Behavioural development of Air Traffic Control Trainees during Aerodrome training

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The central premise of this research is that Air Traffic Controllers (ATCOs) display various behaviours when interacting with a system, dependent on their level of exposure; and that the presence and prevalence of specific Non Technical user behaviours may be used to infer their level of proficiency with the system. This paper reports an observational study of student ATCOs, examining changes in overt Non-Technical Skill behaviour, across the duration of an aerodrome training course. 67 individual 20 minute observations were made using a behavioural observation method developed during earlier research. Strong correlations were found regarding these behaviours across the course duration. In addition, a number of ab-initio behaviours were identified in addition to the existing marker set. The findings confirm that student ATCO behaviour changes as exposure to a system increases; it is proposed that the markers are embedded within a learning and development framework for further analysis.

Introduction

Non-Technical skills (NTS) are defined as "*the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance*" . A combination of effective technical skills, and Non-Technical Skills in conjunction with a positive user state provide the best circumstances in which optimal task performance can occur. The Observation and assessment of NTS (e.g. during Crew Resource Management Training) is performed using an observational sheet containing predefined behavioural markers. .

It is proposed that the presence and prevalence of certain NTS behaviours (e.g. communication, situation awareness), or their levels of engagement with the system (e.g. dexterity manipulating the interface) may be recorded through structured observation. This data may then be used to evaluate the level of development a user has established with a system. It is suggested that this is to be a complementary technique to other assessment methods examining task performance and technical skill competency .

A previous study examined changes in behaviour with fully validated, experienced ATCOs, who were in the process of migrating from paper to electronic flight progress strips . The findings of this research suggest that ATCOs demonstrated a number of novice type behaviours associated with users with limited experience of a new system, however many non-technical skills from the previous system appear to have transferred across and showed no significant change in presence or prevalence. The aim of this second study has been to examine behavioural change with ab-initio student controllers, over a 4 month aerodrome training course. A second aim through these observations is to record any additional markers indicative of ab-initio behaviour.

Method

Permission was obtained to follow a four month aerodrome training course during simulator training (the remaining training being classroom based). Seven days of observation were arranged approximately every two weeks, from the beginning to the end of the course with specific days chosen where simulator training comprised the bulk of the main schedule. The seven days of observation capture data from student ATCOs with approximately 4, 8, 12, 25, 36, and 42 hours consecutively (out of a total of approximately 45 hours of simulator based training). The course consisted of 10 students; data was collected from the full population. A maximum of 6 training runs may be scheduled in a single day, with a run comprising approximately 5 minutes of briefing, 45 minutes of simulator exercise, and 10 minutes of debrief.

Earlier research work identified and developed a set of structured behavioural markers for the purpose of assessing user engagement and development with an Electronic Flight Progress System (EFPS); a system which replaces paper flight strips within NATS UK tower operations . These individual behavioural markers are contained within an observation sheet, and organised into the following categories: Input and interaction with the HMI; Interaction with others; Physical Posture and Body Language; Attitude and Mood; Communications and Verbal Commentary. In total, 67 observations were made using this observation sheet, with each lasting approximately 20 minutes (20 minutes afforded two separate observations, of separate students, to be made within one training run). The observer (author) sat in a chair positioned to allow observations of the side of the face, and of the paper flight strip board, and other equipment. Observations were made using a behavioural marker sheet developed and revised during earlier research .

The observation task involved the occurrence of a specific behaviour noted down against the appropriate marker each instance it was displayed. A frequency limit of 10 instances for each marker within the observation period was set. Space on the observation sheet allowed any additional behaviours not previously contained, to be recorded; along with other notes. A number of other details were recorded such as exercise name and type, start and finish times, and a participant codec for use in differentiating between participants without using names. Following data collection, any additional behaviours recorded were collated, to await further review. Several new behaviours were identified, and displayed by multiple student ATCOs. An assessment of these behaviours was undertaken to determine what these additional behaviours may indicate, and their overall suitability for inclusion with the existing markers set.

Results

In the presentation of these results, the additional newly observed behaviours are discussed first, as some are included within the results presented later in this section. 23 potential new behaviours were recorded across the 67 observations. However a review of these behaviours revealed that many were observed on only one or two occasions, and only against a single individual. In addition several of the behaviours had considerable overlap and were considered to be capturing the same information.

Through the removal of duplicates and extremely limited occurrences, this list of behaviours has been short listed to seven. Each of these is a new behaviour, which has not been previously observed in ATCOs in earlier research (All previous observational work has examined validated and experienced ATCOs migrating from an existing flight strip system [paper flight strips] to an new flight strip system [electronic flight strips]). Table 1 presents these seven ab-initio behaviours identified, along with an explanation of the behaviour.

Behaviour	**Explanation**	**Total times observed**
Clumsy, very positive actions	Demonstrates physical slowness at moving strips and interacting with workstation, movements over emphasised	36
Nervous Physically hand shaking	Shaking hands, shoulders, and holding and writing with a pen	54
Two hands used to move strips	Experienced controllers move strips with one had, quickly and deftly, using two hands to move them is extremely unusual	216
Frantic writing, Frantic approach to the task	Unless in exceptional situations ATCOS approach the task calmly, not frantically	10
Nervous or Extremely Quiet Voice	A strong, positive, and commanding voice is required, nervous quiet voices are undesirable	70
Points things out to themselves or instructor	Re-enforcing spatial information through physical referencing	41
Leans right over strips when interacting with them	Tunnelled into the workstation, rather than sitting back and absorbing ‘the big picture’	72

Table 1 – Ab-initio behaviours identified through observation of student ATCOs

Focusing on the second study aim – behavioural change over time - the data was divided into two groups. The first group contains behaviours indicating novice to intermediate type behaviours, where the desire is for a decrease in the behaviour over time (i.e. the absence of the behaviour indicates a student ATCO developing in proficiency. Examples of the behaviours clustered within this category are apologetic remarks, verbal signs of confusion and being tongue tide, hesitation in physical action and voice, and reaction to prompts from the instructor.

The second data group contains behaviours indicating intermediate to experienced type behaviours, where the desire is for an increase in the behaviour over time (i.e. the greater presence of the behaviour indicates a student ATCO developing in proficiency. Positive behaviour examples include the ability to write and speak at the same time, quick automatic movements, and the maintaining of global awareness. Table 2 presents the Spearman correlation results for each behavioural development category against the amount of EFPS system exposure (Time). Figures 1 and 2 present a graphical expression of these correlations.

Correlation	**Result**	**Significance (P < 0.05)**
Hours * Negative	P < .001 (N = 67) R = -0.586	Correlation coefficient is significant. Results indicate a moderate negative correlation.
Hours * Positive	P < .001 (N = 67) R = +0.625	Correlation coefficient is significant. Results indicate a moderate positive correlation.

Table 2 – Correlation Results behavioural development category vs. system exposure (time)

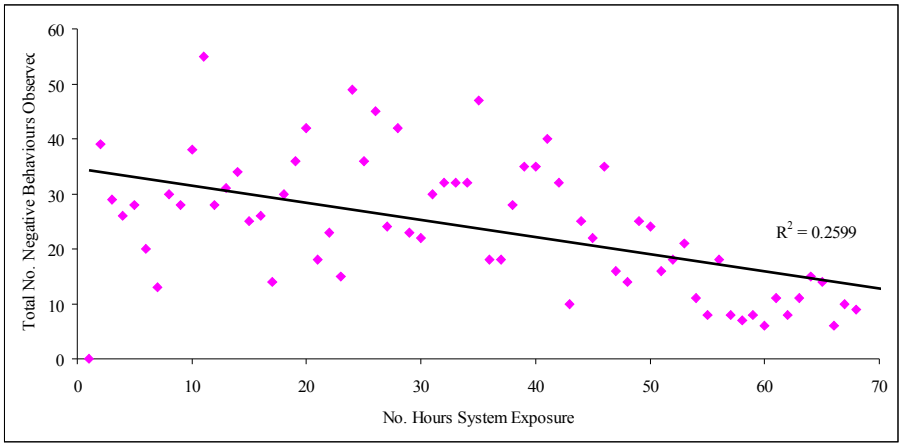

Figure 1 – Total Negative Behaviours of System Proficiency against Hours of System Exposure)

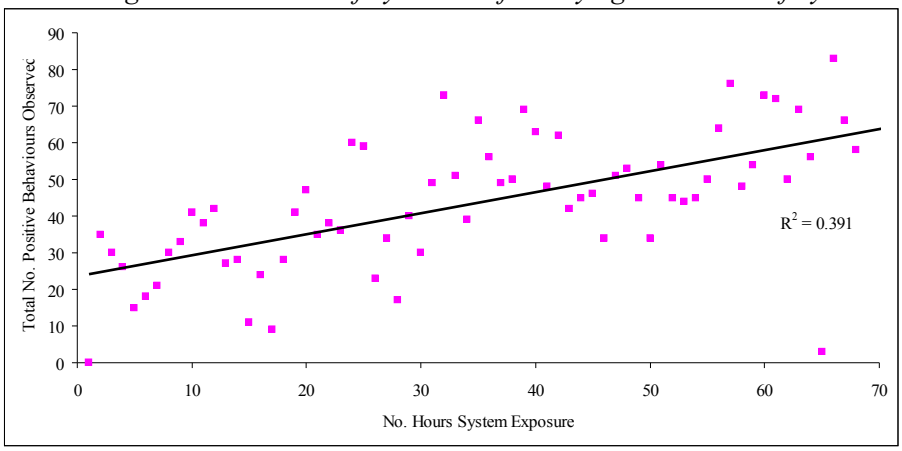

Figure 2 – Total Positive Behaviours of System Proficiency against Hours of System Exposure)

Discussion

The results demonstrate considerable change in the presence and prevalence of specific NTS behaviours over time. The correlations (Table 2) depicted in Figures 1 and 2 clearly illustrate progression and increased proficiency by the student ATCOs across the aerodrome course. Further work should examine individual behaviours and their relationship with the overall trends. In addition this work should examine how these individual behaviours may fit within a learning and development framework such as the cognitive phase, associative phase, autonomous phase framework developed by Fitts and Posner .

Of the seven identified new behaviours included within the analysis, six relate to body posture and body movement. It is evident, that a great deal of insight may be obtained through the examination of these physical properties. The power of the spoken component must not be underestimated; in particular the verbal narrative from several controllers undertaking the task showed many similarities to the 'think aloud' ref process of user interaction evaluation. This narrative regularly indicated the limits of their technical knowledge, often the commentary was providing affirmation that the task was being approached in the correct manner.

Conclusion

Observations of student ATCOs during aerodrome controller training demonstrate considerable change in the presence and prevalence of NTS behaviour over time, with strong significant correlations demonstrated. Newly identified ab-initio behaviours should be formally integrated within the marker set, and this overall set should be examined within the confines of learning and development frameworks.

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