2005

The Relationship Between Controller Opinions and Use of an Atc Decision Support Tool

Carol A. Manning

Melanie Dennis

THE RELATIONSHIP BETWEEN CONTROLLER OPINIONS AND USE OF AN ATC DECISION SUPPORT TOOL

Carol A. Manning
Melanie Dennis
Federal Aviation Administration, CAMI
Oklahoma City, OK

The purpose of this study was to assess the relationship between controllers' opinions about the User Request Evaluation Tool (URET), an air traffic control decision support tool, and their use of various URET functions, including its flight data management capabilities, conflict prediction information, and problem-solving tools (e.g., trial planning). We expected that, compared with those who were less positive about URET, controllers who rated the tool more positively would use it more often in performing sector team duties. In 2002, formal observations were made of 181 en route controllers using URET at six facilities. URET display settings, usage, and use of automated flight strip equivalents were recorded. Controllers were also asked their opinions about the readability/usability of URET, changes in roles and communications between controller team members, their typical use of URET features, their perceptions of URET's effects on safety, workload, time required to perform tasks, and benefits provided to pilots. Dichotomously-coded answers to opinion questions were used as independent variables in t-tests. Dependent variables were counts of activities performed using paper, the Host computer, or URET. Controllers who performed more URET tasks thought the system required less time to use and were more positive about its effect on safety than those who performed fewer URET tasks. They were also more likely to indicate that they checked alerts and performed trial planning. Use of specific Aircraft List (ACL) functions was also related to controllers' likelihood of using URET's decision support capabilities. It is unclear whether controllers' familiarity with URET resulted in their positive opinions about the system or if having positive impressions made them want to use the system more frequently. It is also unclear whether increased use of the system would change controllers' opinions about URET. Regardless, these results indicate that there is a relationship between positive opinions and URET usage.

Introduction

We are interested in identifying factors that will predict the likelihood that air traffic controllers will use new automation tools to help them manage air traffic and perform their job duties more safely, effectively and efficiently. Two factors provide the reason for our interest. The first involves plans for new ATC automation tools to be introduced in the future. For example, Controller Pilot Data Link System (CPDLC), Automatic Dependent Surveillance-Broadcast (ADS-B), En Route Automation Modernization (ERAM), and other tools have been proposed. The second factor is the aging of the controller workforce resulting from the compressed hiring of controllers after the strike in 1981. We previously predicted that older controllers may have more trouble using new automation than younger controllers. However, Manning, Durso, Batsakes, Truitt, & Crutchfield (2003) found that en route controllers' age was not significantly related to their marking of paper flight strips, a process highly integrated in much of air traffic control. They also found that older controllers were able to use an alternative procedure for marking flight strips as easily as younger controllers. Moreover, Manning & Dennis (2004) found that age did not predict en route controllers' opinions about or use of an ATC decision support tool. Thus, while age has been found to be a factor in the use of some new technologies in the general population, it does not seem to be related to use of technology in ATC.

This study was conducted to identify other factors, besides age, that might predict automation usage. If age is not predictive of automation use, perhaps opinions about the automation might be. We assessed the relationship between controllers' opinions about the User Request Evaluation Tool (URET), an air traffic control decision support tool, and their use of certain URET functions. We expected that controllers who rated the tool more positively and, thus, considered it more useful, would use it more often than those who rated URET less positively.

Note that these data were collected soon after the introduction of the URET CCLD system. Several enhancements have been made to the system since that time as a result of controller feedback. Thus, comments provided at that time may no longer be relevant to the version of URET in the field today.

URET

URET is a decision support tool that provides the en route sector team with a conflict probe and electronic flight data management capabilities (FAA, 2001; FAA, 2005). A prototype version of URET was used

on a daily basis at the Indianapolis and Memphis Air Route Traffic Control Centers (ARTCCs) for several years before the production system, called URET CCLD (Core Capability Limited Deployment) was introduced into 6 facilities in 2001 and 2002. URET is now operational at 10 en route facilities. URET provides timely and continuous detection of emerging problems, affording controllers with the opportunity to take action earlier and operate their sectors in a more strategic way. Aircraft-to-aircraft conflicts, for example, are detected up to 20 minutes in advance while aircraft-to-airspace problems are detected up to 40 minutes in the future. Controllers can use URET's trial planning capability to check a proposed flight plan amendment, such as a route change, for conflicts prior to issuing it as a clearance.

The primary URET display, the Aircraft List (ACL), consists of separate entries for aircraft currently under sector control as well as those predicted to enter the sector at some point within the next twenty minutes. ACL entries contain flight plan information, provide room for a controller to update information about issued clearances and show the status of URET-generated alerts for each aircraft. The ACL contains the same information and allows the controller to perform the same activities as the paper flight progress strips formerly used by en route controllers. Because it is difficult for controllers to take full advantage of the URET functionality while simultaneously managing paper flight strips, the requirement to use most flight strips is not in effect at en route sectors where URET is being used.

Method

In 2002, observations of 181 en route controllers were conducted at six facilities: the Kansas City, Chicago, Indianapolis, Memphis, Cleveland, and Washington ARTCCs. The controllers were observed while using URET. A checklist containing 79 items was available to guide the observation. Not every controller responded to all items.

Observers recorded URET display settings and controllers' use of URET automation functionality. Besides observing controllers' behavior, observers also asked them about their typical use of URET features, their opinions about the readability/ usability of URET ACL entries, their beliefs about the changes in roles and communications between controller team members, and their perceptions of URET's effects on safety and workload, the amount of time required to perform tasks, and the benefits they provide to pilots.

Answers to 4 opinion questions were recoded to be dichotomous (positive/negative) and were used as independent variables in t-tests. For t-tests, dependent variables were sums of counts of behaviors performed using URET. Independent variables were dichotomous responses to opinion questions. Chi-square analyses compared use of URET's decision support capabilities with dichotomous responses to opinion questions and observed use of specific URET functions.

Results

Analyses were conducted to investigate the relationships between three variables of interest: controller opinions about URET, use of URET to perform sector team tasks, and reported use of URET's decision support capabilities.

Opinions and URET usage

The first analysis looked at the relationship between controllers' opinions about URET and their observed use of the system. For this question, the independent variables were dichotomous codings (e.g., positive, negative) of controllers' opinions about URET's safety, workload required, time required to perform URET tasks, and benefits provided to pilots. The dependent variables were the number of flight strip equivalents or URET activities performed. URET activities were certain actions the controller could take using the system (see Table 1). These were looking or pointing at the ACL, acknowledging or coordinating route notifications, preferential routes, Unsuccessful Transmission Messages (UTMs), or Inappropriate Altitude for Direction of Flight (IAFDOF) indicators on the ACL, clicking to remove Ns from the bookkeeping box (when moving a new entry to the sorted list), deleting gray entries from the ACL (to remove aircraft that have been handed off to another sector), putting a checkmark in the bookkeeping box (to annotate an item to remember), highlighting ACL entries (to emphasize their importance), moving entries to the Special Attention Area, entering speeds or headings, opening or using the free text area, creating trial plans (for any reason), or using the Graphic Plan Display (GPD).

Table 1. *Specific URET activities recorded during observations*

Look at ACL
Point at ACL
Acknowledge or coordinate route notifications on ACL
Acknowledge or coordinate preferential routes on ACL
Acknowledge or coordinate Unsuccessful Transmission Messages (UTMs) on ACL
Acknowledge or coordinate Wrong Altitude for Direction of Flight indicators on ACL
Click to remove Ns from the bookkeeping box
Delete gray entries from the ACL
Put a checkmark in the bookkeeping box
Highlight ACL entries
Move entries to the Special Attention Area
Enter speeds or headings on the ACL
Open or use the free text area
Create trial plans (for any reason)
Use the Graphic Plan Display

Table 2 shows the relationship between controller opinions about URET and the sum of the different actions (described above) they were observed to perform while using URET. Significant differences were observed in the number of tasks controllers performed as a function of their opinions about the amount of time required to perform tasks using URET, the workload associated with their use of the system, URET's effect on safety, and additional services provided to pilots because of URET.

Controllers who thought URET saved time performed significantly more URET tasks than those who thought the system required the same amount or more time to use ($t(101)= 2.45$, $p < .02$). Controllers who made positive comments about URET's effect on safety performed more tasks using URET than those who expressed neutral or negative comments about its effects on safety ($t(140) = 2.46$, $p < .02$. No significant differences were observed in controllers' URET task performance as a function of their opinions about URET's effects on workload or whether they thought they provided additional services to pilots because of using URET.

Table 2. *Relationship between controller opinions about URET and number of different URET tasks performed*

Opinions about URET	N	Mean # tasks performed	SD	Sig
Amount of time required for use				*
Same or more	19	2.0	1.0	
Less	84	3.2	2.1	
Effects on workload				NS
Increased, no difference	31	2.7	2.0	
Reduced	107	3.2	2.1	
Effects on safety				*
Neutral, negative	73	2.8	2.0	
Positive	69	3.6	2.1	
Additional services to pilots?				NS
Yes	54	2.7	2.0	
No	39	2.1	1.6	

Opinions and reported use of URET's decision support capabilities

The second analysis looked at the relationship between controller opinions about URET and their reported use of URET's decision support capabilities. Table 3 shows the relationship between controllers' opinions about URET's safety, workload required, the time required for URET tasks, and benefits provided to pilots and their reported use of URET's decision support capabilities for checking alerts and performing trial planning.

Controllers who believed URET saved time were significantly more likely to report that they checked alerts than those who did not believe using URET saved time ($X^2(1) = 8.18$, $p < .01$). The reported use of trial planning as a function of the assessment of time saved by using URET was not significant. Controllers who believed that URET reduced their workload were more likely to check alerts ($X^2(1) = 6.58$, $p < .01$) and trial plan ($X^2(1) = 7.35$, $p < .01$) than controllers who thought using URET increased or did not change their workload. Controllers who made positive comments about URET's effect on safety were more likely to report checking alerts ($X^2(1) = 8.04$, $p < .01$) and trial planning ($X^2(1) = 13.00$, $p < .001$) than were controllers who made neutral or negative comments about the effect on safety. Controllers who said URET allowed them to provide additional services to pilots were significantly more likely to report checking alerts ($X^2(1) = 7.78$, $p < .01$) and using trial planning ($X^2(1) = 6.93$, $p < .01$) than those who did not believe they provided additional services to pilots when using URET.

Table 3. *Relationship between controller opinions about URET and reported use of its decision support capabilities*

	Use of URET's decision support capabilities					
	Check alerts?			Trial plan?		
Opinions about URET	#	%Y	%N	#	%Y	%N
Time required for use						
Same, more	19	37	63	19	42	58
Less	81	72	28	82	56	44
Effects on workload						
Increased, no difference	30	47	53	30	33	67
Reduced	103	72	28	101	61	39
Effects on safety						
Neutral, negative	72	56	44	69	39	61
Positive	65	79	22	64	70	30
Additional services to pilots?						
Yes	52	77	23	51	65	35
No	39	49	51	36	36	64

Number of task types performed using URET and reported use of its decision support capabilities

The third analysis examined the relationship between the number of different tasks performed using URET and controllers' reported use of its decision support capabilities. Table 4 shows the results. Controllers who reported that they at least sometimes checked alerts performed significantly more tasks than controllers who reported that they never checked alerts ($t(153)=2.3$, $p < .03$). Controllers who indicated that they at least occasionally used trial planning performed significantly more tasks using URET than those who indicated that they never used trial planning ($t(151) = 3.29$, $p < .01$).

Table 4. *Relationship between number of different URET tasks performed and reported use of its decision support capabilities*

Use of URET's decision support capabilities	N	Mean # tasks performed	SD	Sig
Check alerts?				*
Yes & sometimes	105	3.3	2.1	
No	50	2.5	2.0	
Use trial planning?				*
Yes & sometimes	85	3.6	2.2	
No	68	2.5	1.9	

Relationship of specific ACL functions to use of URET's decision support capabilities

The fourth analysis looked at the relationship between specific ACL functions used by controllers and their reported use of URET 's decision support capabilities. Table 5 shows that those who deleted gray entries from the ACL (a housekeeping task unrelated to planning) were significantly more likely to report that they checked alerts than those who did not delete gray entries ($X^2(1) = 12.39$, $p < .001$). However, deleting gray entries was not significantly related to reporting trial planning. Controllers who highlighted entries on the ACL were more likely to report that they used trial planning ($X^2(1) = 6.41$, $p < .02$) than those who did not. There was no significant relationship between highlighting entries and reporting that they checked alerts. Controllers who annotated speeds and headings were more likely to report that they checked alerts than those who did not ($X^2(1) = 5.56$, $p < .02$), but there was only a marginal relationship between annotation and trial planning ($X^2(1) = 3.08$, $p < .08$). Neither clicking the N to move an entry to the sorted list nor checking the bookkeeping box was related to reporting checking alerts or trial planning.

Table 5. *Relationship between controllers' use of specific ACL functions and reported use of URET's decision support capabilities*

	Use of URET's decision support capabilities					
	Check alerts?			Trial plan?		
Observed use of URET functions	#	%Y	%N	#	%Y	%N
Click N?						
Yes	57	75	25	57	63	37
No	89	62	38	87	48	52
Check box?						
Yes	38	71	29	37	62	38
No	101	67	33	98	54	46
Delete gray?						
Yes	116	72	28	116	54	46
No	17	29	71	15	40	60
Highlight?						
Yes	45	76	24	46	70	30
No	85	62	38	80	46	54
Annotate Speeds/Hdgs						
Yes	32	81	19	33	70	30
No	60	56	43	59	51	49

Discussion and Conclusions

Controllers who had more positive opinions about URET (e.g., saved time and enhanced safety) were observed performing more activities using the system. Positive opinions about URET were also related to whether controllers reported that they used the decision support functions of checking alerts generated by URET or trial planning the effects of making a proposed flight plan change. The number of different tasks performed using URET and the use of specific URET functions were related to whether controllers reported that they checked alerts or used trial planning. The results suggest that use of some URET functions associated with flight data management had a positive relationship with use of other functions related to its conflict probe capabilities.

Another result is that positive opinions about certain URET functions were related to increased usage of some aspects of URET. However, only some positive opinions about URET were predictive of URET usage. Moreover, positive opinions about URET did not predict use of all of URET's functions.

While attitudes have been found to be relevant to predicting behavior (Ajzen, 2001), other variables, as yet unidentified, may moderate the relationship. In this study, it is unclear if being more familiar with URET produced controllers' positive opinions about the system or if having positive impressions made them want to use the system more frequently. It is also unclear whether controllers' opinions about URET would improve after they increased their use of it. Regardless, these results indicate that there is some relationship between positive opinions about URET and controllers' use of the system. This suggests that it would be of value for developers of new ATC systems to assess controllers' opinions about system effectiveness and utility soon after implementation. The information may then be used to respond to concerns, either by providing clarifying information about how to use the system or by making modifications to it.

Acknowledgements

We would like to acknowledge Brenda Boone and Nikki Haase, Human Solutions, Inc., for their role in planning and executing the project. We would also like to acknowledge Skip Fisher and Dave Winokur, ATO-E, for reviewing and commenting on the manuscript.

References

Azjen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology*, *52*, 27–58.

Federal Aviation Administration. (2001). National Airspace System Capital Investment Plan: Fiscal Years 2002-2006. [Online]. Available: http://nasdocs.faa.gov/nasihtml/cip/cip02.pdf Washington, DC: Author.

Federal Aviation Administration. (2005). Free Flight Home Page: Tools: User Request Evaluation Tool (URET). [Online]. Available: http://ffp1.faa.gov/tools/tools_uret.asp.

Manning, C. A., & Dennis. M. (2004, May). Relationship between controller age and use of an ATC decision support tool. Paper presented at the 75th Annual Scientific Meeting of the Aerospace Medical Association, Anchorage, AL.

Manning, C. A., Durso, F. T., Batsakes, P., Truitt, T., & Crutchfield, J. (2003, April). Age, flight strip usage preferences, and strip marking. In R. S. Jensen (Ed.) Proceedings of the Twelfth International Symposium on Aviation Psychology. Dayton, OH: Wright State University, pp. 762-768.