Enhancing Usability of Flight and Fare Search Functions for Airline and Travel Web Sites

Craig Chariton
United Airlines
charitonc@acm.org

Min-Hyung Choi
University of Colorado at Denver
mchoi@carbon.cudenver.edu

Abstract

Airline and travel Web sites have demonstrated usability problems with the flight and fare search mechanisms. These problems appear in the query formulation, result display and locating optimal fares with fewest queries. This paper describes an approach to improve the usability of these airline reservation Web sites by employing proposed design guidelines and advanced search algorithm that exploits the user's scheduling and budget constraints to determine the optimal search space. The design guidelines and search process were tested with a prototype against two production Web sites. Results show that the design guidelines and search algorithm increase user ability to successfully complete a search and cover the search space to find the optimal fare. Users demonstrated better comprehension of the search results and reduced number of queries when searching for a low fare.

1. Introduction

Web sites that provide airline flight and fare information have become very popular in recent years. Many people prefer to shop online for their travel needs as this provides a way to explore destinations and travel options without the need of a travel agent.

Because they are selling a service through the Internet these travel sites are especially susceptible to usability problems due to the lack of well studied user interface guidelines and effective searches specifically designed for the airline industry [5, 12]. These usability problems fall into two categories: design issues (process flow and information display) and search mechanism. This agrees with previous research that shows the product search and display functions of a Web site are the primary area of opportunity for improving site usability [9].

This paper addresses these issues by presenting new design guidelines for such Web sites and by presenting a search algorithm for enhancing optimal fare searches. A prototype was developed and tested against two production Web sites. The results demonstrate that users were able to more accurately understand flight and fare information as well as perform low fare searches with fewer queries. This resulted in improved perceived ease of use by the users and increased preference for the prototype Web site.

2. Design issues

There are three design issues that impact usability: query formulation, process flow and information display. There are very specific examples of problems in each of these areas.

Query Formulation: The formulation of a query for flight information is different from that used for products in that it requires more information to perform the search. The query involves selecting the origin and destination airports, travel dates and times, class of service and type of search desired (one-way, lowest fare, specific times, etc.). A simple box for search terms will not work in this scenario. With the extra items for the query comes more possibilities for error and for usability problems.

Process Flow: Process flow is the procedure by which a shopper formulates and submits a query and reviews the results. Process flow problems are common with these Web sites. These occur when the user expects the query and display of flight information to occur in an order that seems logical to the user. When this is disrupted the user begins to become disoriented and cannot complete the query or interpret the results. For example, many sites hide the one-way search on an advanced search page separate from the main search tool on the home page. Users have demonstrated an inability to locate this advanced search page as it is unexpected and the path to the page is not evident to the user.

Information Display: Flight information, unless information for a product, must be displayed entirely through text. Flight information is complex. If it is not provided in a clear and structured manner the typical user has difficulty interpreting it. Unfortunately, many of the existing commercial sites use location codes (three letter codes for airports and cities), industry-specific terms, legalese in the fare explanations, and information for a specific topic scattered across multiple pages. Terms and concepts, such as code share flights, are not defined or poorly explained. These features consistently cause user confusion and frustration.

3. Search mechanism issues

Although most users are searching for the lowest fare, the lowest fare may not be their true optimal fare when the inconvenience factors of the various flight schedules are considered. Added to this is the complexity of the variable fare structure used by airlines, called yield management [6]. Yield management is the use of variable pricing based upon travel dates and times, advance purchase, and required stays at the destination.

In the past business travelers generally had a specific date and time that they needed to be at a location. Therefore the departure dates and times were of utmost importance with cost being a secondary factor. The same held true for passengers selecting First and Business class.

Leisure travelers generally have a date period in mind when they search for flights, but the overriding criteria is price. Of Priceline.com shoppers 96% are leisure travelers, and 80% will change their travel dates in order to obtain a lower fare [7]. Since price is a higher priority in the search than travel dates and times the user should be more flexible to take advantage of the fare structure in order to find lower fares.

Many existing search tools do not consider users' scheduling and inconvenience tolerance factors in the search algorithm and let users cover the search space with manual multiple query formulations. They also may limit the number of airlines searched at a given time. Others provide the ability to search multiple dates, but the tradeoff is that they require the user to set search parameters that may be counterproductive to the search desired if the user does not understand how the fare structure works. The result is that users may not be able to complete the search or obtain the information they desire.

4. Related research

Much research has focused on the usability of Web sites that sell products. Specific design guidelines have been promulgated by major contributors [8]. Air travel is a service, and it has a complex search and information display process. While portions of the current research are applicable to the area, there are unique aspects that require more specific design guidelines.

Research into the search problems of this domain has not been as significant. Travelocity has performed research to provide their calendar method of search [4]. Another approach has been the SmartClient approach which relies upon significant user interaction via the interface to narrow flights according to a user's goals [11]. Orbitz uses an approach that permits expanded searches, but the user must input the breadth of the search. Each of these processes exhibit usability problems of their own and do not simplify the search for the user. They do not exploit both the scheduling and budgetary constraints of the user. They also do not guarantee coverage of the search space.

5. Proposed design guidelines

Based on the identified design issues we proposed the following design guidelines:

Do not use location codes in the query or display processes. Insulate users from location codes by translating them into airport names in displays, and provide the capability to translate city and airport names into location codes in the query without requiring user input.

For cities served by multiple airports, provide only valid airports and only one selection per airport. Do not provide airports that do not have scheduled air service in selection lists displayed to the user. Provide only one selection choice for each available airport.

Do not use industry specific terms unless specifically defined. Many users do not understand the terms used by the travel industry. Definitions of the terms can be provided via hyperlinks to short definition pages or other mechanisms.

Provide the same information available through a travel agent. Compare the information that is available through a travel agent with that available through the Web site. Provide the same level of detailed information through the Web site that a travel agent can provide.

Display only basic information on the initial results display interface. The basic information required for a user to decide upon the suitability of a flight combination is as follows: origin airport, destination airport, dates of departure and arrival, times of departure and arrival, operating airline, flight number(s), fare, aircraft type and cabin. From this basic level of information a user can decide if further information regarding one of the areas is desired.

Provide access to information for the user in the near vicinity of a topic. A user may require information regarding a specific topic. The information provided should be available in the vicinity of the topic in question.

Provide detailed fare information as secondary information. The total fare should be displayed on the primary flight information display. From this page a link or other device should be provided to allow the user to "drill down" into the more detailed fare information. This information should include base fare, a detailed listing of taxes, and the total air fare.

Fully identify code share flights and their operators to the user. To avoid user confusion, fully identify the operating carrier to the user as well as the marketing carrier. Include a description of what a code share is. Make sure that the information is provided in a way to meet governmental requirements.

Provide a description of the aircraft as secondary information. Provide the user with the ability to identify the type of aircraft that is use for the flight. The goal should be to adequately identify an aircraft type for those shoppers who have concerns about the aircraft they fly on.

Provide low fare search tools on the initial search interface. Provide a simple low fare search process for users with the ability to make a low fare search from the initial search interface.

Permit special searches without requiring special interaction from the user or by using an obvious input parameter on the query interface. Permit the user to perform a special search, such as a one-way search, without proceeding to an advanced search page or by searching for an input parameter on the interface.

6. Optimal fare search method

To resolve the optimal fare search problem there are three requirements that must be met. The first is that the search method must obtain the criteria for a true optimal fare based on the user's scheduling constraints and the search space should be adjusted accordingly. Second the search method must guarantee the coverage of the search space with one query instead of repetitive manual query formulations. Third users should be able to further optimize the search with the individual's inconvenience tolerance factor.

Our proposed method requires one input device on the main page to indicate travel date flexibility. We used a horizontal slider to answer a question regarding flexibility of travel dates within a seven-day period. This could also have been done via a radio button or a select list. The user's input on the device is translated into an integer from 1 to 7. This integer is interpreted by the algorithm as a measure of the user's flexibility of travel dates within a one-week period.

The algorithm performs seven different types of searches based upon an analysis of the industry pricing structure in effect as a result of the use of yield management, known characteristics of travelers, and arbitrary assumptions correlating a user's travel date flexibility and the breadth of search to conduct. This information is deliberately hidden from the user as the user should not be concerned about how the system is performing the search.

The seven types of searches are described in Table 1. It lists the search type, how it searches in relation to the requested departure and return dates and times, and how the results are displayed.

Table 1: Search Type Descriptions

Search Type	Departure Date	Return Date	Display Method
Type #1	Search day / time	Search day / time	Non-stop first
Type #2	Search entire day	Search entire day	Price order
Type #3	6:00 p.m. day prior	12:00 p.m. day after	Price order with preferred dates first
Type #4	Search one day prior	Search one day after	Same as Type #3
Type #5	Search two days prior	Search two days after	Same as Type #3
Type #6	Search three days prior	Search three days after	Same as Type #3
Type #7	Search four days prior	Search four days after	Same as Type #3

6.1 Ensuring adequate search

After a search has been performed with this method a concern arises as to whether or not the system has correctly ascertained the user's flexibility. If a user is not convinced that the system has performed the appropriate search the user will perform another search. This will inconvenience the user, drain system resources, and defeat the goal of having the system provide the results for the user with one search query. If a complete search is not performed and the user chooses to not perform another search, then the user may miss a lower fare that is within their flexibility.

To counter this problem an extra search is added to the end of the Type 2 through Type 7 searches. This expands the search space by holding the return date as input by the user and searching one and two days prior to the earliest departure dates searched. Then the departure date is set as indicated by the user and a search is performed one and two days after the latest return date searched. This should compensate for an incorrect interpretation of a user's flexibility and provide a more complete search. If a lower fare is located during this search a pop-up dialogue box appears on the initial display indicating to the user that a fare of a certain amount has been located if the user can depart on a certain date. A button is displayed that will allow the user to look at a separate page to see the flight details is so desired.

6.2 Savings threshold parameter

An individual's optimal fare criteria varies not only based on the scheduling constraints but also on their tolerance to the inconvenience in flight schedule. For example, a small saving at the cost of a long wait for the connecting flight may not be considered an optimal fare even if it is the absolutely lowest fare.

Corporate customers are using more of the cheaper non-refundable tickets due to the changed industry climate [2, 3]. One cost savings approach being used by corporate travel departments is to have the traveler stay overnight, sometimes even over a weekend, in order to obtain a better air fare by using leisure fares. The traveler incurs more costs for lodging and food, but the overall savings can be significant. Any such type of search requires manual searching across the extra dates of travel, assigning a value for food and lodging, then computing the result to determine if the extra stay is economically justified.

We propose incorporating a cost threshold in non-Type #1 searches as a measure of user's inconvenience factor into the low fare search. An optional input parameter can be used to indicate that a user desires a cost threshold type of search by providing a cost threshold target for the search. Our search tool asks, "If the savings is less than T then I would prefer a better schedule" and set the T value. All candidate fares are reevaluated based on the number of stops and hours of delay in connections. During the sorting process for the lowest fare the flight with the best schedule for the travel date is located. A flight is considered "best" if it is a non-stop on the specified dates of travel. To the fare of this flight is added the flight time t multiplied by a constant c to account for a traveler's time. This becomes the target fare F against which all other fares are compared. A candidate itinerary is examined to determine if it is less than the target fare F. It does this by examining the dates of travel, number of stops and connection times. If a flight itinerary does not meet the original dates of travel, then a rate h is added to the fare f for the flight itinerary for each day of difference d between the dates of travel for the flight itinerary and the original dates of travel. This would account for the cost of a hotel room. If a flight has a stop s, then a penalty p is added to the fare f to account for the connection penalty which is the extra inconvenience the passenger encounters due to the stop and possible connections. This would account for the extra time required to take a flight that is not non-stop. If there is a flight connection at another point, then c is added to the fare for each hour t between the arrival time of the first flight and the departure time of the second flight. The equation for $f_{weighted}$ becomes:

$$f_{weighted} = f + (h*d) + (p*s) + (c*t)$$

with the variables f for the fare, h for the rate of one night at a hotel, d for the days difference between the preferred travel date and the dates of the flights, p the penalty rate to account for inconvenience due to a stop or possible connections, s for the number of stops, c the hourly rate for the user's time during a stop or connection, and t the hours of difference between the arrival time of a flight and departure time of a connection.

The fare $f_{weighted}$ for the flight itinerary is then compared to the target fare F. If $f_{weighted} + T < F$i it is moved to the top of the display according to the other variables mentioned previously. If it does not meet those criteria then it remains in its current place in the list of flights. For the prototype we used \$90.00 for h, \$50.00 for p and \$40.00 for c [1].

7. Prototype

A prototype Web site was developed for the user tests using the proposed guidelines and the search method. The prototype was designed to test the guidelines and the search process. It did not incorporate advertisement banners or other functions that may be found on a home page for a Web site.

The prototype interface was developed using HTML, CSS and JavaScript. The backend consisted of two Perl scripts to support the query process, database search and display. The database was static and consisted of flight data for the Denver - Los Angeles and Denver - Santa Barbara markets for three weeks in August 2001. This static database allowed us to control data for certain tests and to verify that specific correct answers were found by the users.

8. User test method

Two separate user tests were performed. Both rounds of tests used the production sites of Expedia and Travelocity for comparison with the prototype. The first round of tests focused on the design guidelines. These tests were performed with seventeen subjects ranging in age from 18 to 65, with a mean age of 38.5 years. The second round of tests focused on the optimal fare search. These tests were performed with nineteen subjects ranging in age from 19 to 49, with a mean age of 31.7 years.

Determination of improvement of usability was based upon two separate criteria [10]. First, shoppers are able to obtain specific pieces of information more often using the prototype as compared to the production Web sites. The second criteria is user preference for use among the three Web sites.

Five tasks were provided for the first round of tests that simulate typical shopping scenarios. Two tests were provided for the second round, one a low fare search with a threshold savings amount of $200.00 and the other without a threshold requirement. The users were allowed to quit a search at any time or choose not to attempt a task. This would simulate actual shopping experiences as well as meet university human subject testing rules.

9. Results

The results for successful completion of a query for Questions 1 - 5 (obtain correct answers in accordance with the question) from the first experiment are shown in Table 2. The results for answering of basic flight and fare information, tasks directly related to testing of the design guidelines, are shown in Table 3.

Table 2 is significant in that it shows how many users were not able to successfully complete a query using the production Web sites. Many users became disoriented trying to use the multiple query pages using the production Web sites and quit the scenarios. This was especially true when the scenario required using an advanced search page. Many users tried to use the compact search tool on the home pages when the scenario required use of the advanced search page. They would fail to see the link to the advanced search page and become quickly frustrated.

Table 2: Successful completions of a query

Web Site	Attempts	Successful Completions	Completion Rate
Expedia	52	31	59.6%
Travelocity	37	19	51.3%
Prototype	64	56	87.5%

Table 3: Successful answering of flight and fare questions

Web Site	Attempts	Successful Completions	Completion Rate
Expedia	40	13	32.5%
Travelocity	31	0	0.0%
Prototype	63	51	80.9%

Table 3 is significant in that it demonstrates how users are able to interpret the information from a successful search query. The questions asked were pertinent to understanding the basic flight and fare information necessary to make a purchasing decision. It should be noted that Travelocity had no successes because it did not provide all of the information available from the reservation system, mainly the breakdown of the fare information into the basic fare and applicable taxes.

Users were asked to rank the Web sites as 1, 2 and 3 as to their ease of use, with a 1 being the best and 3 the worst. The results are shown in Table 4 .

Table 4: Ranking of perceived ease of use

Web Site	Mean	Standard Error of Mean
Expedia	2.142	0.150
Travelocity	2.528	0.125
Prototype	1	0.0

The Friedman test for the results of Table 4 resulted in a chi-square value of $X^2 = 24.088$, df = 2, $p < 0.001$. All users struggled more with the production Web sites than with the prototype.

The second round of experiments focused on the optimal fare search scenarios. A user answer in this round was considered successful for the production Web sites if the user conducted four or more searches to cover the possible date combinations. A user answer was considered successful for the prototype when the user gave an answer other than $300.00 for the first scenario and an answer of $300.00 for the second scenario either by completing one search using the flexibility scale or four manual searches. The overall completion rates for the second round of experiments are shown in Table 5.

Table 5: Successful task completions

Web Site	Attempts	Successful Completions	Completion Rate
Expedia	38	10	26.3%
Travelocity	38	11	28.9%
Prototype	38	27	71.7%

The results for the production Web sites were not unexpected after initial results on similar tasks during the first round of experiments. Many users were not willing to attempt four separate searches in order to locate information as required by the shopping scenarios. They missed some combinations and did not find the optimal fare. An interesting observation was that many of the users would try two or three searches and consider that they had searched the search space. They did not realize that because of yield management and seat availability that the best fare may be on the dates that the user had not searched. This demonstrates why it is better to provide this broad search mechanism for the user via the computer to reduce these types of errors.

Table 6: Ranking of perceived ease of use for low fare searches

Web Site	Mean	Standard Error of Mean
Expedia	2.1	0.186
Travelocity	2.3	0.154
Prototype	1.6	0.192

Table 6 shows how users ranked the ease of use of shopping for the lowest fares, with 1 being the best and 3 the worst. The Friedman test for Table 5 resulted in a chi-square value of $X^2 = 5.47$, df = 2, $p < 0.05$. While not statistically significant, the results show a tendency toward preference for the prototype design for a low fare search. These results may be clouded by the difficulty of the test scenarios and that some users never used the savings tool. However, the results confirm the intuitive idea that a Web site can have very good search tools and yet not have a significant impact unless users can find them and properly use them. Table 7 shows how users ranked the perceived ease of use when shopping for the lowest fare with a cost savings threshold, with 1 being the best and 3 the worst. The Friedman test for Table 6 resulted in a chi-square value of $X^2 = 20.63$, df = 2, $p < 0.001$. The results confirm that those who located the savings tool found the prototype easier to use than conventional Web sites.

Table 7: Ranking of perceived ease of use when shopping for lowest fare with threshold

Web Site	Mean	Standard Error of Mean
Expedia	2.3	0.154
Travelocity	2.5	0.140
Prototype	1.2	0.086

10. Conclusions

The experiment results are encouraging regarding the ability of the proposed design guidelines to aid in designing more usable Web site tools for the flight and fare search function. While the prototype was not perfect in all areas of translating the proposed guidelines to reality, it did outperform the production Web sites in the basic tests. Users were more successful in formulating queries and answering basic questions with the prototype, and they showed a preference for the prototype design. Further research into how to display the results may reveal other guidelines that could be added to those in this paper.

The low fare search mechanism used in the prototype also demonstrated better usability over the production Web sites. Our approach incorporated scheduling and budgetary constraints, including an inconvenience factor, in a search that provides a truer optimal fare. This method guarantees coverage of the search space and requires fewer query formulations by the user. The result is a simpler and more accurate search that improves the usability of the Web site.

Web sites that incorporate flight searches into their design require significant help to improve their usability. While this research touches the surface of the issues facing these Web sites, it is hoped that the guidelines and search approach will be explored further and incorporated into future designs to aid users in their shopping experiences and improve this important sales channel.

11. References

[1] Adler, T., "Air Travelers 2001: What Do They Tell Us About the Future of U.S. Air Travel?", *Survey Cafe.com*, http://www.surveycafe.com/surveycafe/air/air.asp.

[2] Ananova, " 'No Frills' Flights to Save Business £1.1 bn This Year", *Ananova*, http://www.ananova.com/business/story/sm_657168.html.

[3] Bailey, D., "U.S. Business Air Travel Shows Signs of Post-War Rise", *Yahoo! Finance*, http://biz.yahoo.com/rc/030529/airlines_travel_1.html.

[4] Carr, D., "How Travelocity Gives Consumers Rock-bottom Airfares", *Internet World*, http://www.internetworld.com/print/9999/05/17/webdev/19990517-how.html.

[5] Collett, S., "Study: Most Travel Web Sites Suffer Basic Usability Problems", *Computerworld*, http://www.computerworld.com/cwi/Printer_Friendly>>>/0,1212,NAV47_STO43234-,00.htm.

[6] Daudel, S., and G. Vialle, *Yield Management: Applications to Air Transport and Other Service Industries*, Les Presses d L'Institute du Transport Aerien, Paris, 1994.

[7] Donoghue, J., "The Future is Now", *Air Transport World*, (38) 4, pp. 78-79.

[8] IBM, *IBM Ease of Use: Web Design Guidelines*, http://www.ibm.com/easy.

[9] Lohse, G., and P. Spiller, "Electronic Shopping", *Communications of the ACM*, 41(7), pp. 81-87.

[10] Nielsen, J. and J. Levy, "Measuring Usability: Preference vs. Performance", *Communications of the ACM*, 37(4), pp. 66-75.

[11] Pu, P. and B. Faltings, "Enriching Buyers' Experiences: The SmartClient Approach", *CHI Letters*, 2(1), 2000.

[12] Selvidge, P., "How Usable are the Airline Web Sites?", *Usability News*, http://psychology.wichita.edu/surl/usabilitynews/1w/Usability_airline.htm.