Aviation-Related Expertise and Usability:
Implications for the Design of an FAA E-Government Website

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ABSTRACT

The Federal Aviation Administration (FAA) Human Factors Team − Atlantic City conducted a usability assessment of the www.fly.faa.gov website to examine user satisfaction and identify site usability issues. The FAA Air Traffic Control System Command Center uses this website to provide information about airport conditions, such as arrival and departure delays, to the public and the aviation industry. The most important aspect of this assessment was its use of quantitative metrics to evaluate how successfully users with different levels of aviation-related expertise could complete common tasks, such as determining the amount of delay at an airport. The researchers used the findings from this assessment to make design recommendations for future system enhancements that would benefit all users. They discuss why usability assessments are an important part of the process of evaluating e-government websites and why their usability evaluation process should be applied to the development of other e-government websites.

Keywords: *aviation; e-government; expertise; government to consumer (G2C); heuristic evaluation; usability assessment; user needs; website usability*

INTRODUCTION

On November 15, 2007, President Bush announced actions to address aviation delays during the Thanksgiving holidays. As part of this announcement, he directed people to visit the website fly.faa.gov, which is a Federal Aviation Administration (FAA) e-government website that provides real time information about airport delays.

Fourth, the federal government is using the Internet to provide real-time updates on flight delays. People in America have got to know there's a website called Fly.FAA.Gov; that's where the FAA transmits information on

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airport backups directly to passengers and their families. If you're interested in making sure that your plans can -- aren't going to be disrupted, you can get on the website of Fly.FAA.Gov. As well, if you want to, you can sign up to receive delay notices on your mobile phones. In other words, part of making sure people are not inconvenienced is there to be -- get transmission of sound, real-time information. (Bush, 2007)

There has also been a concerted effort by the FAA to publicize its website by placing advertisements in airports across the United States. Many news outlets now provide airport delay information as part of their weather forecasts, and this delay information comes, most often, directly from the fly.faa.gov website.

Because this website is the public face of a large federal agency, it is important that it presents the agency in the best light possible. An agency website should be a positive public relations vehicle and should not, in itself, create any public relations problems. Although use of e-government websites is increasing annually, low user acceptance of e-government websites is a recognized problem (Hung, Chang, & Yu, 2006). Many factors affect whether or not someone will use or accept an e-government website, including past positive experience with e-government websites (Carter & Bélanger, 2005; Reddick, 2005); the ease of use of the website (Carter & Bélanger, 2005; Horst, Kuttschreutter, & Gutteling, 2007); the perceived trustworthiness of the information presented on the website (Carter & Bélanger; Horst, et al., 2007); the perceived usefulness of the website (Hung et al., 2006); and personal factors such as education level, race, level of current internet use, and income level (Reddick, 2005). If a website has many functional barriers, such as having a poor layout or producing incomplete search results, customers of the site may not use it (Bertot & Jaeger, 2006).

Early work in e-government has consistently ignored studying the needs of end users, and there has been little research focusing on the demand side of e-government (Reddick, 2005). That is, *what are customers looking for when coming to an e-government website?* Although there have been many benchmarking surveys conducted on e-government websites, benchmarking surveys often do not describe the benefits provided by a website and only enumerate the number of services offered by that site (Foley, 2005; Yildiz, 2007). Benchmarks do not evaluate the user's perception of sites and do not measure real progress in the government's delivery of e-services. However, governments often chase these benchmarks to the exclusion of all other forms of evaluation (Bannister, 2007).

E-government academics emphasize the importance of usability testing and highlight the need to focus on website functionality, usability, and accessibility testing (Barnes & Vigden, 2006; Bertot & Jaeger, 2006). However, despite its importance, many organizations still are not performing usability testing on e-government websites. Current work often does not address the needs of different user communities, employ user-centered design, or use rigorous methods to test the services being delivered (Bertot & Jaeger; Heeks & Bailur, 2007).

Governments around the world are working to review best practices for e-government evaluation methods (Foley, 2005). Because of the social and economic benefits of providing information online, it is important that e-government website designs meet the needs of its targeted users. In addition, it is important to document the benefits provided by the website to increase public support (Foley). Carter and Bélanger (2005) point out that e-government websites should be easy to navigate. They note that the organization of information on the site should be congruent with citizens' needs. When consumers visit an e-government website, they are most frequently looking for information (Thomas & Streib, 2003), which they need to be able to find quickly and easily. If users encounter problems while using a website, they may become frustrated and be less likely to adopt or utilize e-government services in the future. A positive experience with an e-government website will be communicated to others (Carter & Bélanger), and a usable website can

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play a significant role in engendering trust in the agency itself.

Most web usability research focuses on e-commerce sites and privately run websites (Hung et al., 2006), and people expect e-government websites to be as good or as usable as private sector sites (Irani, Love, & Montazemi, 2007). People are more likely to use an e-government website if the transactions with that site are compatible with previously conducted transactions on similar, non-government websites (Carter & Bélanger, 2005).

However, there are clear differences between e-government and e-commerce websites. For instance, e-government sites must provide universal accessibility so that all citizens have access to information. Additionally, e-government websites are accountable to the public, whereas commercial websites are only accountable to people who have a financial stake in the website. It is not always clear, however, where the boundary between these two types of sites lies (Salem, 2003). Additionally, there are often challenges faced in producing e-government websites that are not faced by commercial sites (Gil-Garcia & Pardo, 2005). For example, when creating e-government websites, designers need to consider whether the project goals align with the goals or mission of the government agency (Yildiz, 2007). They also must make sure that all project stakeholders are involved, determine whether they are in compliance with all relevant government regulations, and work within government budget cycles and changing government contractors.

The FAA and fly.faa.gov

The FAA Air Traffic Control System Command Center provides information about airport conditions, such as arrival and departure delays, to the public and the aviation community via their website, www.fly.faa.gov. This website allows users to view airport conditions for specific airports.

The website has many different functions that help the user to search for delay information (see Figure 1). Using the **Search by Region** function, users are able to look up airports in different geographic regions, such as the Northeastern states and the Southeastern states. When using the **Search by Airport** function, users are able to search for airport delay information by typing in the name of a city, airport, or a three-letter airport code. The **View by Major Airport** function allows users to search for delay information using a drop down list of 40 major airports.

The site is also a repository of information for use by airlines, pilots, passengers, government personnel, academics, individual aircraft operators, and other stakeholders in the aviation community. It provides access to real-time and historical advisory information, real-time airport arrival demand information, current reroutes, and reroute restrictions. It also provides access to information related to air traffic management tools, a glossary of aviation terms, a national routes database, pilot tools for making arrival and departure reservations, a collection of National Airspace System documents, and many other air traffic tools.

The focus of this assessment was on the evaluation of site elements that the general public would access the most, such as the airport delay information and the glossary of aviation terms. From the user's point of view, the website needs to provide accurate information quickly, with minimal effort, while minimizing potential mistakes. The site should be easy for users to learn and provide an appealing and satisfying experience.

We faced some unique issues and challenges when evaluating the fly.faa.gov website. First, the fly.faa.gov website presents real-time, up-to-the-minute data, whereas most e-government websites often present static information or information that changes infrequently. It was also clear that the expectations of site users were likely to be influenced by the information found on more commercial aviation sites. Because people have preconceived notions about the airlines and the reliability of information provided by airlines, it was possible that this perception could transfer to their perception of this website.

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Figure 1. The www.fly.faa.gov home page, illustrating the View by Region, Search by Airport, View by Major Airport, and Site Map search methods.

The website was also originally designed for use by people associated with the aviation industry, such as pilots and local airport authorities, who have at least a working knowledge of various aviation concepts. Because it is accessible on the internet and other travel sites have links to it, members of the traveling public (who may have little, if any, understanding of aviation or its associated jargon) also frequently use the site. The website is also being touted (Bush, 2007) as the first place the public should visit on the web when looking for travel-related delays in the aviation system. Therefore, it was important to evaluate whether this site is usable by people who do not have a background in aviation. In this usability assessment, we examined how effectively people with different levels of domain knowledge were able to use the site.

It was difficult to identify a single typology that described the website. Although the site often looks like a Government to Consumer (G2C) site (Hiller & Bélanger, 2001), its original purpose was to function as a Government to Business (G2B) site or a Government to Employee (G2E) site. The site allows people to perform basic transactions (Hiller & Bélanger, Stage 3), but it also attempts to be a full-service, one-stop site for many types of aviation related information (Hiller & Bélanger, Stage 4). For instance, although this evaluation did not focus on the G2B information, airlines often use the site to find delay information, and general aviation pilots use the site to make route reservations. Although the site tries to organize its content to meet the different needs of these different categories of users (Ho, 2002; Schelin, 2003), it is not clear how the organizational structure was determined or whether it is the most optimal organization for all types of users.

We conducted this formal usability assessment to determine how successfully the website meets these usability goals and the needs of its users, including both expert and novice users. The assessment employed techniques commonly used in usability evaluations (Ahlstrom & Longo, 2003; Nielsen, 2003). The participants

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completed a set of representative tasks using the website, while researchers observed and recorded their actions and comments. Users also answered a series of questions rating the usability of the site. The data collected through these activities helped us identify a number of problems. After identifying the final list of usability issues, we used a part of the heuristic evaluation technique (Nielsen) to determine the most critical issues. This paper discusses the technique used in this evaluation, highlights some of the most critical issues, and provides suggestions to designers on how to fix them. We also discuss the benefits of applying this formal process to the development of other e-government websites.

METHODOLOGY

Participants

We recruited 32 adult volunteers from the FAA William J. Hughes Technical Center to serve as participants. Because the participants were FAA employees, many had greater aviation-related knowledge than the general public. However, many FAA employees, such as administrative assistants and facility support workers, do not have significant knowledge of aviation or air traffic control. We included participants of both categories.

Equipment

The laptops used in the experiment contained fully interactive offline versions of the fly.faa.gov website. A User Script asked the participants to use the website to find information to answer 17 questions: 12 asked users to search for delay information, 3 asked users to find the definitions for aviation-related terms, and 2 asked users to identify the authority to be contacted when trying to obtain specific information. The script also asked users to use the **Search by Region**, **Search by Airport**, and **View by Major Airport** methods for specific questions. This allowed us to evaluate the usability of each function.

Procedure

Each session lasted 30 to 45 minutes. After signing an informed consent form, the participants completed a Background Questionnaire that collected information about the participants' knowledge of computers, websites, and aviation terminology.

After completing the Background Questionnaire, the participants next completed the User Script. We observed each participant during the experiment and recorded pertinent actions or comments. At the end of the experiment, the participants completed a Post-Session Questionnaire, where they rated their experience and identified usability issues.

Because using participants who all had a high level of aviation-related knowledge could have biased the results, we used the data to categorize the participants into three groups (novices, moderate knowledge users, and experts), based on their aviation-related knowledge. We analyzed the data by level of expertise to determine whether aviation-related knowledge had an impact on user performance. By analyzing the results in this way, we could make recommendations targeted toward making the site usable for the different user populations. When even individuals with a high level of aviation-related expertise had trouble using certain features, this provided strong evidence that those features needed to be redesigned. Even if novices were the only ones who had a problem with a feature, we rated that problem as severe if the impact for those users was severe.

RESULTS

Background Questionnaires

The Background Questionnaire asked the participants questions regarding their familiarity with aviation-related terms and acronyms. For example, participants were asked to list

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three-letter abbreviations for airports (e.g., Philadelphia International Airport = PHL), or were given the three-letter abbreviations and asked to list the airports associated with those abbreviations (e.g., MIA = Miami International Airport). Using the correct responses to these and other aviation-related questions, we categorized the participants as novices (n = 8), moderate knowledge users (n = 15), and experts (n = 9). The novices were slightly younger than both the experts and those with moderate-knowledge (M_{novice} = 41.6 years, $M_{moderate}$ = 49.9 years, M_{expert} = 49.1 years). More than 70% of novices and those with moderate knowledge reported never using the fly.faa.gov website. In contrast, 75% of the experts reported using the website a few times a year.

All the participants had extensive experience using computers and the Web. Because we found no discernable differences in reported web and computer use among the participants, we were unable to stratify the participants based on these factors.

User Script Data: Overall Analysis

Of the 12 questions that asked users to find specific delay information, the participants answered 79.4% correctly. For the subset of five delay questions that allowed the participants to use their preferred search method, the participants answered 71.2% correctly. For the subset of four **Search by Airport** questions, 84.5% of the participants answered the questions correctly. For the **View by Major Airport** question, 90.6% of participants found the correct answer; for the **View by Region** question, 81.3% found the correct answer; and for the **Site Map** question, 87.5% found the correct answer.

Three questions asked the participants to use the site to provide the definition of three aviation related terms and abbreviations. Although 84.4 % of participants answered all three questions correctly, 6.3% answered one incorrectly, 3.1% answered two incorrectly, and 6.3% were not able to answer any of the questions. By comparing the percentage of participants who answered a question correctly, we determined that all three questions were equally difficult.

Two questions asked the participants to find whom to contact to obtain information about the status of an individual flight or why an airport was closed. For these questions, only 28.1% of the participants answered both questions correctly, 56.2% answered one incorrectly, and 15.6% answered both incorrectly.

User Script Data: Analysis by Level of Expertise

We analyzed the data by level of expertise to determine whether aviation-related knowledge had an impact on user performance. Analyzing all 17 questions, we found an effect of expertise on overall task performance, F (2, 29) = 3.54, p = .04. Post hoc pairwise contrasts indicated expert participants were able to answer significantly more questions than novices (85.6% vs. 69.1%, p = .01), and there was a trend suggesting moderate-level users answered more questions than novices (79.6% vs. 69.1%, p = .07).

We performed ordinal (linear) chi-square tests on individual questions to determine whether the percentage correct increased or decreased across the user categories (Howell, 2007). Although only three of the questions were significant, 7 of the 12 delay questions showed the expected pattern of results (see Table 1). Therefore, we also tested the binomial probability that 7 of the 12 delay questions would show the expected ordering of expert > moderate > novice. We found that it was unlikely that this pattern would occur by chance 7 out of 12 times, $p < .001$. This suggests that experts were better able to find information on the fly.faa.gov website than moderate users, who in turn were better than the novices. We did not find the same pattern for the aviation term or contact information questions.

We grouped the questions to analyze performance on the different subsets of questions. For the 12 questions that asked users to find specific delay information, novices, moderate-level users, and experts answered 65.6%, 81.7%, and 88% of the questions correctly, F (2, 29) = 5.04,

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Table 1. Percentage correct by level of aviation-related expertise

Questions	% Correct		
	Novices	Moderate Users	Experts
1. Los Angeles to Salt Lake City.**	75.0	100.0	100.0
2. Portland to Memphis.	25.0	53.3	33.3
3. Denver to Philadelphia. **Search by Airport**.	87.5	93.3	88.9
4. Houston to Chicago. **Search by Airport**.**	62.5	73.3	100.0
5. Newark to Burlington.	50.0	73.3	88.9
6. Las Vegas to New York. **View by Major Airport**.	75.0	93.3	100
7. Phoenix to Dallas.*	12.5	73.3	77.8
8. Cincinnati/Northern Kentucky to Detroit. **View by Region**.	75.0	80.0	88.9
9. Pittsburgh to Washington DC. **Site Map**.	75.0	86.7	100.0
10. New York to San Jose. **Search by Airport**.	75.0	80.0	100.0
11. Orlando to St. Louis. **Search by Airport**.	87.5	86.7	77.8
12. Houston to Tulsa.	87.5	86.7	100.0
Using information available on the site, provide the definitions of the following aviation-related terms or abbreviations:			
13. CIGS	87.5	93.3	88.9
14. MULTI-TAXI	87.5	86.7	88.9
15. VOL	75.0	93.3	100.0
Using information available on the site, who should a visitor contact to obtain information about the following:			
16. Status of an individual flight	100.0	78.6	87.5
17. Why an individual airport was closed	50.0	26.7	44.4

** $p < .10$, two-tailed. * * $p < .05$, two-tailed.*

$p = .01$. Post hoc pairwise contrasts indicated experts and moderate-level users were better able to find delay information than novices ($p = .005$ and $p = .021$, respectively).

We further divided the 12 delay questions into subcategories based on search method. For the subset of questions that allowed people to find information using their preferred search method, we found an effect of expertise on user performance, $F(2, 29) = 9.93$, $p = .001$. Experts and moderate users performed better than novices when searching for delay information using their preferred search method, answering an average of 80% and 77.3% of the questions

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correctly, while novices only answered an average of 50% correctly ($p < .001$ for both post hoc pairwise comparisons).

For the four delay questions that asked users to specifically use the **Search by Airport** method, novices, moderate users, and experts answered 78.1%, 83.3%, and 91.7% of them correctly. Although these results were not statistically significant, they demonstrated the same trend as the other sets.

Post-Session Questionnaire: Overall Analysis

The Post-Session Questionnaire asked the participants to rate their subjective experience with the fly.faa.gov website using 6-point scales. Except for the question asking about the level of detail, higher ratings indicated positive responses and lower ratings indicated negative responses. For the question that asked the users how detailed the information on the site was, a rating of 1 indicated too little detail and a 6 indicated too much detail. For these summaries, we omitted responses from the participants who chose more than one number on the rating scale. The ratings indicated that the participants thought it was fairly easy to find information on the site ($M = 4.4$, $SD = .8$) and that they understood information once they found it ($M = 4.8$, $SD = 1.0$). The participants also found it fairly easy to navigate between pages on the site ($M = 4.9$, $SD = 1.2$) and found the design of the site to be consistent ($M = 4.9$, $SD = 1.0$). They indicated that there was somewhat too much detail ($M = 3.9$, $SD = 0.8$), but that information on the site was fairly readable ($M = 4.8$, $SD = 1.1$). Finally, they indicated that, overall, they were mostly satisfied with the site ($M = 4.7$, $SD = 0.8$). When we compared satisfaction ratings to actual performance, it was apparent that participants were not able to accurately estimate performance, given that they answered an average of 20.1% questions incorrectly. However, despite their performance, the participants still reported high satisfaction with the site. Given this dissociation between performance and satisfaction, it is important that usability experts evaluate not just user satisfaction, but actual user performance, when evaluating a website.

Post-Session Questionnaire: Analysis by Level of Expertise

We found no significant differences in the ratings between experts, moderate-level users, and novices. There were, however, some interesting trends in the data. The ratings on information comprehensibility indicated that experts found the information to be somewhat more comprehensible than moderate-level users, who, in turn, found the information to be more comprehensible than novices. In evaluating design and layout consistency, the experts were the least satisfied with the design consistency, with novices being the most satisfied, and moderate users falling somewhere in the middle. For the ratings on the level of detail, experts gave the highest ratings (i.e., slightly too much detail), with novices giving the lowest ratings (i.e., slightly too little detail), and moderate users falling in the middle (i.e., an appropriate level of detail).

Rating of Usability Issues

Using comments and questionnaire ratings made by the participants, along with our observations of the participants while they completed the User Script, we compiled a consolidated list of usability issues and rated the severity of each issue (for a comprehensive list, see Friedman-Berg, Allendoerfer, & Pai, 2007). When rating the severity of each problem, we considered the following factors (Nielsen, 2003).

1. **Frequency:** Is the problem very common or very rare?
2. **Impact:** How easy is it for the users to overcome the problem when navigating through the website?
3. **Persistence:** Can users overcome the problem once they know about it, or will the problem bother users repeatedly?

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The researchers rated each issue as having high, medium, or low frequency, impact, and persistence, and then used these three ratings to determine a severity rating from 0 to 5. The severity rating scale was adapted from Nielsen (2003).

0 = I don't agree that this is a usability problem at all
1 = minor/ cosmetic problem only: not necessary to fix, should be given lowest priority
2 = usability problem: small benefit from fixing, should be given low priority
3 = moderate usability problem: moderate benefit from fixing, should be given medium priority
4 = major usability problem: important to fix, should be given high priority
5 = usability catastrophe: extremely important to fix, should be given highest priority

After each researcher independently assigned a severity rating for each issue, we averaged them to compute a consolidated severity rating (Nielsen, 2003). These consolidated severity ratings provide a good estimate of additional usability efforts needed when developers establish priorities for future enhancements. We rank ordered the usability issues from those having the highest severity rating to those having the lowest.

The following section discusses the eight usability issues that had the highest severity rating and provides suggestions and design recommendations regarding how these issues could be resolved. User interface design standards and best practices drive these suggestions (Ahlstrom & Longo, 2003). In some cases, we developed simple prototypes to demonstrate potential design concepts that designers could use to remediate some of these issues.

Issue 1: User Confusion Regarding Delay Types

The primary purpose of fly.faa.gov is to provide travelers with airport delay information. For example, a traveler going from Philadelphia to Miami might want to find out about departure delays at PHL and arrival delays at MIA. The traveler also might have some interest in the causes of delays, which can include factors like weather, airport construction, and traffic flow programs. However, the difference between delay types was not readily apparent to many participants. For example, one question asked users to find information about delays at their arrival destination. The arrival airport had no arrival delays, but did have general departure delays. Because the instructions indicated that they were arriving at that airport, the participants should have focused on the lack of an arrival delay, but only 40.6% of the participants answered this question correctly. Those who answered incorrectly seemed to be looking at the departure delay, which indicated that they did not understand which delays were relevant for them. This issue received a mean severity rating of 4.3, $SD = 0.5$.

It is important that the site provide users with the information they want without requiring them to understand difficult air traffic concepts. We also found that novices had greater difficulty in finding delay information than both moderate level users and experts. This was likely due to novice users not understanding more technical concepts. We recommend that the site not try to present difficult concepts to the lay public, but instead present information in a less technical manner. For instance, instead of referencing ground delay programs as the cause of a delay, the site could indicate that a delay was due to congestion. For users seeking more detailed information, the website could provide additional information about ground delay programs using links to additional pages.

Because the participants were not always able to identify relevant delays, we recommend that the site provide users with a capability that gives them easy access to pertinent delay information. For example, the site might provide an interactive tool that allows users to input departure and arrival airports or click on city pairs to generate a single report on relevant delays for air traffic traveling between a pair of airports.

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Issue 2: Information Presentation: Clutter and Redundant Information

The participants' comments and researchers' observations suggested that there was too much information on the typical search results page (see Figure 2). This issue received a mean severity rating of 4.3, *SD* = 0.5. The site sometimes presented information for a single airport in multiple places on the same page. The information was dense, used too much text, and was not well organized. In many instances, the participants had difficulty finding the delays that were relevant for them. Displaying so much information can be especially problematic when users are in a hurry to find information. Users may scan too quickly and get lost. They may read the wrong line, overlook information they are looking for, or see a big block of text and give up.

We recommend simplifying and reorganizing these pages to make it easier for users to find and understand information on the page. The page could use a tabular layout arranged in columns and organized by arrivals and departures (see Figure 3). Much of the text information is not useful, creates clutter, and should therefore be removed. Because the distinction between general departure delays and destination-specific delays is not clear to users, it should be deemphasized or eliminated. Finally, all delay information related to an individual airport should be consolidated.

Presenting two sets of delay information for one airport, especially if the data are inconsistent, is confusing. The website should avoid going into too much technical detail regarding the causes of delays. It might instead use icons or graphics (e.g., clouds with snow, clouds with rain) to depict weather or other causes of delays. The website could offer links to additional information for advanced users.

Issue 3: Overuse of Aviation-Related Acronyms and Jargon

The site uses too many aviation-specific acronyms and jargon when providing specific information about the causes of delays. This issue received a mean severity rating of 4.0, *SD* = 0.0. Aviation-specific acronyms, abbreviations, and jargon are difficult for the general public to

Figure 2. Crowded Airport Status Information page.

AIRPORT STATUS INFORMATION
provided by the FAA's Air Traffic Control System Command Center

Waterloo Muni Airport (ALO) Real-time Status

The status information provided on this site indicates general airport conditions; it is not flight-specific. Check with your airline to determine if your flight is affected.

Delays by Destination:

- Due to WEATHER/WIND, departure traffic destined to **General Edward Lawrence Logan International Airport, Boston, MA (BOS)** is currently experiencing delays averaging **1 hour and 46 minutes**.
- Due to WEATHER/WIND, departure traffic destined to **Newark International Airport, Newark, NJ (EWR)** is currently experiencing delays averaging **2 hours and 17 minutes**.
- Due to WEATHER/LOW CIGS, departure traffic destined to **John F Kennedy International Airport, New York, NY (JFK)** is currently experiencing delays averaging **4 hours and 3 minutes**.
- Due to WEATHER/WIND, departure traffic destined to **La Guardia Airport, New York, NY (LGA)** is currently experiencing delays averaging **3 hours and 10 minutes**.
- Due to WEATHER/SNOW, departure traffic destined to **Chicago Midway Airport, Chicago, IL (MDW)** is currently experiencing delays averaging **1 hour and 9 minutes**.
- Due to WEATHER/SNOW, departure traffic destined to **Chicago Ohare International Airport, Chicago, IL (ORD)** is currently experiencing delays averaging **1 hour and 10 minutes**.
- Due to WEATHER/WIND, departure traffic destined to **Philadelphia International Airport, Philadelphia, PA (PHL)** is currently experiencing delays averaging **3 hours and 38 minutes**.
- Due to WEATHER/WIND, departure traffic destined to **Teterboro Airport, Teterboro, NJ (TEB)** is currently experiencing delays averaging **1 hour and 3 minutes**.
- Due to WEATHER/TSTMS, departure traffic destined to **Newark International Airport, Newark, NJ (EWR)** will not be allowed to depart until at or after 4:15 pm CST.
- Due to WEATHER/TSTMS, departure traffic destined to **La Guardia Airport, New York, NY (LGA)** will not be allowed to depart until at or after 4:15 pm CST.
- Due to WEATHER/ENROUTE WX, departure traffic destined to **Philadelphia International Airport, Philadelphia, PA (PHL)** will not be allowed to depart until at or after 4:15 pm CST.

General Departure Delays: Traffic is experiencing gate hold and taxi delays lasting 15 minutes or less.

General Arrival Delays: Arrival traffic is experiencing airborne delays of 15 minutes or less.

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Figure 3. Airport Status Information in a redesigned format.

AIRPORT STATUS INFORMATION
provided by the FAA's Air Traffic Control System Command Center

Waterloo Muni Airport (ALO) Real-time Status

The status information provided on this site indicates general airport conditions; it is not flight-specific. Check with your airline to determine if your flight is affected.

Departure Delays			Arrival Delays
Are you flying to:			
Airport	Delay		Arrival traffic is experiencing airborne delays of 15 minutes or less.
Logan International Airport, Boston, MA (BOS)	1 hour 46 minutes	Snow	
Newark International Airport, Newark, NJ (EWR)	2 hours 17 minutes	Thunderstorms	
John F. Kennedy International Airport, New York, NY (JFK)	4 hours 3 minutes	Congestion	
LaGuardia Airport, New York, NY (LGA)	3 hours 10 minutes	Emergency	
Chicago Midway Airport, Chicago, IL (MDW)	1 hour 9 minutes	Equipment Outage	
Chicago O'Hare International Airport, Chicago, IL (ORD)	1 hour 10 minutes	Construction	
All other airports	Delays of 15 minutes or less		

understand, and the glossary is difficult to find. The average user of the website may never be aware that it exists. When the participants had to find the definition of three aviation-related terms, 16% were unable to find the definition for at least one of them. Therefore, we recommend eliminating the use of these terms when they are not essential. This would eliminate unnecessary detail, simplify the site, and make it easier to use and understand.

Issue 4: User Confusion with Using the View by Region Maps

The fly.faa.gov website provides users with a **View by Region** search function that allows users to look up airports by searching in different geographic regions. These regions include the Northeast, North Central, Northwest, Southeast, South Central, and Southwest regions, along with Alaska and Hawaii. When a user uses the **View by Region** function, they are taken to a map that contains only states that are part of a region. However, it is not easy for someone with little knowledge of geography to determine the region for a particular state. The participants got lost when looking for airports that were not on the main U.S. map because they were unable to determine the relationship of regional maps to the main U.S. map. This was especially difficult for states such as Ohio that lie at the edge of a region These issues make the **View by Region** method difficult for the general public to use and the participants found the **View by Region** maps to be confusing. This issue received a mean severity rating of 4.0, $SD = 0.0$.

One question asked the participants to find delay information for an airport that was not available on the main map or on the **View by Major Airport** menu. Only 71.9% of the participants found the correct answer for this question, indicating that the participants had some difficulty finding information when they needed to drill down on the maps.

There are several recommendations that could alleviate some of the issues related to the use of the **View by Region** method. First, the site could place an outline around the different regions or use color coding to highlight the different regions on the U.S. map. This would

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help users identify which states belong in which region. The site could display split portions of the main U.S. map on the same page to better orient users to the different regions. To familiarize people with relevant geographic information, the site could label states, both on the main U.S. map and on the smaller regional maps. The site could also offer users a drop-down menu that listed the various airports by state.

Issue 5: Lack of User Knowledge Regarding Three-Letter Airport Identifiers

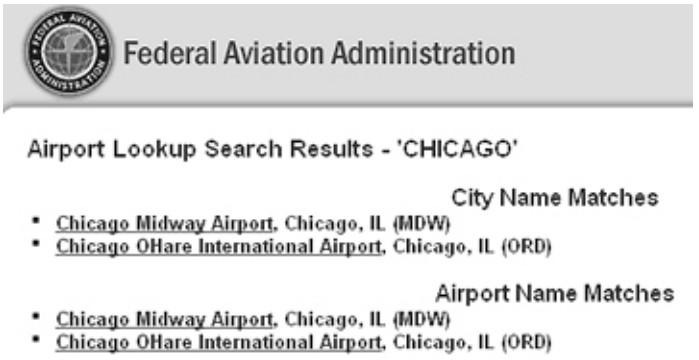
All commercial airports have three-letter identifiers, and using them is an efficient way to obtain delay information about an airport. The site provides a function that allows users to type a three-letter identifier directly into the **Search by Airport** text box, which will take the user to the details page for that airport. It also provides cues to site users by labeling airports on the main U.S. map with their three-letter identifiers (see Figure 1). However, many participants did not know the correct three-letter identifiers for airports and did not use the cues on the main map to determine the correct identifier. This issue received a mean severity rating of 3.3, *SD* = 0.6.

The site should emphasize that the **Search by Airport** text box accepts regular airport names and city names in addition to three-letter identifiers. Although the **Search by Airport** text box does have a label indicating that users can enter city, airport code, or airport name information in this field, we recommend that the website provide the user with specific examples to highlight and better explain the different search options.

Issue 6: The Search by Airport Function Returns Redundant and Irrelevant Results

City name searches using the **Search by Airport** function generate an intermediate results page that lists multiple airports. These listings often contain redundant and irrelevant results. This issue received a mean severity rating of 3.3, *SD* = 0.6. For example, a search for Chicago generates a search results page listing two airports: Midway and O'Hare International. The site lists each result twice, once under **City Name Matches** and once under **Airport Name Matches** (see Figure 4). This format is confusing and users may not realize that both links take them to the same information. Some participants questioned why the site listed an airport twice. We recommend that the **Airport**

Figure 4. The www.fly.faa.gov results page for a Search by Airport search for Chicago.



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Lookup Search Results page consolidate search results and list airports only once in any search results list.

Issue 7: User Spelling and Misspellings and Their Impact on the Search by Airport Function

User spellings and misspellings can have a serious impact on the **Search by Airport** function. In some instances, the correct spelling does not work, but a misspelling does. For example, typing *O'Hare* does not return any results, but *Ohare* does. Typing *LaGuardia* returns no results, but *La Guardia* does. In addition, common misspellings do not produce any results at all, even when the system could provide reasonable guesses about what the user intended. For example, *Newyork* does not produce any search results at all. This issue received a mean severity rating of 3.3, $SD = 0.6$. The participants quickly became frustrated and confused when the site did not return any search results for correct spellings or reasonable misspellings. The search function should always result in a hit when the correct spelling is used, should provide "best guess" search result even when users make spelling mistakes, and should ignore spacing errors.

Issue 8: Inconsistent Use of Pop-up Windows

The fly.faa.gov website is inconsistent in its use of pop-up windows. When users access information using the **Search by Airport** method or when they click on the color-coded dots on the main site map, the website displays the search results in a pop-up window. However, when users access information using the **View by Major Airport** method, the site displays the same information in the current browser window rather than in a pop-up window. This issue received a mean severity rating of 3.0, $SD = 0.0$.

During the assessment, some participants accidentally closed the browser by clicking the **Close** button when search results appeared in the main browser window. These participants had become accustomed to results appearing in a pop-up window. When search results appeared in the main browser window, they still reacted as if they were in a pop-up window and accidentally closed down the site, along with the browser.

We recommend that the site be more consistent in how it returns search results and **Airport Status Information** pages. Users become confused when the site responds differently to similar actions. If the standard convention of the site is to bring up search results in pop-up windows, then the site should bring up all search results in pop-up windows.

DISCUSSION

The level of aviation-related expertise had an impact on many aspects of user performance. Experts were more likely than novices and moderate-level users to have had some prior interaction with the fly.faa.gov website. They were also better at finding delay information on the website. Experts appeared to have a better conceptual understanding of the different types of airport delays than both novices and moderate users. Finally, experts indicated that they found the information on the website to be slightly more comprehensible than both novices and moderate level users. Although we realize that there may be some performance decrement for people who have no affiliation with the FAA, we expect that their performance and their issues should be most similar to our novice users.

On the basis of performance differences, we recommend that the primary goal of site designers should be to make the site more usable for people who do not have an aviation background. If people in the general public visit this site without an aviation-related background, we would expect them to have substantial difficulty (a) understanding which delays were relevant for them, (b) understanding how airport delays differ from airline delays, and (c) interpreting

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much of the jargon used by aviation experts. Although both experts and novices use the site, simplifying the website should help all users, not just novices. Links to additional information can be provided for expert users.

Subjective reports indicated that the participants were generally satisfied with the fly.faa.gov website, and objective data revealed that they could successfully complete most tasks using the site. By evaluating user performance data in conjunction with user comments and researcher observations, we were able to identify a number of human factors issues with the website that we would not have identified by relying solely on subjective data.

After identifying issues, we rated each one in terms of its impact on site usability, discussed each issue in detail, identified supporting data when appropriate, and provided recommendations for improving the usability of the website. Many of the suggested improvements should be easy to implement and should further increase user satisfaction and site usability.

CONCLUSION

One of the primary lessons that we learned from this usability evaluation is that developers should not simply rely on subjective reports of usability when evaluating e-government websites. It is just as important to observe users interacting with a website and collect objective performance data to better identify usability issues. By having people use the website to find different types of information, we were better able to identify those areas of the site that caused problems for users. To encourage organizations to perform usability evaluations on e-government sites, we should ensure that they provide value by identifying important usability issues that can be remedied through redesign. As we saw in this evaluation, subjective reports often fail to identify these issues. If research on website usability fails to identify significant usability issues, it is likely that such evaluations will not be used.

We also found that having researchers rate the severity of usability issues improved our evaluation. Future e-government usability assessments could reap benefits by using this technique. Many times, when a usability assessment is performed, the output of the assessment is a laundry list of issues that usability experts present to site designers. If guidance is given on issue severity or criticality, it is usually ad hoc and is not derived using any formal methodology. By requiring evaluators to explicitly rate each item on frequency, impact, and severity, they are required to think about how and in what ways the problem will affect the user. This user-centric focus is the key element of this methodology. It allows site evaluators to provide designers with a roadmap of how they can best focus their effort to provide a more optimal user experience. Additionally, we recommend that usability assessments use more than one evaluator to make severity ratings. We found that different evaluators might have different priorities, but by using combined severity ratings from three or more evaluators, you can increase the reliability of the ratings (Nielsen, 2003).

By employing an evaluation processes like the one used in this study to evaluate e-government sites, whether they are B2B sites, B2C sites, or B2E sites, designers and system developers can better allocate limited resources during the design process. In general, it is important that e-government website designers take into consideration the demographics of those who will use their website or application. If an e-government website or application, initially targeted to users with a specific area of expertise, is going to be redesigned for use by the general public, the site must be evaluated for usability. Based on the results of such an evaluation, changes need to be made to ensure that the site is usable by the broadest possible audience.

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