Final Technical Report

A GIS Enhanced Cultural Resource Management System

by

Thomas J. Green
Lela Donat
Jerry Hilliard
Jami J. Lockhart

Arkansas Archeological Survey
P.O. Box 1249
Fayetteville, AR 72702

January 9, 1995

Funded by

Mack-Blackwell National Rural Transportation Study Center
Room 4190 Bell Engineering Center
University of Arkansas
Fayetteville, Arkansas

Introduction:

In May of 1993, the Arkansas Archeological Survey entered into a cooperative agreement with the Department of Arkansas Heritage to develop an integrated digital information infrastructure combining innovative data management technologies, long-distance networking potentials, and extensive statewide archeological and environmental data. The integrated system described in the following report was designed to enable government agencies and other organizations to make use of computer-based mapping and analytical tools in a variety of management, planning, and research activities within the State of Arkansas. The project was made possible in large part by a grant from the Department of Transportation, and administered by the Mack-Blackwell National Rural Transportation Study Center, University of Arkansas, Fayetteville.

Project Objective:

The primary objective of the GIS Enhanced Cultural Resource Management System project was to develop a computer-based geographic information system (GIS) map layer and an associated digital database containing comprehensive information on all archeological surveys and excavations within the State of Arkansas. Secondly, in order to make this data fully useful, an ancillary but integral objective was to provide accessibility to other decision-making agencies for their planning needs by taking advantage of recent technological advances in telecommunications and networking.

These objectives have been accomplished. The resulting integrated system, as developed under this contract, will allow state and federal agencies to remotely access and easily query the computer system via ARKnet or Internet for locational and non-locational attribute data associated with all recorded archeological sites and surveys statewide, as well as related environmental map data.

Project Purpose:

Section 106 of the National Historic Preservation Act of 1966 requires federal agencies, and state agencies using federal money, to assess the effects of their projects on archeological and historic properties. To do this, agencies must determine if archeological and historic properties exist in their project right-of-ways and consult with the State Historic Preservation Office (SHPO), which in Arkansas is part of the Department of Arkansas Heritage (DAH). By reviewing and analyzing past archeological research in an area, the SHPO and the requesting agency decide if new or additional archeological investigations are necessary before a project is initiated. Prior to the development of this archeological project database and GIS, it was very time-consuming to determine where archeological projects had been undertaken in the state. Having this information readily available will save state and federal agencies time and money, and allow for more meaningful consultations between the SHPO and other agencies.

The newly-developed integrated system described herein was designed to augment the existing information system created and operated by the Arkansas Archeological Survey (AAS). A key component of that original system is the Automated Management of Archeological Site Data in Arkansas (AMASDA) database, which is a computerized relational database management system consisting of over 130 separate fields of information relating to each of the more than 29,000 archeological sites recorded in the state (Figure 1). AMASDA is coupled to a Geographic Resources Analysis Support System, or GRASS-based full-functioned GIS that provides the ability to manually digitize locational information, and to import existing digital data such as digital line graphs, digital elevation models, and satellite imagery. Once data have been entered into the system, they can be manipulated, analyzed and displayed as color images, hardcopy maps or tabular information. The Survey currently has a number of statewide GIS data coverages on-line, including archeological, cultural and socioeconomic data themes, TIGER census data,

transportation, hydrography, elevation, soils, and geology, as well as a variety of multi-state regional coverages and more localized, site-specific and intrasite applications.

Before the development of the data and query capabilities associated with the current contract, the AMASDA database was already extremely useful in finding out where archeological sites have been recorded in the state, but it could not provide information about where archeologists have looked for sites but found nothing. Over a period of years, the Survey has compiled information on more than 3,100 archeological project reports statewide. These reports contain information on the location and extent of archeological investigations, even if no archeological sites were found. Knowing what areas have been previously surveyed for cultural resources and how those surveys were conducted can be just as important as determining the location of known archeological sites in various developmental planning processes, such as highway construction, timber sales, and the siting of sewage treatment facilities. Depending on the methods used to locate archeological sites in past surveys, and the type of project being proposed, an agency may or may not be required to do additional archeological work before construction begins.

By developing an integrated GIS/relational database that displays the locations and boundaries of these projects, the Arkansas Archeological Survey has provided a system that will enable federal and state agencies to effectively and efficiently determine whether any archeological work has been conducted in the areas of their proposed projects. Consequently, this system has the potential to greatly reduce redundant archeological investigations within the same locations, thereby saving valuable planning dollars. At the same time, by adding the project locations to the GIS system, meaningful predictive models of archeological site location can be developed using existing information pertaining to the

environmental and cultural characteristics associated with the presence or absence of sites in previously surveyed areas.

Project tasks:

A number of tasks were involved in the development and implementation of the archeological project GIS and accompanying relational database. The first of these tasks was to create a project database schema (Appendix 1). The schema is the digital structure or framework designed to contain and manage the information to be encoded in the database. Decisions about the types of information to be included in the database were made in consultation with archeologists from the State Historic Preservation Office (SHPO). Input from the SHPO was given particularly careful consideration because that agency will be one of the principal users of the system. Information encoded into the system includes the project name and number, who did it, when they did it, why it was done, and who sponsored it. The database also includes information on size and location of the project and the type of project, such as intensive survey, archeological testing, or extensive excavation, among other facts. Information on the number of sites found, if any, and whether any human remains were found is also included. Finally there is information on the field conditions, restraints, and subsurface indicators of archeological deposits that allows one to judge the adequacy of the investigation without imposing a judgmental confidence level rating system. The database was created using Informix Relational Database Management System software on a UNIX platform.

The next step in the process was to gather all the reports of archeological projects completed in the state. Many of these were located in the archives of the Arkansas Archeological Survey, but more than 350 previously unrecorded reports were unexpectedly discovered at the State Historic Preservation Offices in Little Rock.

The most labor intensive and time consuming part of the project was converting the

original written archeological reports into digital form. Eight students from the Department of Anthropology, University of Arkansas, were hired to do this work. Their first task was to plot project boundaries on 7.5-minute USGS quadrangle maps. On average, it took approximately one hour per project to plot the boundaries and to extract information about the project for the database. Archeological excavations were plotted as points and could be mapped relatively quickly, while right-of-way surveys for highways, power lines, pipelines, and large surveys took correspondingly more time to interpolate and plot. Once plotted on USGS maps, the project boundaries were digitized into the GIS, and the attribute information for each project was encoded into the database (Figures 2 and 3). The proposal estimate of approximately one hour per project to digitize the boundaries was found to be accurate. However, because of the more than 350 additional project reports subsequently supplied by the SHPO, more time was required to complete this portion of the project. A system is now in place to convert all newly received archeological reports to digital form in the GIS and relational project databases. To date, more than 3,100 projects have been entered into the system, and the databases are maintained with continual updates.

The next task involved conversion of U.S. Census TIGER data to a digital format for use in the Survey's integrated data management environment. In cooperation with the Arkansas Archeological Survey and Department of Arkansas Heritage, the Center of Advance Spatial Technology at the University of Arkansas, Fayetteville supplied the raw TIGER files and programs to be used in the data conversion process. The TIGER data contain modern community boundaries, and up-to-date highway maps, hydrographical coverages, as well as traditional census data. Knowledge of the modern environment is essential in making informed decisions concerning the need for archeological investigations prior to a project. With that in mind, these critical data provide the capability to cartographically overlay archeological project boundaries onto modern digital map layers for display purposes, and, more importantly, for purposes of analysis.

The Department of Computing Services, University of Arkansas provided the supervision and technical expertise for connecting West Avenue Annex (the location of the Arkansas Archeological Survey's Coordinating Office) to the campus fiber optic backbone and Internet. This portion of the overall project took more time than anticipated because of the unexpected duration of negotiations with various utility providers in Fayetteville, and the attendant communication and coordination issues typically involved in a cooperative effort involving a number of large organizations.

In Little Rock, the State Historic Preservation Office was connected to the Internet through the APSCN K-12 educational network with cooperation from the Arkansas Department of Computing Services. Similarly, this portion of the project also took somewhat more time than was originally allotted due to delays comparable to those encountered in Fayetteville. During the network connection phase, the State Historic

Preservation Office purchased a computer that now functions as a GIS terminal connected via Internet to the computer running the integrated data management system in Fayetteville at the Arkansas Archeological Survey.

The final task of the project was to train the SHPO staff on the use of the system. Arkansas Archeological Survey personnel have provided on site demonstrations and training, as well as maintaining continuous communication and technical support for the SHPO staff. AAS also assumes that this will be an ongoing endeavor however.

Results:

The project has been completed as designed. All archeological projects for which written reports were made available to either the Arkansas Archeological Survey or the Arkansas State Historic Preservation Office are now incorporated into the Projects database and the GIS maintained by the Arkansas Archeological Survey. These new data sets compliment and extend the utility of the existing AMASDA database and GIS system already in operation there.

The integrated systems described above give Arkansas state-of-the-art digital data management and archeological research capabilities. A number of State Historic Preservation Offices and/or State Archeology Offices have some sort of relational databases for basic site information and project information. However, only Arkansas has both archeological site and project boundary information that can be analyzed using a statewide GIS system integrated with a relational database. Individually, and particularly in combination, the system components developed by means of this grant provide powerful mapping and analytical tools that a number of state and federal agencies have long needed to enhance resource management and planning within the State.

Appendix 1
Project Database Screens

```
================================================================================
                    *** AAS PROJECTS DB ***

**AMASDA NO:   [ANUM]

Project name [NAME                                          ]

Project # [PNUM      ]       Outside # [OUTN               ]

Archaeologists:   [ANO]         [OLD1               ]
                  [A2 ]
                  [A3 ]

Year [YEAR]    # Yrs   [Y ]

Investig.Entity [INVE                                       ]

Princ.Sponsor.  [PINV                                       ]

================================================================================


================================================================================
                    *** OVERLAPPING PROJECTS ***

**AMASDA NO:   [ANUM]

See Also Projects:   [SA  ]

================================================================================


================================================================================
  +-----------------+
  |   LABELS        |
  +-----------------+

WORK-TYPE:

Work type code:  [WT]

Work type label: [WLAB                                      ]

================================================================================


================================================================================
                    *** PROJECT WORK TYPE ***
```

**AMASDA NO: [ANUM]

Work type code: [WT]

Work type label: [WLAB   ]

==========

==========
*** PROJECT COUNTIES ***

**AMASDA NO: [ANUM]

County codes: [CO]

==========

==========
+---------------+
| LABELS |
+---------------+

*** STANDARDISED ARCHAEOLOGISTS NAMES ***

Archaeologist name code: [ANO]

Standardised name: [OLD1   ]

==========

==========
*** PROJECT TYPE ***

**AMASDA NO: [ANUM]

Judgemental: [c]

Intensive/systematic: [d]

Field survey with site(s) testing: [e]

Site testing only: [f]

Extensive excavation: [g]

Remote Sensing: [h]

Nautical Excavation: [i]

==========

==========

*** PROJECT DATA USGS 7.5-MINUTE QUADRANGLES ***

**AMASDA NO: [ANUM]

Quad Number(s): [MAP]

==========

==========

*** EXTENDED PROJECT INFORMATION #1 ***

Report Availability: [j]

**AMASDA NO: [ANUM]

Purpose of Project:

compliance [k] research [l] rescue [m]

Project area plotted on USGS 7.5' map: [n]

Approximate project size:

Total number of hectares [TOTHECTA]
Number of hectares surveyed [HECTSURV]

For linear projects:

Total length of segments in kilometers [SEGLENGT]

Total width of right-of-way in meters [WIDTHMET]

==========

==========

*** EXTENDED PROJECT INFORMATION #2 ***

**AMASDA NO: [ANUM]

Total number of sites recorded/investigated: [TNSRI]

Number of sites eligible for National Register: [NSENR]

Number of sites NOT eligible for National Register: [NSNEN]

Number of sites of undetermined/unknown NR eligibiltiy: [NSUUE]

Number of crew persons: [NOCP]

Number of field days: [NOFD]

==========

==========

*** EXTENDED PROJECT INFORMATION #3 ***

**AMASDA NO: [ANUM]

Percent bare ground visibility: [BGV]

Project area ground cover:

Wooded [o] Pasture [p] Plowed/disced [q] Planted field [r]

Recently harvested field [s] Rice field [t]

Secondary undergrowth vegetation [u] Urban built environment [v]

Not reported/unknown [w]

==========

==========

*** EXTENDED PROJECT INFORMATION #4 ***

Restraints:

**AMASDA NO: [ANUM]

No major restraints [x]

Flooding [d1]

Access denied [z]

Extreme slope [a]

Secondary vegetation/undergrowth [b]

Hazardous Materials [b1]

==========

==========

*** EXTENDED PROJECT INFORMATION #5 ***

No subsurface testing: [b2]

**AMASDA NO: [ANUM]

Shovel test: [b3] Auger test: [b4] Core test: [b5]

Maximum test interval (in meters): [MTIOO]

Screened: [b6] Unscreened: [b7]

Size and number of controlled excavation units (example size - 2x2):

Unit 1 [U1SIZ] Unit 2 [U2SIZ] Unit 3 [U3SIZ] Unit 4 [U4SIZ]

No. U1 [U1NUM] No. U2 [U2NUM] No. U3 [U3NUM] No. U4 [U4NUM]

Number of trenches: [NTO] Maximum depth of trenches (meters): [MDOT]

Feature(s) excavation only: [b8]

Number of features: [FEANO]

==========

==========

*** EXTENDED PROJECT INFORMATION #6 ***

(Remote Sensing)

**AMASDA NO: [ANUM]

Magnetometer: [b9]

Metal detector: [c1]

Resistivity: [c2]

Ground penetrating radar: [c3]

Dowsing: [c4]

Human remains reported: [c8]

Aerial: [c6]

Satellite: [c7]

==========

KEY TO FIELDS

tables

p_main p_worktype p_counties p_archname worktypes p_type p_quad p_see_also

attributes

ANUM = amasda_no,noupdate,reverse,required;
= w_amasda, include = (1 to 2000), reverse, required;
= c_amasda, include = (1 to 2000), reverse, required;
= t_amasda, include = (1 to 2000), reverse, required;
= q_amasda, include = (1 to 2000), reverse, required;
= s_amasda, include = (1 to 2000), reverse, required;
NAME = proj_name,required;
PNUM = project_no,reverse;
OUTN = outside_no,reverse;
ANO = arch1,reverse;
= name_no;
A2 = arch2,reverse;
A3 = arch3,reverse;
OLD1 = archname,required,noupdate;
YEAR = proj_year,include = (1800 to 1999,9999),required,reverse,
comments = "Enter 9999 if unknown";

Y = no_year,reverse;
INVE = con_entity;
PINV = prin_investig;
SA = see_also;
WT = worktype,include = (1 to 99),required,reverse,
comments = "Enter 99 if unknown";
= wk_cd,reverse,noupdate;
WLAB = wk_type;
CO = p_county,reverse,comments = "Enter xx if unknown";
c = judge;
d = intense;
e = fs_test;
f = testonly;
g = ext_exc;
h = remote;
i = nautical;
j = report;
k = compliance;
l = research;
m = rescue;
MAP = pmap_no;
n = plotted;
TOTHECTA = tot_hectare;
HECTSURV = hectare_surv;
SEGLENGT = linear_long;
WIDTHMET = linear_wide;
TNSRI = tot_no_sites,required,reverse;
NSENR = nr_elig;
NSNEN = nr_inelig;
NSUUE = nr_undeter;
NOCP = no_crew;
NOFD = no_days;
BGV = percent_vis;
o = wooded;
p = pasture;
q = plowed;
r = planted;
s = harvested;

t = rice;
u = sec_un_veg;
v = urban;
w = unreported;
x = unrestrained;
d1 = flooding;
z = denied;
a = ex_slope;
b = sec_veg;
b1 = hazmat;
b2 = no_sub_test;
b3 = shovel;
b4 = auger;
b5 = cored;
MTIOO = interval;
b6 = screened;
b7 = unscreened;
U1SIZ = unit1_size;
U1NUM = unit1_no;
U2SIZ = unit2_size;
U2NUM = unit2_no;
U3SIZ = unit3_size;
U3NUM = unit3_no;
U4SIZ = unit4_size;
U4NUM = unit4_no;
NTO = trench_no;
MDOT = trench_deep;
b8 = fea_excav;
FEANO = fea_no;
b9 = magnetom;
c1 = metal_detect;
c2 = resistivity;
c3 = radar;
c4 = dowsing;
c6 = aerial;
c7 = satellite;
c8 = human;

instructions
delimiters "[]";
p_main master of p_see_also;
p_main master of p_worktype;
p_main master of p_counties;
p_main master of p_type;
p_main master of p_quad;