likely cause for differences in desire for rewards and advancement opportunities.

The results can inform training, equipment, and procedure designs. In content areas where values and attitudes have been discovered to be amenable by organisational and professional cultures, the use of national background as the criterion for equipment and procedural changes to 'fit the task to the human', as is often the case in culturally responsive designs, may not be entirely ideal. Suggestions for further research include expanding the study to other vocational positions to evaluate inaccuracies arising from pilot and ATC similarities, and to introduce objective assessments of culturally influenced traits to take into account intra-cultural variations.

References

1. Helmreich, R. L. (1998) 'Building Safety on the Three Cultures of Aviation', in *Proceedings of the IATA Human Factors Seminar*.
2. Dahlstrom, N. and Heemstra, L. R. (2009) 'Beyond multi-culture: When increasing diversity dissolves differences', in Strohschneider, S. and Heimann, R. (eds) *Kultur and sicheres handeln*. Verlag fur Polizeiwissenschaft, pp. 79–95.
3. Chan, W. T.-K. and Harris, D. (2019) 'Third-Culture Kid Pilots and Multi-Cultural Identity Effects on Pilots' Attitudes', *Aerospace Medicine and Human Performance*, 90(12), pp. 1026–1033. doi: 10.3357/AMHP.5397.2019.
4. Tanu, D. (2008) 'Global Nomads: Towards a Study of "Asian" Third Culture Kids', in *Proceedings of the 17th Biennial Conference of the Asian Studies Association of Australia*. Melbourne, Australia.
5. Merritt, A. and Maurino, D. (2004) 'Cross-Cultural Factors in Aviation Safety', *Advances in Human Performance and Cognitive Engineering Research*. doi: 10.1016/S1479-3601(03)04005-0.
6. Roitsch, P. A., Babcock, G. L. and Edmunds, W. W. (no date f) 'Human Factors Report on the Tenerife Accident', in Fitzgerald, A. (ed.).
7. Li, W.-C. (2019) 'Safety Presentation: Top Five ANSP Risks and Associated Mitigations'. Bedford: Safety and Accident Investigation Centre, Cranfield University.
8. Knecht, C., Muehlethaler, C. and Elfering, A. (2016) 'Nontechnical Skills Training in Air Traffic Management Including Computer-Based Simulation Methods: From Scientific Analyses to Prototype Training', *Aviation Psychology and Applied Human Factors*. doi: 10.1027/2192-0923/a000103.
9. Helmreich, R. L. and Merritt, A. C. (1998) *Culture at Work in Aviation and Medicine*. New York, NY: Routledge.

10. I. C. A. O. (2013) *Doc 9859, Safety Management Manual (SMM)*, *Doc 9859 AN/474*.
11. Bunjevac, S. and Seychell, A. F. (2015) *Eurocontrol Guidelines for TRM Good Practices*. Brussels.
12. Hopkin, V. (2009) 'Air-Traffic Control Automation', in *Handbook of Aviation Human Factors, Second Edition*. doi: 10.1201/b10401-27.
13. Sherman, P. J., Helmreich, R. L. and Merritt, A. C. (1997) 'National culture and flight Deck automation: Results of a multination survey', *International Journal of Aviation Psychology*. doi: 10.1207/s15327108ijap0704_4.
14. Chialastri, A. (2012) 'Automation in aviation', in Kongoli, F. (ed.) *Automation*. 1st edn. Rijeka, Croatia: InTech, pp. 79–102. doi: 10.5772/49949.
15. Nisbett, R. E., Choi, I., Peng, K. and Norenzayan, A. (2001) 'Culture and systems of thought: Holistic versus analytic cognition', *Psychological Review*. doi: 10.1037/0033-295X.108.2.291.

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