DETERMINING THE INFORMATION NEEDS OF PUGET SOUND BOATERS

David W. Jones and Janet I. Olsonbaker
Applied Physics Laboratory, University of Washington
Seattle, Washington

Puget Sound is known for its highly variable weather and ocean currents. Trip planning for this challenging environment is critical for boating safety. We conducted a survey of the Puget Sound boating community to determine their information needs. We used a web-based questionnaire supplemented with face-to-face surveys. We received 610 responses. The respondents represented a wide range of the boating community. The boaters' most important environmental need was for daily weather forecasts and their most desired forecast parameters were wind speed, currents, and wave height. Respondents also commented on their frustration with accessing the needed information. Analysis of this survey and guidance from an advisory panel are being used to develop a user-centered designed (UCD) web portal, the Boater Information System (BIS) that will attempt to improve the situation awareness (SA) for a diverse user group.

INTRODUCTION

The boating community (weekend boaters, cruisers, racing sailors, windsurfers, kayakers, and recreational fishers) of the Pacific Northwest has to search numerous sources for information critical to activities such as cruise planning, boating safety, and navigation. Access to this information is cumbersome and what is retrieved is not always understandable or usable by boaters. This can result in dangerous situations because the marine weather of Puget Sound is highly variable, due to its fjord-like topography (Renner, 1993), and it can catch boaters unprepared.

Every year there are numerous boating accidents in the Pacific Northwest that require rescue assistance. For example, from January to November 2002, the U.S. Coast Guard's District 13 conducted 2,795 search and rescue missions and responded to 642 oil spills. Many accidents or incidents also result in death and a majority of these happen in small crafts. In 2003 the Coast Guard reported that 618 out of 703 reported boating related deaths nationwide (numbers not broken out by geographic regions) occurred in boats less than 40 feet.

Boaters are more likely to die if they are involved in an accident in the fall or winter, due to the adverse effects of cold water. Also, of the 5,438 reported accidents on U.S. waterways, 356 were due to hazardous waters and 184 were due to weather. It is not reported if these accidents were due to lack of critical information or knowledge, but it seems reasonable to assume that people armed with information about potential dangers or adverse environmental conditions will be more likely to make smarter decisions that lead to more enjoyable outings on the water.

Owners of larger ocean-going vessels or those who spend a significant time on the water often have specialized equipment that provide critical environmental information. For example, some Nobeltec navigation systems provide the ability to download basic graphical weather forecasts that can be overlaid onto a digitized navigational chart. These are powerful systems, but can be expensive, confusing to use, and many recreational boaters may not know about them, or be willing to pay the extra cost. Recreational boaters need easier access to environmental information.

The Internet provides a potential answer, but much of the information is spread over many web sites, and finding the right information when needed is difficult. Boaters could benefit from a web site similar to that developed for aviators, the *Aviation Digital Data Service (ADDS)*. (Note: the website is free and available at http://adds.aviationweather.noaa.gov/.)

ADDS is a thorough, frequently-updated source of data on turbulence, icing, convection, winds, and temperature. The site has airfield observations and forecasts, plus satellite and radar products

The Applied Physics Laboratory, University of Washington (APL-UW) is in the second phase of a project sponsored by Washington Sea Grant Program to determine the weather and oceanographic needs of Puget Sound boaters. Based on the needs analysis, a prototype web portal, the Boater Information System or BIS, is being developed to improve the access and use of essential information.

METHOD

Following a User-Centered Design (UCD) paradigm (Norman & Draper, 1986; Vredenburg, Isensee, & Righi, 2002; Endsley, et al., 2003) APL-UW went to the intended users of the prototype to determine their requirements. We contacted local yacht clubs, marinas, and marine supply stores. From this interaction, we generated a list of expert boaters. They provided us with a basic understanding of typical boater needs.

Some of these individuals volunteered to be members of a citizen advisory board. Others helped by allowing us to contact members of their organizations.

Because our web portal is intended for a wide cross-section of boaters, we needed to sample the needs of a much wider community than the experts we initially contacted. Thus, with input from our advisory board, we developed a questionnaire to survey a wide range of boater needs. To learn about boaters' use of environmental information, the survey asked the following questions:

- What kind of weather and oceanographic information do you need?
  - Daily weather forecast
  - Five or ten-day forecast
  - Wind speed
  - Wave height
  - Tides and Currents
  - Water depth
  - Other
- Where do you normally go for this information?
  - Local TV weather
  - NOAA weather radio
  - Local radio (commercial) weather report
  - Tide charts
  - Web
  - PDA, cell phone
- Please specify any website(s) or news groups you use.
  - NOAA National Weather Service
  - Local news websites
  - UW Department of Atmospheric Sciences
  - Weather Underground
  - Other
- How do you use weather and oceanographic information? Do you use it to decide:
  - Where to go?
  - When to leave?
  - What route to take?
  - How long to stay on the water?
  - What gear to take along?
- In what method(s) and/or format(s) would you like to receive weather and oceanographic information?

(Note: When a question asked about frequency of use respondents were given the option to answer: never; seldom; often; always. Most questions had a space for additional comments.)

We conducted the survey for approximately three months, July – September 2004, and received a total of 610 surveys. To facilitate the survey we developed a visually interesting website that explained the goals of the research and the importance of boaters' input. Respondents could select to fill out the survey on-line. They also had the ability to add additional information or comments.

We went to several venues where we could meet boaters both to generate community interest in the research project, and to ensure that we had the widest boating representation possible. These included a sailing regatta, yacht clubs, a marine store, and a boat show (primarily power boaters). We asked boaters to fill out the survey on paper or via laptop computers with an Internet connection to our website. We also sent out hundreds of email invitations to sailing and kayaking schools and clubs, and other boating organizations to fill out the survey.

The majority of our responses were completed via the web. All respondents were given the opportunity to remain anonymous if they desired, or they could provide a name and email address for possible follow-on communication and service on the BIS Advisory Board.

RESULTS

We found that the web made it easier for people to respond to the survey, and also, we could quickly tabulate the results. We received many responses based on our email requests, but we found getting out into the boating community was the most helpful to learn about boater needs; our personal interaction often resulted in more extensive and helpful comments on the questionnaire.

Respondents were asked about the boats they used. The survey allowed respondents to choose more than one boat type and 10% chose two or more. Of the 610 responses, the break out of boater type was: 41% sailors; 44% power boaters; 14% kayakers; 10% fishers; and 9% wind surfers or kite boarders.

The Puget Sound National Estuary report of March 2001 states that there are approximately 165,000 powerboats, 21,500 sailboats, and 45,000 canoes/kayaks in the Puget Sound region. The percentage of our respondents who reported themselves as sailors far exceeds the expected percentage of the overall Puget Sound boating population (41% verses 9.3%). This may be a function of our survey recruitment, which did not specifically target boaters by boat type nor ask boaters to answer questions only as one type of boater. However, it seems reasonable to assume that the larger percentage of sailor respondents indicates that they perceive a more immediate need for environmental information, more so than power boaters. For example, 61% of sailor respondents always need wind speed whereas only 40% of power boaters do. And, over half as many sailors (29%) check the University of Washington Atmospheric Sciences Department website for information than do power boaters (11%).

Our respondents had a range of boat sizes: 68% had boats between 20 feet or greater; 20% had boats 15-20 feet; and 17% had boats that were less than 15 feet. Most respondents felt they were fairly knowledgeable about boating. Only 3% said they were novices, while over 66% said their skills ranged from experienced to expert. Also, these respondents were active in boating; 55% of them use their boats multiple times per week.

Table 1 lists the typical types of weather and oceanographic information or products respondents needed. Boaters also had the opportunity to add additional requests. Examples included wind trends and direction, pressure trends, river flow information (particularly from kayakers), temperature gradients in fishing areas, fog, and bar conditions. Table 2 shows the relationship between information and how boaters use that information to make decisions about their trips on the water.

DISCUSSION

Boater Needs

Our survey revealed several major findings. First, boaters use environmental products. They have indicated their top priorities are weather (primarily wind speed) and tide information prior to departure. For a typical trip on their boat, 91% of boaters said they wanted one hour to 3-day weather forecasts. The next highest priorities for boaters are long-term weather forecasts, charts, and mooring information. The second finding confirmed our assumption that the Internet is an important source for information retrieval. Most boaters (77%) currently use the Internet to find environmental information. The third finding is that environmental information plays a role in boaters' decision-making and planning. The types of decisions that confront boaters depend on issues such as: who the user is, the kind of boat in use, the boating event, and the location or time of the activity. Key issues are when to begin a trip and the route to take.

An additional finding was derived from the comments boaters made on the survey. Many of them indicated the difficulty in extracting information. One boater (names were kept separate from data collected) said that the weather sites they typically use are not easy to navigate. Other boaters pointed out the need for localized information so as to avoid wading through an entire report. Many boaters search numerous web sites; one boater stated he used as many as eight. However, not all information retrieved agrees; as one boater stated, he has to do "an average mean," which is time consuming.

The following kayaker / sailor knows what she wants in a weather information tool; this comment speaks to the problem boaters have and the challenge researchers face:

> "Graphical representation of current direction and speed overlaid on nautical chart, for a selected region and date/time. Currents are critical for planning kayaking and sailing trips in Puget Sound, but the existing tools that I am aware of (or have access to) are time consuming and/or cumbersome to use. Also, ability to select a region graphically and get links to available charts, applicable sections of Coast Pilots, Local Notice to Mariners, critical chart corrections, Light List, etc. in addition to weather and tide information. Another useful tool would be the ability to select a route and then get tide and current info, as well as predicted and/or historical weather data, for that route for several dates in the future, as a way to figure out the best time to go. For example, there are some kayak routes where currents play a huge role in determining when to go. It would be nice to be able to quickly determine that next weekend looks better for that particular route than this weekend."

Here, too, is a boater, cognizant of current difficulties, who also presents the researchers' technology challenge.

> "Another website similar to NOAA but instead of only showing the current weather patterns, it interprets these into an accurate forecast. Although weather forecasting is everywhere (CNN, NBC, KING 5, etc.) a forecast that gives the same in-depth info on ocean conditions as is on the NOAA site (i.e., swell height, water temp, tidal flux...) would be extremely useful. This way it isn't necessary to interpret the data myself (either correctly or incorrectly), but I can then compare it to the other forecasts on other sites."

Boater Situation Awareness (SA)

The need that many of these boaters have identified can be summarized as a desire for improved situation awareness, or SA (Endsley, 1995). SA is a critical factor in successful decision-making and it can be thought of as comprising three different cognitive processes: perceiving, comprehending, and projecting into the future (Endsley, 1997). SA for boaters includes the need to know the present status of the weather and the ocean, understand how the environment will impact their particular activity, and anticipate how that impact will change in the future.

Based on the survey, and aptly described in some boaters' comments, it appears that boaters have

difficulty extracting data needed to perceive the situation in their potential operating environment. They describe complicated search tasks and a lack of information organized in a fashion that fits their needs and workflow.

In a follow-up study to this survey, we asked several of our advisory panel members to describe their process of planning a boat trip. We have begun to analyze these conversations with the goal of developing a goal-directed task analysis (GDTA), as described in Endsley et al. (2003). Table 3 shows a typical boater's task of planning a trip. The main goals of the task are shown, with amplification in the sub-goal area of understanding the impact of wind. The types of data needed for the three levels of SA are also indicated.

Design Directions

We intend to develop further our task analysis of boater activities with a focus on understanding the information needed to provide boaters with an optimum SA of their boating environment. This analysis will drive our development process. An additional development principle will be to keep the intended user's individual application and technological constraints in mind. We know that boaters obtain most of their information via the Internet, and that they often do not have much time to plan. Also, many of our potential users may be novice boaters with limited knowledge about the effect of winds and currents on their boats.

Based on these considerations we are developing a web portal system that delivers SA information according to the users' needs and when the users need it. The portal will be based on the user's activity or application, such as racing or kayaking. Information and tools will be provided in a way that follows a user's normal workflow, as determined by our GDTA. Users will be presented with data to help them perceive the weather and water conditions via instrument panel displays of essential environmental parameters, such as the kind of displays found in airplane cockpits. The user will also have access to visualizations that aid their comprehension of the environmental data. When needed, they will be provided tools via the interface that help them project environmental conditions into the future. These will include animated forecasts that move over time and the ability to interact with data, such as creating a rule to send the user an email when a particular threshold of wind is expected in the area they want to sail.

CONCLUSION

Our next step is to continue to develop goal-directed task analyses, broken down by boating activity and boat type, to arrive at a system that brings boaters not only the data they need when they need it, but lets them interact with the information in new ways. We will also investigate potential designs for an information portal that improves boater situation awareness. The goal of BIS is to help boaters better comprehend the impact of weather and water, and understand how that impact will change over time.

ACKNOWLEDGEMENTS

We want to acknowledge the many hours of pro bono support from our advisory board, and the opportunity to survey boaters at the 2005 Seattle Boat Show and the 2004 Whidbey Island Race Week. This research is supported by the Washington Sea Grant Program, for which we are grateful.

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Table 1: Required Weather and Oceanographic Information. Percentages are based on total respondents; rows may not add to 100% because some respondents did not answer all the questions.

Information / Product	**Never**	**Seldom**	**Often**	**Always**
Daily Weather Forecast	1%	4%	29%	60%
Five-Ten Day Forecast	3%	18%	42%	22%
Wind Speed	4%	6%	28%	53%
Wave Height	4%	17%	30%	35%
Tides & Currents	2%	8%	29%	49%
Water Depth	11%	19%	19%	29%
Precipitation	3%	23%	33%	21%
Small Craft Advisory	3%	7%	25%	48%

Table 2: Utilization of Weather and Oceanographic Information for Decision Making. Percentages are based on total respondents; rows may not add to 100% because some respondents did not answer all the questions.

Decision	**Never**	**Seldom**	**Often**	**Always**
Where to Go	6%	25%	35%	18%
When to Leave	2%	11%	44%	32%
What Route to Take	6%	14%	44%	21%
Time on the Water	6%	16%	41%	19%
Necessary Gear	5%	15%	30%	29%

Table 3. Goal-Directed Task Analysis. Overall goal is to plan a day's outing on the water. Table shows additional amplification of wind impact sub-goal and its required decisions and situation awareness requirements.

1.0. Major Goal: Determine destination
2.0. Major Goal: Determine route
3.0. Major Goal: Determine departure and arrival times
4.0. Major Goal: Determine water conditions
5.0. Major Goal: Determine weather conditions
5.1. Sub Goal: Learn about wind during the trip
5.1.1. Decision: Decide if the amount of wind is a concern
SA L1: Perception Requirements
Data example: NWS radio forecast
SA L2: Comprehension Requirements
Data example: Weather chart
5.1.2. Decision: Decide if the amount of wind requires a change of plans
SA L3: Projection (future) Requirements
Data example: Animated weather loop
6.0. Major Goal: Adjust departure time
7.0. Major Goal: Decide what to bring