Army Aviators' Perceptions of Advanced Cockpit Aircraft

Kathryn A. Feltman; Amanda M. Kelley; Ian P. Curry

BACKGROUND: Perceptions of features of automation, such as its safety and effects on basic flying skills, can shape how someone uses automation and accepts newly developed technology. The purpose of the present study was to evaluate current U.S. Army rotary-wing aviators' perspectives of cockpit automation in terms of safety features and effects on the retention of basic flying skills. In doing so, future lines of research can utilize this information to develop programs for the transitioning and training of advanced aircraft into the Army.

METHODS: An anonymous, 125-item questionnaire was completed by 214 U.S. Army aviators. A subset of five items related to perceptions of automation were examined based on experience level and are reported here. The majority of subjects were male aviators with a mean age of 33 yr.

RESULTS: Results suggest a difference in perceptions of some of the safety features, with 8 and 12% more of the experienced pilots reporting safety concerns on two items. A 13% difference in the perceptions of effects of automation on skills retention items were found based on experience level. More experienced aviators' responses identified possible distrust of several automation features.

DISCUSSION: The findings of this survey identified perspectives of automation which differed based on experience level. Specifically, more experienced individuals indicated some distrust of automation features and a possible overconfidence in basic flying skills. This can be used to further develop research aimed at the transition of advanced technology to aviators.

KEYWORDS: automation acceptance, aviators, advanced aircraft, military.

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The U.S. Army is moving toward further technological advancement by converting legacy aircraft into advanced cockpits (e.g., UH60A/L into UH60M), as well as the development of future aircraft, currently known as Future Vertical Lift. The introduction of new cockpit technology implies questions regarding how pilots will perceive and use it. Previous studies[2,7] examining perceptions and use of advanced cockpits have typically focused on commercial or general aviation pilots, with few studies focused on military pilots, and even fewer on rotary-wing. Evaluating attitudes and perceptions toward advanced cockpit systems can aid in identifying key areas for research that can support the development of programs to successfully integrate new systems with current and newly trained pilots.

Of the issues that typically present with the incorporation of new technology, prominent are those associated with automation. An abundance of previous work has demonstrated the benefits and pitfalls associated with increased automation use.[5,9,10] While the intent of automation is to reduce human error associated with manual tasks, an often unintended consequence of automation is operators becoming complacent. Specifically, research has repeatedly demonstrated that automation complacency most frequently occurs in multitasking environments where the operators are performing both manual tasks and supervising automated tasks.[11] It has been inferred that this occurs because the operator is required to attend to multiple tasks at once and, in order to offload attentional demands, the operator can become complacent in assuming the automation is adequately carrying out tasks and focus attention on completion of manual tasks. Given that future systems will undoubtedly

From the Aircrew Health and Performance Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL.

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Address correspondence to: Kathryn Feltman, Ph.D., U.S. Army Aeromedical Research Laboratory, 6901 Farrel Rd., Fort Rucker, AL 36362; kathryn.a.feltman.civ@mail.mil.

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include more automated features, as well as the teaming of manned with unmanned aircraft, future aviators may be required to engage in more multitasking by operating their own aircraft while also monitoring unmanned aircraft. This could result in an increased likelihood for complacency to occur, with operators placing more trust in the automated systems to maintain flight, as well as operators misusing automation features to reduce their own attentional demands. For successful future operations, adequate training with, acceptance of, and proper use of the automation available will be crucial. Recent work by Bekier and Molesworth[1] has demonstrated that an individual's acceptance and subsequent use of automation can be altered through prior exposure and training. This suggests that with proper transitioning and training programs in place prior to the introduction of new technology, aviators' acceptance and use of the technology could be shaped to increase acceptance and proper usage.

Examining pilots' current perceptions of automated technology, particularly factors that may impact their use of future technologies, such as safety features and how new technology could impact the retention of their basic flying skills, can provide valuable insight for shaping future research aimed at transitioning new technology to military pilots. As such, the present study's objective was to gain a baseline understanding of current Army rotary-wing pilots' perspectives of safety and skill retention issues surrounding current automated systems in order to gauge where future research and training programs may need to focus efforts to ensure proper transitioning of future systems. The design of this study consisted of a descriptive, survey research design that employed a questionnaire administered to U.S. Army rotary-wing aviators.

METHODS

Subjects

The study was reviewed and approved by the U.S. Army Aeromedical Research Laboratory's Regulatory Compliance Office; all data collected were anonymous. A total of 214 U.S. Army (active duty and reserve) and National Guard rotary-wing pilots who had performed flight duties in the previous 6 mo participated in this survey. This sample makes up approximately 3.1% of the population of U.S. Army rotary-wing pilots based on data supplied by U.S. Army Human Resources Command that shows a total population of 6927 pilots (Human Resources Command; personal communication, 2016). Of the 214 respondents, 69 completed the survey electronically and 145 completed it using paper and pencil. An invitational email was sent to approximately 650 U.S. Army active-duty aviators with 69 responses, yielding a response rate of approximately 10%. While a 10% response rate is typical for an online survey, it did not yield a sufficient sample size for the purpose of the overall survey. Thus, the hardcopy version of the survey was distributed to eligible participants through briefings given to aviation units at Fort Rucker, AL, without leadership present. A total of 187 aviators were asked to complete the hardcopy survey and 146 chose to participate (response rate of 77.5%). Those who chose not to participate typically reported not having time to complete the survey. Participation was voluntary. Respondents were primarily men ($N = 203$, 95.3%; 1 missing response); women ($N = 10$, 4.7%) were slightly under-represented [approximately 5.2% of U.S. Army aviators are female (Human Resources Command; personal communication, 2016)]. The mean age of respondents was 33.03 yr (SD = 8.22). All subjects had at least 50 flight hours of flight experience. Levels of experience are summarized in **Table I**.

Materials

Survey items included in the present report are a subset of 5 items from a 125-item survey instrument which included topics related to fatigue, sleep quality and quantity, health habits, nutrition, spatial disorientation, hypoxia, workload, and technology/automation. The subset of items reported here includes those within the domains of workload and technology/automation, specifically pertaining to perceptions of safety and basic skills retention. This subset of survey items were modified from a prior published study by Casner[2] in order to capture perspectives of workload and technology/automation relevant to advanced cockpit systems in current Army rotary-wing aviation. For the purpose of this survey study, we defined advanced cockpit aircraft as consisting of flight augmentation systems which use automation to assist in controlling the flight. The survey items were modified with input from U.S. Army aviators, research psychologists, and flight physicians. Responses to statements were on a 5-point Likert scale, ranging from Strongly Agree (1) to Strongly Disagree (5).

Procedure

Subjects were recruited either electronically through an invitational email from the principal investigator to participate in the online survey or recruited locally at Fort Rucker to complete the pen-and-pencil version of the survey. Electronic recruitment emails were distributed by the U.S. Army Aviation Center of Excellence to aviation units and contained a link to the survey, instructions for accessing the survey, and a password to enter the survey. Local recruitment

Table I. Summary Statistics for Reported Levels of Experience.

	N	MEDIAN	MEAN	SD
Flight time in last year	208	110.00	147.04	92.99
Flight time in last 90 d	191	30.00	38.12	30.13
Flight time in last 30 d	189	15.00	15.38	13.99
Total hours pilot-in-command	192	741.02	0.00	1485.51
Total hours instrument flight – actual	196	20.00	45.80	84.31
Time since last instrument flight – actual (wk)	189	8.00	18.72	76.62
Total hours instrument flight – simulated	200	30.00	93.38	240.75
Time since last instrument flight – simulated (wk)	195	9.00	12.72	13.88

occurred outside of the chain of command; potential subjects were briefed by research personnel and provided the survey to complete.

Statistical Analysis

Responses submitted using the web-based system were outputted in a spreadsheet and reviewed by a member of the research team for validity. Responses from hardcopy surveys were entered by two members of the research team to minimize data entry errors. Data entry accuracy was assessed using a 10% sample. Statistical analyses were performed using the statistical software package SPSS release 23.0.0. Frequencies for each response item were examined and are reported below.

RESULTS

Respondents who omitted responses to the questions examined were removed ($N = 38$), leaving 176 respondents who responded to one or more items within this subset of questions. Survey results were examined by separating respondents into two groups: Experienced and Expert. Experienced respondents reported less than 499 total flight hours ($N = 99$; M = 123.36 h, SD = 82.29), whereas Expert respondents reported greater than 500 total flight hours ($N = 77$, M = 2486.72 h, SD = 1831.91). Respondents were split by experience due to a low response rate for age, which is attributed to the location of the age item on the paper version of the survey being easy to miss. Regarding safety-related questions, Experts tended to demonstrate slightly more distrust of advanced cockpit systems, with 84.5% ($N = 65$) reporting agreement to the statement, "Advanced cockpit systems can get you into trouble just as easily as they can get you out of trouble," whereas 77% ($N = 74$, 3 missing responses) of Experienced respondents reported agreement (**Table II**). Experts also reported slightly more agreement [$N = 35$ (45.5%)] with the statement, "Some pilots will misuse cockpit systems to stretch the boundaries of safety," as compared to the Experienced group [$N = 32$ (33.7%), 4 missing responses]. Expert and Experienced respondents did not differ in response to the final safety statement, "Advanced cockpit systems will make flying less safe," with the majority in each group reporting either neutral [Experienced: $N = 25$ (26.6%, 5 missing responses); Expert: $N = 19$ (24.7%)] or disagreement [Experienced: $N = 69$ (73.4%); Expert: $N = 54$ (70.2%)]. However, four individuals (5.2%) in the Expert group responded with agreement to the statement, with three strongly agreeing with the statement.

Two statements addressed perceptions of the retention of flying skills (**Table III**). The first statement, "I am concerned that I might become too dependent on using advanced cockpit systems during flight," yielded similar perceptions for both groups. Both groups' responses to the statement were similar [agreement: Experienced: $N = 34$ (35.4%, 3 missing responses), Expert: $N = 28$ (36.4%); neutral: Experienced: $N = 25$ (26%), Expert: $N = 17$ (22.1%); and disagreement: Experienced: $N = 37$ (38.5%), Expert: $N = 32$ (41.6%)]. For the final retention of skills statement, "I am concerned that flying advanced cockpit aircraft will cause my basic flying skills to deteriorate," Experts indicated less concern, with 27 (35.1%) disagreeing with the statement compared to 23 (24%) of Experienced disagreeing.

DISCUSSION

The present survey assessed rotary-wing Army aviators' perceptions of advanced cockpit technology within the domains of safety and retention of skills based on experience level. The results of the survey items evaluated here indicate a slight difference in perception based on experience level in attitudes toward safety and retention of skills when using advanced cockpit technology. These findings provide insight of where further research can aid in the successful integration and use of new aircraft technology.

Results from the survey indicate those with more experience flying show some distrust of automated systems. Experts reported more concern with the safety features in advanced cockpit systems. Specifically, 7% more Experts than Experienced reported they agreed that the systems can get you out of trouble just as easily as get you in, as well as agreeing (~12% more than Experienced) with some pilots misusing cockpit systems to stretch the boundaries of safety. This difference may be because individuals with more experience flying recognize the potential dangers in using automation based on personal experiences, such as automation complacency or overreliance. A recent review of factors influencing trust in automation by Hoff and Bashir[6] identified that experience with a system will alter

Table II. Frequency Responses to Safety Items.

SURVEY ITEM	GROUP	*N*	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
Advanced cockpit systems can get you into trouble just as easily as they can get you out of trouble	Experienced	96	30 (31.3)	44 (45.8)	19 (19.8)	3 (3.1)	
	Experts	77	34 (44.2)	31 (40.3)	6 (7.8)	4 (5.2)	2 (2.6)
Some pilots will misuse advanced cockpit systems to stretch the boundaries of safety	Experienced	95	4 (4.2)	28 (29.5)	37 (38.9)	23 (24.2)	3 (3.2)
	Experts	77	7 (9.1)	28 (36.4)	17 (22.1)	22 (28.6)	3 (3.9)
Advanced cockpit systems will make flying less safe	Experienced	94			25 (26.6)	50 (53.2)	19 (20.2)
	Experts	77	3 (3.9)	1 (1.3)	19 (24.7)	37 (48.1)	17 (22.1)

Percentages are in parentheses.

Table III. Frequency Responses to Skills Retention Items.

SURVEY ITEM	GROUP	*N*	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
I am concerned that I might become too dependent on using advanced cockpit systems during flight	Experienced	96	1 (1)	33 (34.4)	25 (26)	34 (35.4)	3 (3.1)
	Experts	77	7 (9.1)	21 (27.3)	17 (22.1)	26 (33.8)	6 (7.8)
I am concerned that flying advanced cockpit aircraft will cause my basic flying skills to deteriorate	Experienced	98	9 (9.1)	38 (38.8)	28 (28.6)	19 (19.4)	4 (4.1)
	Experts	77	6 (7.8)	28 (36.4)	16 (20.8)	18 (23.4)	9 (11.7)

Percentages are in parentheses.

perceptions of trust in the automated system, which they called "learned trust." However, age has also been found to be implicated in perceptions of automation[4] and those with more experience tend to be older in age. Thus it could be speculated that the more experienced pilots' views of the dangers in using automation is influenced by their age and cohort effects, but these factors were not assessed in the current study.

Regarding the final safety statement where participants rated whether they thought advanced cockpits make flying less safe, the majority within both groups responded with neutral or disagreement. Noteworthy was four individuals in the Experts reporting agreement to the statement. Without follow-up questions it is impossible to know what motivated those responses, but it can be speculated that there is some level of distrust with automated systems, possibly due to learned trust factors. Such a finding is in line with work by Lyons and colleagues,[8] who examined automation trust in Air Force fighter pilots' perceptions and use of the automatic ground collision avoidance system (AGCAS) introduced to F16 aircraft in 2014. They identified several predictors of trust in the system, which included its reliability and perceived benefits. The perception of benefits of the automated systems currently in use that have been developed through interaction with the systems may be influencing pilots' overall perceptions of safety.

Responses to the retention of skills found Experts are more confident in their ability to retain their basic piloting skills despite using automated technology. While both groups indicated mixed responses to pilots becoming too dependent on using advanced cockpit systems, Experts were less concerned over the loss of basic skills than Experienced (~11% difference). This may be due to pilots with higher hours having flown more overall and thus having more confidence in their overall skillset. However, this perspective may be cause for concern, as previous research has suggested basic manual flight skills can decay when pilots mainly fly automated aircraft; therefore, the perceptions reported here may point to overconfidence in skills which can contribute to misusing automation.[3,5,12]

The overall findings from this survey identified that experience level likely influences views regarding safety features and basic skills retention with advanced cockpit aircraft. These findings can be used to prioritize future research, particularly that related to the development of programs for transitioning advanced aircrafts within the military. By using the information garnered from this survey, future work can further evaluate underlying causes of differences in perceptions of distrust related to safety features and views of skill retention found in the different experience levels. Further evaluation of these factors can be used to design transitioning and training programs that address distrust of automated systems, such as unawareness of safety features or ability to retain basic flying skills. Given that previous work[1] has demonstrated that individuals' perceptions and acceptance of automation can be altered with exposure and training, further work to identify the underlying causes of different pilots' reluctance toward advanced technology should be completed to identify methods for transition and training to ensure acceptance of new technologies.

The present study was limited by the representativeness of the sample. This sample was limited by convenience of availability and thus may not be representative of the opinions and perceptions of Army aviators as a whole. Additionally, the methodology, namely self-report survey, produces limitations in and of itself. Self-report surveys are not always reliable as individuals' responses may be shaped by peers at the time of the delivery of the survey and time constraints in responding can lead to less thoughtful responses. Future studies should aim to use a stratified sampling approach in regards to experience levels to increase the representativeness of the sample and enable a better understanding of Army rotary-wing aviators' views as a whole.

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Authors and affiliation: Kathryn A. Feltman, M.A., Ph.D., Amanda M. Kelley, M.S., Ph.D., Ian P. Curry, BM, B.S., D.Av.Med., Aircrew Health and Performance Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL.

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