Brief Technical Report on a Workshop on Integrating Predictive Models into the CRM Process

Legacy Resource Management Program, Project 09-457

David W. Cushman, Christopher L. Nagle, and Michael Heilen

Prepared with funding from the Legacy Program

for Air Force Air Materiel Command,
Martyn D. Tagg, Principal Investigator

Submitted to:
Paul R. Green, Ph.D.
Headquarters Air Combat Command
129 Andrews Street, Suite 102
Langley AFB, VA 23665-2769

and

Cecilia Brothers
Legacy Program
CRM Specialist
1225 South Clark Street, Suite 1500
Arlington, VA 22202

March 2010

Technical Report on the Workshop on Integrating Predictive Models into the CRM Process

INTRODUCTION

Since 2001, several studies were funded via the Department of Defense's (DoD's) Legacy Resource Management Program that investigated the integration of modeling into DoD cultural resource management (CRM) compliance. The Advisory Council on Historic Preservation and the National Conference of State Historic Preservation Officers have been consulted regarding this integration. To date, these studies have demonstrated that predictive models can provide a strong scientific foundation for decision-making about archaeological resources. These studies have also demonstrated that for predictive models to be sufficiently strong to be used in compliance, they must address issues of data quality and statistical modeling and fully utilize the capabilities of geographic information systems (GIS) technology. The models used in these studies on DoD lands have consistently shown weaknesses that could be easily overcome with a better understanding of how past use of landscapes could be conceptualized in GIS. The key to improving models, which was identified as part of an earlier Legacy project (#01-167) in 2001, is training. The purpose of the current project was to rectify this deficiency by developing and delivering a pilot workshop dedicated to improving technical aspects of predictive modeling and identifying key processes for integrating modeling in CRM compliance. The workshop was delivered on August 10, 2009, at the 2009 Sustaining Military Readiness Conference in Phoenix, Arizona. This report describes how this training was developed, the results of delivering the workshop, and recommendations for future delivery of this workshop to DoD CRM and National Environmental Policy Act (NEPA) staff in the future.

BACKGROUND

Three DoD Legacy projects on predictive modeling, in addition to an ongoing Environmental Security Technology Certification Program (ESTCP) project (# 200720), served as the foundation for the pilot workshop. The Legacy projects included #01-167, which evaluated the strengths and weaknesses of predictive models used at four DoD installations, and Legacy project (#03-167), which involved a working conference of DoD managers, State Historic Preservation Office (SHPO) representatives, tribal representatives, and modeling experts. The working conference reviewed the results of Legacy project #01-167 and made recommendations on how to best utilize modeling in installation compliance programs. The third Legacy project (#06-167) crafted an outline of a Section 106 (of the National Historic Preservation Act [NHPA]) programmatic agreement for integrating locational predictive models with installation CRM compliance and planning. This project also created the structure of a model that programmatically evaluates the significance of archaeological sites, rather than using a site-by-site, case-by-case approach to evaluation. The ongoing ESTCP project builds on these three Legacy projects and will result in the development of programmatic agreements for four demonstration installations, fully integrating predictive modeling with installation CRM compliance programs. An additional product of the ESTCP project is Web-based guidance on the development and use of predictive models and their integration into an installation's historic preservation compliance program.

These Legacy projects and the ESTCP demonstration project showed that:

- Predictive modeling can be used for NHPA and NEPA decision-making.
- Most large DoD installations do not use predictive models as a tool for NHPA or NEPA compliance.
- Few DoD CRM managers have a clear understanding of how these models are built and updated or how they can be integrated into the environmental review and compliance process; and few DoD

GIS specialists understand archaeological data well enough to design spatial databases that can provide information to develop strong predictive models, which can then be used as a compliance tool.

Given these findings and observations, there is clearly a need for training on the development, refinement, and validation of predictive models, so they can be effective environmental and historic preservation compliance tools. Many installations have predictive models that could be improved and then used for compliance activities, if only installation personnel had a greater understanding of the modeling process and GIS techniques and the role of modeling in compliance. The current pilot workshop on integrating predictive models into the CRM process fills this need.

PILOT WORKSHOP

As a first step, the SRI Foundation (SRIF) and Statistical Research, Inc. (SRI), developed a participants' workbook, containing a course outline and four training units: (1) building predictive models, (2) validating predictive models, (3) refining and updating predictive models, and (4) using models as an environmental and CRM compliance tool. Next, SRI and SRIF delivered the workshop at the Sustaining Military Readiness Conference, held in Phoenix, Arizona, on August 10, 2009. During the workshop, participants received practical experience on how to develop predictive models and were provided problem-solving applications using both real-world DoD examples and hypothetical scenarios. The first part of the workshop involved a hands-on session, using laptop computers and GIS programs, on how to build archaeological predictive models, validate models, and update models with new information. The second workshop component focused on incorporating predictive models into the Section 106 and NEPA compliance process. The workshop was partly underwritten by a donation of ArcGIS and Spatial Analyst GIS software licenses from ESRI.

Specific topics addressed during the first part of the workshop included:

- Defining the Universe—How much area should be covered by the model? Should the installation be modeled as a single unit or should it be divided by physiographic features? Military activities? Proposed impacts?
- Creating Independent Variables—What is a proxy variable? What are the pros and cons of selectively defining environmental variables that may relate to human behavior as opposed to using every environmental variable possible? What environmental GIS layers exist and where do you find them?
- Creating Dependent Variables—What are we modeling? The difference between GIS shape files and raster cells and archaeological sites. Can we model all sites at once or do we split them by time and culture? Can we model historical period sites? What about buried sites?
- Modeling Techniques—What is the difference between a Boolean, weighted, and a logistic regression model? What is agent-based modeling and when is it appropriate?
- Validating the Model—What is a jackknife? How do we measure the power of a model and how much confidence we should have in it? Is statistical verification enough? How important are independent data?
- Updating and Refining Models—Are we interested in a model or in modeling? How to incorporate new data into a model? Should you refine the model incrementally (i.e., as each new survey is entered into the database) or periodically (e.g., every year)?

The second part of the workshop examined the use of predictive models as a tool for Section 106 compliance, focusing on the following issues:

- Anticipating the kinds of properties likely to be encountered in an Area of Potential Effect, so that efficient property identification, evaluation, and management strategies can be developed as required under Section 106 of the NHPA.

2

- Anticipating the costs of archaeological survey needed to satisfy the identification requirement under NHPA.
- Facilitating the use of phased identification of archaeological sites as a means to streamline Section 106 decision-making.
- Designing an archaeological sample survey in order to collect sufficient information to identify historic properties and to assess effects as required under Section 106.
- Evaluating the integrity and National Register eligibility of archaeological sites.
- Redesigning undertakings to avoid/minimize adverse effects on significant resources, thus preserving sites and reducing costs.
- Assisting with tribal consultation by providing information early in the Section 106 process on potentially sensitive areas or resources that may be of special concern.
- Facilitating the development of Programmatic Agreements to streamline DoD installation-wide compliance with Section 106.

In the context of NEPA compliance, this second part of the workshop also looked at:

- Linking environmental planning with Section 106 compliance by integrating potential archaeological site locations with information on the spatial distribution of natural resources, known and modeled.
- Streamlining consideration of archaeological sites under categorically excluded undertakings.
- Facilitating the scoping of potential impacts/issues for a proposed action under NEPA and informing the public and other stakeholders about the potential for impacts.
- Selecting alternatives for detailed study in compliance with the NEPA regulations.
- Characterizing the affected environment for EAs and EISs under NEPA without having to physically inventory every alternative.

One instructor taught the first part of the workshop, and another instructor taught the second part.

At the end of the pilot workshop, participants were asked to complete a workshop evaluation form. The comments and ratings provided by these forms, in addition to the instructors' observations made during the delivery of the workshop, were subsequently used to revise the workshop materials.

WORKSHOP RESULTS AND RECOMMENDATIONS

At the outset, it had been decided that the maximum number of workshop participants would be 24. Therefore, SRI rented 24 laptop computers, in addition to 2 spare laptops. A total of 24 individuals officially registered for the workshop. However, there were an additional 24 "walk-ins" to the workshop, and 12 of these individuals stayed and participated in the entire workshop, whereas the other 12 came and went. SRI and SRIF were not able to control who participated in the workshop, given the overall logistics established by the Sustaining Military Readiness Conference organizers.

The following is a breakdown of the workshop participants by service: US Army, 18; US Air Force, 17; US Navy, 5; US Marine Corps, 3; US Army National Guard, 3; and Others (unidentified), 2. Twenty-two participants filled out evaluation forms following the workshop. Many of these participants noted that this type of workshop had great value.

Based on the comments received, and the instructor's evaluations, the following four issues were identified and need to be addressed before this workshop is delivered in the future:

- There needs to be a limit on the number of participants, and the workshop should be open to only individuals with specific skills and work experience

- More than one instructor is needed to deliver the first part of the workshop. A minimum of two instructors is required, or an instructor and an assistant.
- The workshop should be expanded to 2 full days
- More real-world examples are needed to illustrate how modeling can be used to streamline the regulatory compliance process

As noted above, SRI and SRIF had little control over the number and type of participants who could attend the workshop during the conference. As a result, the computer and GIS software skill levels of the participants varied tremendously. This slowed down the pace of the hands-on computer-based training and resulted in teaching individuals with no practical experience with GIS. For future workshops, the number of participants should be limited to 20–24 individuals. The first part of the workshop should focus on GIS technical specialists, with their DoD CRM and NEPA counterparts sitting next to the specialist as they work. In this way, the CRM and NEPA staff will have at least a basic understanding of the requirements for model development, validation, and refinement. The second part of the workshop should focus on DoD CRM and NEPA staff, with the GIS specialists also participating so they can understand the context for their GIS-based modeling efforts.

In terms of instructors, it is recommended that the instructor for the first part of the workshop have the assistance of second instructor or a GIS analyst/technician who can work with the participants at their computers while the primary instructor provides the overall lessons.

As noted above, the 1-day format for the workshop was inadequate for presenting the necessary lesson content. In revising the workshop, SRI and SRIF have redesigned the structure and the content of the workshop to fit a 2-day format. Several participants noted in their evaluations that the data preparation exercises in part one of the workshop consumed too much time. Accordingly, SRI and SRIF revised these lessons to decrease the time spent on data preparation and now include more finished GIS data layers. This revision will make it possible to avoid much or all of the data preparation and proceed directly to model building. Finally, to address the comments on the lessons dealing with how to use predictive modeling to streamline the regulatory compliance process, SRI and SRIF revised the workshop to include more "real-world" examples from DoD and other federal agencies.

Given the positive response from the pilot workshop participants, SRI and SRIF recommend that the revised workshop should be made available to DoD installation CRM and NEPA staff, and the consultants and other organizations that work with these staff in the context of both NEPA and Section 106 compliance programs. Locations for delivering the revised workshop might include national Air Force and Army CRM meetings, professional meetings such as the Society for American Archaeology and the Society for Historical Archaeology, and other military conferences that attract significant numbers of DoD CRM professionals. If the workshop is delivered at these types of national meetings, the workshop instructors must have the ability to restrict the number and type of participants.

It also may be useful to deliver the workshop at regional DoD meetings that bring together personnel from installations with similar environments and cultural settings. For example, the workshop can be tailored for desert-based installations in California, Arizona, and Nevada. The workshop can also be tailored for a specific, large installation with complex military missions and extensive cultural resources, such as Fort Bliss in Texas and New Mexico.