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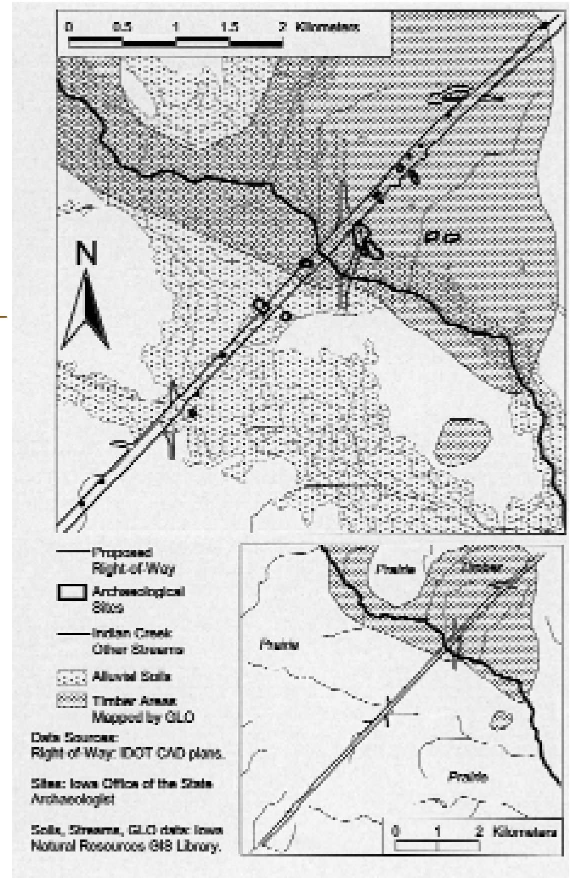
Past Landscapes, Future Roads

GIS, Archeology, and Highway Planning In Iowa

Archeologists in cultural resource management often find themselves in the paradoxical, if not anachronistic, situation of visualizing the effects of future development on past landscapes. In considering the natural and cultural environmental contexts of past occupations, archeologists work with many kinds of maps, including topographic quadrangles, soil surveys, aerial photographs, and historic survey plats. In considering the effects of future development on cultural resources, archeologists often rely on client-provided plans that show the spatial extent of a proposed undertaking. The Iowa Department of Transportation (IDOT), for example, routinely provides its cultural resource consultants with plans that show where a given undertaking will be built.

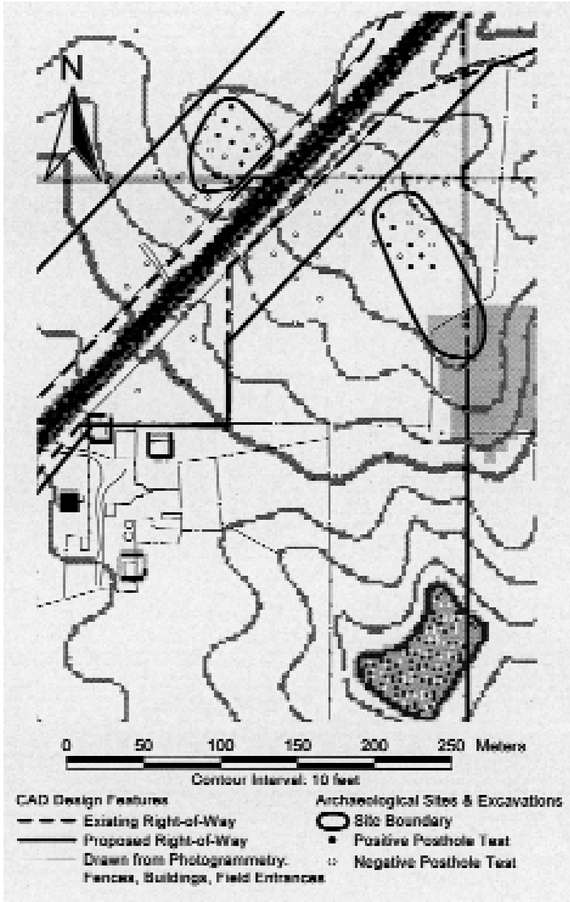
Determining the location of a specific archeological site on such a variety of maps can be a daunting task using traditional tools such as an engineer's scale. Fortunately, the ability to work with spatial data at various scales is greatly facilitated by computer technology: computer-assisted drafting (CAD) and geographic information systems (GIS) hold great promise for spatial data integration in archeology. CAD is basically a drawing tool in which drawing elements are organized into thematic layers. Layers are assigned different colors, line weights, line styles, or marker symbols to facilitate their identification. Layers can be on or off as needed to reduce visual clutter. GIS software combines the drawing capabilities of CAD with the analytical capabilities of a relational database; GIS not only displays spatial data on maps but also maintains a database of information about mapped features. The database can be queried and the results can be mapped. In a GIS, mapped features are georeferenced, i.e., assigned coordinates that identify them to a specific location on the earth's surface. The user specifies coordinate systems, such as degrees of latitude/longitude or coordinates of the Universal Transverse Mercator (UTM) system.

Recently, the University of Iowa Highway Archaeology Program, under contract to IDOT, surveyed a proposed construction corridor along an existing highway. ArcView®, a software package developed by ESRI, Inc., was used to develop a GIS for the project that incorporated the following map data sources:



This map shows the proposed highway corridor in relation to historic map data on natural vegetation, and modern soils data. The small map at lower right shows the entire corridor. The top map shows the northeast half of the corridor, where all but one of the prehistoric sites recorded by the project are found.

- CAD files provided by IDOT. The files are electronic drawings depicting various construction features, such as rights-of-way, property lines, culverts, bridges, pavements, medians, ditches, water bodies, fences, tree lines, and buildings drawn from aerial photographs.
- Digital representations of 7.5 min. quadrangle maps obtained from the USGS <mcmcweb.er.usgs.gov/>.
- Digital maps showing streams and native vegetation obtained from the Iowa Natural Resources GIS library <www.igsb.uiowa.edu/nrgis/gishome.htm>.
- A digital map of soils in the project area obtained from the Natural Resource Conservation Service <www.ia.nrcs.usda.gov/soils/iowa_soils.html>.
- Field notes used to plot site boundaries and excavation locations. These locations, recorded in the field, were digitized on-screen using CAD files as a backdrop.



In this "snapshot view" of one portion of a transportation archeology GIS, CAD design and photogrammetry data, provided by the Iowa Department of Transportation, are layered atop a digital raster graphic (DRG) of a 7.5 minute quadrangle map. Layers for archeological site boundaries and excavations are also shown, with excavations coded to indicate which yielded artifacts. DRGs are scanned at a minimum resolution of 250 dots per inch. At scales smaller than ca. 1:5000, individual pixels (small squares comprising the raster image), each measuring ca. 2.3 m on a side, become visible.

By bringing these data sources together in a GIS, any variety of maps can be prepared showing the location of the project corridor and archeological sites in relation to features of the cultural and natural environment. At relatively small scales, the location of specific sites in relation to the proposed corridor are easily visualized. At larger scales, the relation of the project area to features of the natural environment can be examined. In the map image, for example, the proposed construction right-of-way from the CAD files is superimposed on a map showing two layers of environmental data. The "alluvial soils" layer was created from the soil survey map; the "timber areas" layer was created from a digitized 1:1200 survey plat showing vegetation cover as mapped by the General Land Office in 1846.

As shown in 1846, forest formed a narrow belt along Indian Creek and extended into the uplands northeast of the valley. Most of the valley, however, and a large expanse of upland south of the valley was prairie (inset map). Of the 136 hectares occupied by the proposed project corridor, about 36%, or 49 hectares, was forested at the time of the General Land Office survey. The forested zone, however, contains 11 of 18 prehistoric sites recorded by the project, a density of 2.2 sites per 10 ha. In contrast, only seven sites were found in the prairie zone, a density of only 0.8 sites per 10 ha. Sites in the forested zone in the northeast half of the project area tended to yield more abundant and diverse artifact assemblages, suggesting profound functional differences in prehistoric utilization of the two broadly defined "ecozones."

This simple ecological comparison does not begin to exhaust the analytical sophistication possible with a GIS. It does, however illustrate the technology's ability to help visualize and quantify spatial data. Readily available GIS technology enables archeologists to bring together geographic data from various media produced at various scales, including CAD drawings. Incorporating CAD designs as part of a cultural resources GIS facilitates visualizing and analyzing project effects and communicating these results to regulators, planners, and engineers. CRM surveys are usually conducted in the preliminary stages of project planning. CAD plans available at the time of survey often represent an early stage in a dynamic planning and design process. Design modifications made after the initial survey is completed often require review and reassessment to determine whether initial CRM recommendations still apply, and to determine whether a supplemental survey is needed.

The effects of proposed design changes on cultural resources can be immediately determined if information on known site locations and previously surveyed areas is incorporated as a layer in the engineer's CAD designs. By exporting a GIS data layer to a CAD file format, cultural resource locations can be added directly to the engineering CAD plans. Alternatively, the archeologist can review proposed design changes by adding client-provided CAD files to an existing cultural resources GIS. GIS promises to become an important tool in all stages of CRM, with the software providing a dynamic interface for sharing information among archeologists, planners, designers, and regulators.

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