A Web-based DSS Supporting the Multiple-Perspectives of the Manatee-Watercraft Collision Problem

Lars Linden
University of Central Florida

James Courtney
University of Central Florida

Follow this and additional works at: http://aisel.aisnet.org/amcis2007

Recommended Citation
http://aisel.aisnet.org/amcis2007/2
A WEB-BASED DSS SUPPORTING THE MULTIPLE-PERSPECTIVES OF THE MANATEE-WATERCRAFT COLLISION PROBLEM

Lars P. Linden
University of Central Florida
llinden@bus.ucf.edu

James F. Courtney
University of Central Florida
jcourtney@bus.ucf.edu

Abstract

The Florida manatee (sea cow) is an endangered mammal living in waters and coastal areas of the Florida peninsula. Collisions with watercraft are a major cause of manatee deaths. A model of the manatee-watercraft collision problem is presented based on stakeholder theory and implemented within a Web application that allows the user to highlight different stakeholder perspectives. A prize is proposed for technology that leads to ameliorating the manatee-watercraft collision problem. Manatee population growth is postulated to increase with the size of the prize, the number of innovators attracted by the prize and the quality of the innovations.

Keywords: Florida manatee, multiple-perspective decision-making, Web-based DSS

Introduction

Florida manatees are listed as endangered according to the classification by the federal Endangered Species Act of 1973 (Florida Fish and Wildlife Conservation Commission, 2006; Reep & Bonde, 2006). These marine mammals swim in the waters of Florida and neighboring states and collisions with motor boats are a major cause of death. The year 2006 was the deadliest on record as some 416 of the animals died and collisions with watercraft was the leading cause of death (Save The Manatee Club, 2007). One primary tactic for preventing these collisions is the designation of slow speed zones and sanctuaries on the rivers and waterways. Another tactic is education about manatees.

This paper proposes a model of the manatee-watercraft collision problem in order to aid in designing a solution that will work in conjunction with other current efforts to protect the manatee. The model is placed in a Web application that allows for the highlighting of different stakeholder perspectives in an effort to aid the development, learning, and sharing of viewpoints.

Multiple-Perspectives of the Manatee-Watercraft Collision Problem

The problem of boaters colliding with manatees has found no quick solution and any proposed solution must be vetted by different stakeholders. The design of a Web-based decision support model is grounded on decision-making theory that encourages the development of many stakeholders' perspectives (Courtney, 2001; Elgarah, Haynes, & Courtney, 2002; Linstone, 1984). Following Linstone (1984) the decision made in solving this problem can be viewed from multiple perspectives, including technical, organizational, and personal. A model based on this research would reflect these differing perspectives, help emphasize the different viewpoints of the problem, and allow the study of how the viewpoints interact with respect to the problem.
For example, the technical viewpoint might focus on the damage done by propellers and the difficulty of seeing these underwater animals. The organizational perspective might be expressed by the activities of advocate groups, such as Save the Manatee Club, that educate the public about the problem, or by the activities of government agencies such as the Florida Fish and Wildlife Conservation Commission. The personal perspective might contain a wide range of examples, including boaters who just want to go fast in their boats and people (many of them children) who see a special wonder in the "gentle giants." While it may be a challenge to represent viewpoints in terms of numbers that can be used for the model's calculations, this weakness does not preclude the model from rough but meaningful representations.

Other important perspectives could be added. For example, Courtney (2001) includes, along with Linstone’s three perspectives mentioned above, the ethics and aesthetic perspectives, arguing that these two perspectives are especially suitable for complex problems and play an important part in the development of perspectives. Viewing the problem of manatee-watercraft collisions from the ethical perspective is a stark contrast with the other perspectives. People argue whether or not the manatees even have a right to existence. Environmental ethics holds that humankind shouldn’t knowingly allow a species to become extinct because of human activities. Aesthetic perspectives, in the case of the manatee-watercraft problem, might focus on a creature that has algae growing on its thick skin or on the design of a versatile motor boat or on the lovable nature of the creatures and the beauty of the realm they inhabit.

The model applies decision-making theory that emphasizes the generation of knowledge through the development of multiple perspectives in the context of a wicked problem. The use of decision-making theory of Linstone and Courtney is relevant to the environmental context, such as the manatee-watercraft problem. Kolkman et al. (2005) suggest the use of concept mapping techniques to increase knowledge of problems related to complex systems and propose to test it in the context of environmental (water) management. The design of the user interface for the proposed model would allow for the designation of variables to particular perspectives. This research seeks to answer whether a model that is built using the decision-making methods which develop multiple perspectives can create new knowledge to help in the protection of manatees.

The Model

The perspectives supported in the model include the manatees, boaters, environmental organizations and innovators that may contribute to solving the problem. The model that is developed as a starting point for the development of the perspectives explores the potential benefit of a announcing a research prize for innovations that may contribute to solving the problem. The prize would be awarded for a designed solution to the problem of manatee protection. The intention of the research prize is to generate innovation, particularly from parties that currently might not even be aware of the problem. Building a model that explores whether or not a research prize is feasible encourages the elaboration of a description of the environment, a description that would be necessary for communicating to prospective innovators the details and constraints of the problem domain. Anchoring the initial model with the research prize dynamics gives the model a directed, immediate focus.

The research prize is a tactic for finding solutions through innovations in which a large amount of money is awarded to a design solution that meets the constraints. The research prize is an idea that has both a recent and a rich history. Recently, an X PRIZE was awarded to Burt Rutan and associates for having made a spaceflight with a private craft (X PRIZE Foundation, 2007). Aeronautical history mentions many prizes for flying firsts, such as Charles Lindbergh's solo flight from New York to Paris (Davis, 2004). Richard Branson recently announced a $25 million prize to be awarded to a solution that removes carbon dioxide from the atmosphere (Sullivan, 2007). Masters (2003) proposes awards for agricultural innovations that benefit Sub-Saharan Africa as a way to help overcome market failures. Scientists are often awarded research prizes, for example the Nobel Prizes.
The model is depicted in Figure 1 and the state variables and flows of the model are defined in Table 1.

The basic assumptions of the model are as follows:

- The animals (manatees) and human technology (watercraft) have a base growth rate that can be affected by changes in technology.
- Technological innovators are attracted to work on manatee-friendly technology with the announcement of the prize, the larger the prize the more innovators that are attracted.
- The number and quality of innovations increases with the number of innovators and once a threshold is reached, the prize is awarded to a winning innovator.
- The rate of animal deaths (and hence the number of deaths) decreases with the quality of the innovation.

![Figure 1. Relational Diagram of the Model](image)

<table>
<thead>
<tr>
<th>State Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>manatee count</td>
<td>number of animals</td>
</tr>
<tr>
<td>watercraft count</td>
<td>number of watercraft</td>
</tr>
<tr>
<td>organization count</td>
<td>number of organizations administrating prizes</td>
</tr>
<tr>
<td>innovator count</td>
<td>number of innovators working on the problem</td>
</tr>
<tr>
<td>watercraft quality</td>
<td>degree to which watercraft are animal-friendly</td>
</tr>
<tr>
<td>prize purse</td>
<td>money payout for successful prize</td>
</tr>
<tr>
<td>innovation rate</td>
<td>rate of innovators innovation</td>
</tr>
<tr>
<td>manatee growth rate</td>
<td>rate of manatee pop. change due to natural causes</td>
</tr>
<tr>
<td>watercraft growth rate</td>
<td>rate of watercraft count change</td>
</tr>
<tr>
<td>organization growth rate</td>
<td>rate of organization count change</td>
</tr>
</tbody>
</table>
innovator growth rate | rate of innovator count change  
collision rate | rate of interactions between manatee and watercraft  
innovators attraction rate | rate of new innovators attracted by prize  
funding rate | rate of raising prize money  
winning threshold | quality level required to win prize  

| Flows  
manatee growth | change manatee population  
watercraft growth | change watercraft count  
organization growth | change organization count  
innovator growth | change innovator count  
funding growth | change prize money  
novation | change watercraft quality  
award prize | pay the purse money for successful innovation  
innovators due to prize | change innovator count due to prize  
interact | change to manatee population due to interactions  

Research prizes do have several pitfalls. Some of the problems are how the submissions are evaluated, determining who judges the submissions, and, of course, how the prize money is raised. While the idea of the research prize might not be recommended, the creation of a model to test the feasibility of a research prize would provide a platform for elaborating all aspects of the problem. The creation of the description of the problem, including all stakeholders' perspectives and a list of the constraints, would be a low cost way of evaluating whether a research prize might be effective.

Proof-of-Concept Implemented as Web Application

A proof-of-concept of the initial model has been developed to evaluate the potential of applying the theory (Gregg et al., 2001). A Web-based DSS was developed by combining the model and the functionality that allows multiple-perspective data views into a Web application that is hosted on a Web site (Power & Kaparthi, 2002). The Web was deemed an appropriate platform because Web-based DSS increase access for geographically disperse decision makers and stakeholders (Shim et al., 2002). For example, a Web-based DSS for the management of a large international river system was developed to help practitioners and scientists participate in the decision making process even when they seldom met face-to-face (Salewicz & Nakayama, 2004). To overcome the typical need to call the server between webpage views and to make the simulation model more responsive as a person explores the model and interacts with it, Ajax techniques were used. Buttons (hyperlinks) built using Ajax techniques function more like a rich desktop application and overcome the typically stateless nature of the Web by using JavaScript and the XMLHttpRequest object to broker the request without a full page refresh (Thomas & Hansson, 2005).

The variables of the model are made explicit so that the user can manipulate them (see the screen print in Figure 2). The variables are then saved in a database in order to allow the user the ability to return and continue exploration as well as the sharing of configurations with other users. In Figure 2 the manatees’ perspective has been selected and the manatee count and watercraft quality variables are highlighted. The current population of manatees is about 3000 as shown in the manatee count field at the upper left of the variables column and for time period 0 in the tabular output on the right. Here it is assumed that the manatee population growth rate is -1 percent and the watercraft growth rate is 1 percent.

The possible impacts of a research prize on the manatee population can be shown using the model with estimates of the collision rate, innovation rate, and other parameters. For example, one analysis performed compared a scenario in which a $50,000 research prize was administered with a scenario in which there was no research prize. The simulations showed that as innovators were attracted to the prospects of the prize and devoted their attention to the problem, the watercraft quality increased. In the research prize scenario watercraft quality, the degree to which watercraft were manatee-friendly, doubled in
half as much time as compared to the no prize scenario (6 time periods as compared to 13 time periods). This increase in watercraft quality in turn led to a greater survival rate of manatees. The simulation results indicated that in time period 6, the one in which the research prize was awarded, the manatee population was greater by 64.

![Figure 2. A screen print showing example model output.](image)

During a simulation the program instantiates the state variables as objects and creates references to the flow methods, then proceeds through each discrete time instance using these objects for the calculations. Inspiration and guidance was provided by Zaima (2005) who discusses an agent-based simulation on the diffusion of R&D for environmental products and by Robertson et al. (1991) who provide the logical structure of an ecological model in System Dynamics form. The application incorporates the multiple perspective decision-making theory by allowing the user to select between stakeholders of the domain. The model contains a society of Manatees, Boaters, Organizations, and Innovators, and when the user selects a button for one of these particular views, the data is displayed such that the variables that are important to that perspective are highlighted. In the proof-of-concept this functionality is implemented using Ajax, style attributes in the XHTML elements, and cascading style sheets.

Finally, the Web application has been designed so that the model of the manatee-watercraft problem is separable. Other Web sites can explore the impacts of a research prize model with respect to a problem where animal and human-technology conflicts. The Web-based environmental management decision support model supporting the multiple-perspectives is presented as initial work toward a design theory (Walls et al., 1992) whose goal is to establish collaborative perspective-building for complex problems of endangered species. A priority for future work on the prototype will be further testing of the model’s implementation and the development of validation of the user input, because, in the context of Web-based DSS, information quality has been demonstrated to affect the user’s decision making satisfaction (Bharatia & Chaudhury, 2004). Future work may also involve instantiating the model in additional software tools in order to compare and contrast different approaches to model specification and visualization, and user acceptance. A variable representing provision of research funding to scientists, innovators and others interested in addressing the manatee – watercraft collision problem may also be added.
References