Archaeological Applications of GIS at the San Diego Presidio Chapel

David Gerrit Hyde, Keshia Montifolca, and Scott Mattingly
San Diego State University

The full potential of Geographic Information System (GIS) as a site-specific analytical tool in archaeology has not yet been fully realized. The San Diego State University (SDSU) Presidio Chapel GIS Project illustrates the benefit of a post-excavation GIS-focused project in creating a resource base for generating and addressing various research questions. A digital reconstruction of the excavation methods was created by linking spatial data with artifact catalogs, allowing for the generation of three-dimensional models to display spatial and temporal archaeological data. The versatility and manipulability of the resulting GIS models facilitate the recognition of spatial patterns of artifacts and features at the Presidio Chapel.

Geographic Information Systems have become an integral part of contemporary archaeology. The capability of the system as an analytical tool, however, has not been fully realized. Historically, GIS in archaeology has been used almost exclusively as a regional intersite mapping tool and for creating site location predictive models (Wheatley and Gillings 2002). The purpose of this paper is to illustrate the value of GIS in archaeological research beyond this relatively limited scope. When utilized as a method to aid in intra-site analysis, GIS can help archaeologists to synthesize, recognize, analyze, and share archaeological data. These applications of GIS aid in the ability to reconstruct past behaviors and to make social inferences through the study of material remains.

Specifically, using the San Diego Presidio Chapel excavations as a case study, we illustrate the potential value of GIS as a data management system, a 3-D site reconstruction tool, and as a tool for generating research topics in post-excavation analysis. Contrary to the common conception that GIS is solely useful for displaying archaeological data in a convenient and interactive medium, this project demonstrates the value of GIS in its ability to reveal previously unobserved patterns and correlations that bring to light past behaviors. In doing so, we illustrate that GIS has immense value in archaeology beyond simply displaying and managing spatial data.

During excavation, archaeologists record artifacts and features according to measurements along three planes: latitude, longitude, and depth. Combined, these recorded aspects of space help to identify data within a specific location in time and space (Fagan 2006). This archaeological focus on spatial attributes makes GIS a natural methodological pairing for archaeological investigations (Ebert 2004). Specifically, GIS has been adopted in archaeology based on the powerful capabilities to place sites, features, and artifacts within the geographic landscape (McCoy and Ladefoged 2009). These GIS applications in archaeology are grouped according to three major hierarchical categories: visualization, management, and analysis (Ebert 2004).

Visualization, the "lowest level" of GIS application, focuses on map production and visual representations of GIS data (Ebert 2004:320). Management, often employed outside of academic research in fields such as Cultural Resource Management, refers to the organization and editing of spatial data without further analysis or interpretation (Ebert 2004). Analysis, as a means of generating and/or testing archaeological theory, refers to the investigation and interpretation of resulting spatial data (Ebert 2004).

Diverse archaeological purposes necessitate various applications of the above categories, but oftentimes only one category or another is utilized. Utilizing all three categories in the San Diego Presidio Chapel GIS Project, however, illustrates the value in effectively applying these GIS methods in a site-specific, post-excavation archaeological context.

Beyond illustrating the value of GIS in intra-site data visualization, management, and analysis, the San Diego Presidio Chapel GIS Project employs 3-D modeling techniques allowing for the temporal, as well as spatial, display of archaeological data. 3-D models address the inherently limited aspects of traditional 2-D archaeological maps by accurately displaying spatial data and allowing for the recognition of stratigraphically related spatial patterns (Craig and Aldenderfer 2003; Moyes 2002). Various studies (Craig and Aldenderfer 2003; Mallios et al. 2008; Moyes 2002) emphasize the need to represent stratigraphy in 3-D across an archaeological site in order to better visualize and examine the vertical and horizontal aspects of archaeological artifacts and features.

Overall, 3-D models help to remedy the inaccurate display of artifact locations and quantities that may result from two-dimensional maps. The use of 3-D visualization not only aids in overcoming the limitations of traditional mapping, but also aids in the recognition of spatial patterns of artifacts in relation to archaeological features by providing the ability to view entire sites in real-world context on a single screen in an interactive medium (Moyes 2002).

SAN DIEGO PRESIDIO HISTORY AND CHAPEL EXCAVATION HISTORY

Founded on July 16, 1769, the San Diego Presidio was Spain's first military outpost in Alta California (Beddow 1999). The Royal Presidio played an important part in the protection of local colonial inhabitants and continued to be used for military purposes until the fortified city was abandoned in 1839. The site was first investigated by the archaeological community in the spring of 1965 when San Diego State College, collaborating with the San Diego Historical Society, established the first archaeological field school at the Presidio site (Brockington and Brandes 1965). The mission-style chapel located in the center of the Presidio, completed in 1784, became the focus of San Diego State College's excavation entitled "Chapel Complex Project" (CA-SDI-38) headed by Dr. Paul Ezell, taking place between 1965 and 1976 (Brockington and Brandes 1965; Colston 1982). This initial investigation was followed by a number of other excavations conducted by multiple institutions, led by different principal investigators, and excavated by numerous individuals. As a result, the cumulative body of data now available for the Presidio is expansive. The "Chapel Complex Project" collection was cataloged and curated at San Diego State University under the direction of Paul Ezell, Lynne Christenson, and Lynn H. Gamble. The remaining collections are currently stored in several facilities in San Diego County.

Prior to the first controlled excavations, archaeologists were unable to locate any design plans for the San Diego Presidio, and concluded that none had ever been drafted (Ezell and Ezell 1986). This presumption led excavations to focus on identifying various structures within the fortified city in an attempt to recreate a comprehensive plan of the San Diego Presidio (Ezell 1976). However, a set of plans of all four Alta California presidios was discovered in 1982. Drafted by General Mariano Guadalupe Vallejo in 1820, the plan of the San Diego Presidio became instrumental in deriving information when used as a comparison tool for excavation results (Figure 1) (Ezell and Ezell 1986). Vallejo's 1820 plan, however, is idealized, and it is debated whether it is a "true" plan drawn before the construction of the San Diego Presidio (Ezell and Ezell 1986). The lack of a comprehensive detailed map to compare with the San Diego State College excavation field drawings fueled the need for a contemporary map of the excavations conducted during the Chapel Complex Project.

In February 1968, burial sites were discovered within the Royal Presidio by San Diego State College field school excavations. The existence of a cemetery on Presidio Hill had been largely forgotten and was not represented on any historical maps. It was similarly surprising when burials were found within the Chapel itself (Larkin 1968). Subsequent excavations revealed that a cemetery exists between the chapel and the south rampart, an important feature absent from the 1820 Vallejo plan (Ezell and Ezell 1986). The lack of cohesion between the historical maps and the archaeological field maps highly limits the information that they present. The general discrepancies of mapped information furthered the need for a contemporary and comprehensive map of the Royal Presidio Chapel to be used in current archaeological investigations.

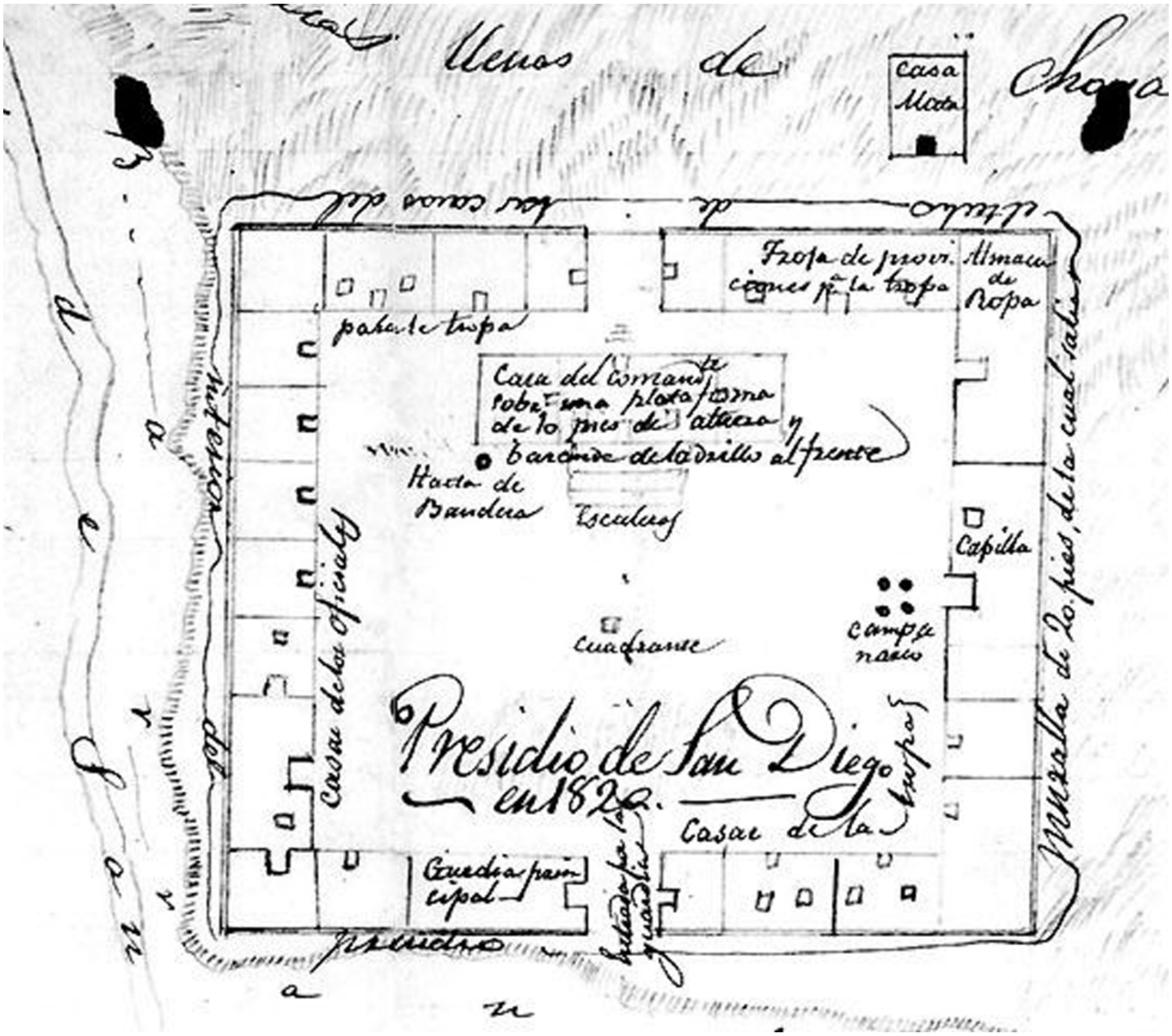

Figure 1. General Mariano Guadalupe Vallejo's 1820 plan of the San Diego Presidio.

GIS APPLICATIONS

Historically, in archaeology, GIS has been utilized primarily for its areal map generating and feature locating capabilities. This project begins similarly by organizing the data and compiling field maps to provide a solid archaeological base-map. However, we then go beyond these basic functions to create both a 2-D and 3-D reconstruction in which carefully designed spatial queries display the data in new and revealing ways. The use of multidimensional models offers better insights into the provenience of artifacts and features that traditional two-dimensional maps cannot provide. GIS better enables the synthesizing, analyzing, and sharing of archaeological data, which in turn aids in the interpretation and reconstruction of past behaviors. Through this project, the value of GIS in archaeology is shown not to be limited to displaying what is already known in an interactive medium, but in the ability to use GIS to uncover previously unobserved patterns or correlations that reveal past behaviors at the site.

Visualization

Visualization refers to the illustration and map-making capabilities of GIS (Ebert 2004). For the Presidio Chapel, this initial visualization stage focused on the creation of a base-map layer with a feature

Figure 2. Presidio base-map imagery covering the extent of the Chapel Complex Project overlaid with a 5 x 5 ft. digital excavation grid.

class identifying the architectural outline of the excavated Chapel area, including rooms and various features, and the construction of an excavation grid layer.

Using ESRI ArcMap v.10 software, visualization began with the importing of satellite areal base-map imagery available from ESRI, in which the faint outline of the architectural features can be seen in the contemporary Presidio Park. Before importing maps, we created a digital grid overlay layer to correspond with the grid used during 1965-1976 excavations. Using the "create vector grid" tool downloaded from Hawth's Analysis Tools for ArcGIS at spatialecology.com, we created a virtual excavation grid consisting of 5 x 5 ft. units covering the extent of the Chapel Complex Project archaeological site (Figure 2). Using Richard Carrico's burial location map from Howard's 1975 thesis on the Presidio Chapel excavations (Howard 1975:96), and a collaborating student field journal (Myers 1970), we were able to determine the location of the datum point used for the Chapel excavations. As was done during the excavations, all other grid units were determined in North, South, East, and West designations based on the North 0, West 0 datum.

The areal data is limited in detail, and creating a base-map based solely on these data would be a drastic oversimplification. Ideally, we would have used a floor plan of the Presidio Chapel, but, as discussed above, a detailed official floor plan had never been created. The situation was further complicated because most available maps were partial excavation maps drawn in the field, focusing on discrete sections of the Chapel. A few nearly complete Chapel maps were found, but these were vague and idealized to present the focus material. Overall, the collection of available research maps for the

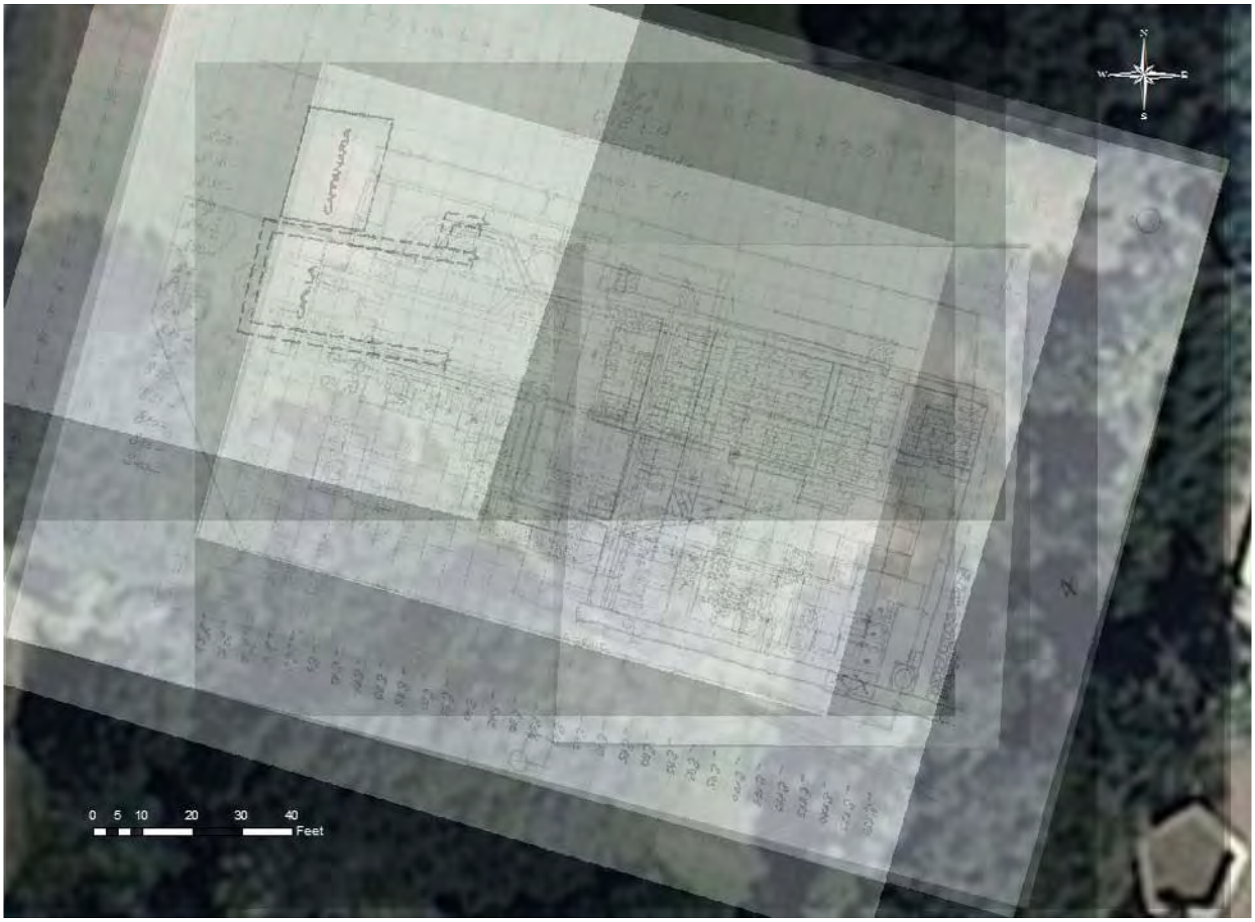

Figure 3. A composite of six idealized Chapel plans overlaid directly above the Presidio base-map imagery.

Chapel was fragmented and did not effectively reflect feature locations. To remedy this problem, we overlaid various excavation maps and areal imagery to create an aggregate map representing what was beneath the soil (Figure 3). The excavation maps used to create a composite map of the chapel site were taken from the student archaeological field journals, reports, and other San Diego Presidio excavation notes (Barbolla 1993; Colston 1982; Howard 1975; Lister 1969; Loughlin 1972; Myers 1970).

The discernible features in the base-map were used as a rough guide to import and georeference the various rectified excavation maps. Using the datum as a georeference collaboration point, we were able to conglomerate a series of maps to create what we believe to be a floor plan most accurately reflecting the Chapel rooms and walls as they lay when excavated (Figure 4). The final floor plan was created as a feature for use in later steps where spatial queries could contrast burial and artifact distribution with architectural feature location.

Having created an acceptable floor plan, we then turned to the reconstruction of excavation levels. Using Light Detection and Ranging (LIDAR) data downloaded from the United States Geological Survey (USGS) (United States Geological Survey 2011), we populated each unit within our digital excavation grid with surface elevation data. With the elevation data in place, the individual grid units had unique x, y, z designations for the entire surface layer. The 1965-1976 archaeological excavations undertaken at the Chapel followed a method of arbitrary 6 in. excavation levels to a depth of 78 in. To reflect this method, we created 13 duplicate digital excavation grids with elevation data that decreased by increments of 6 in. In doing this, we effectively created an excavation model that could be linked to

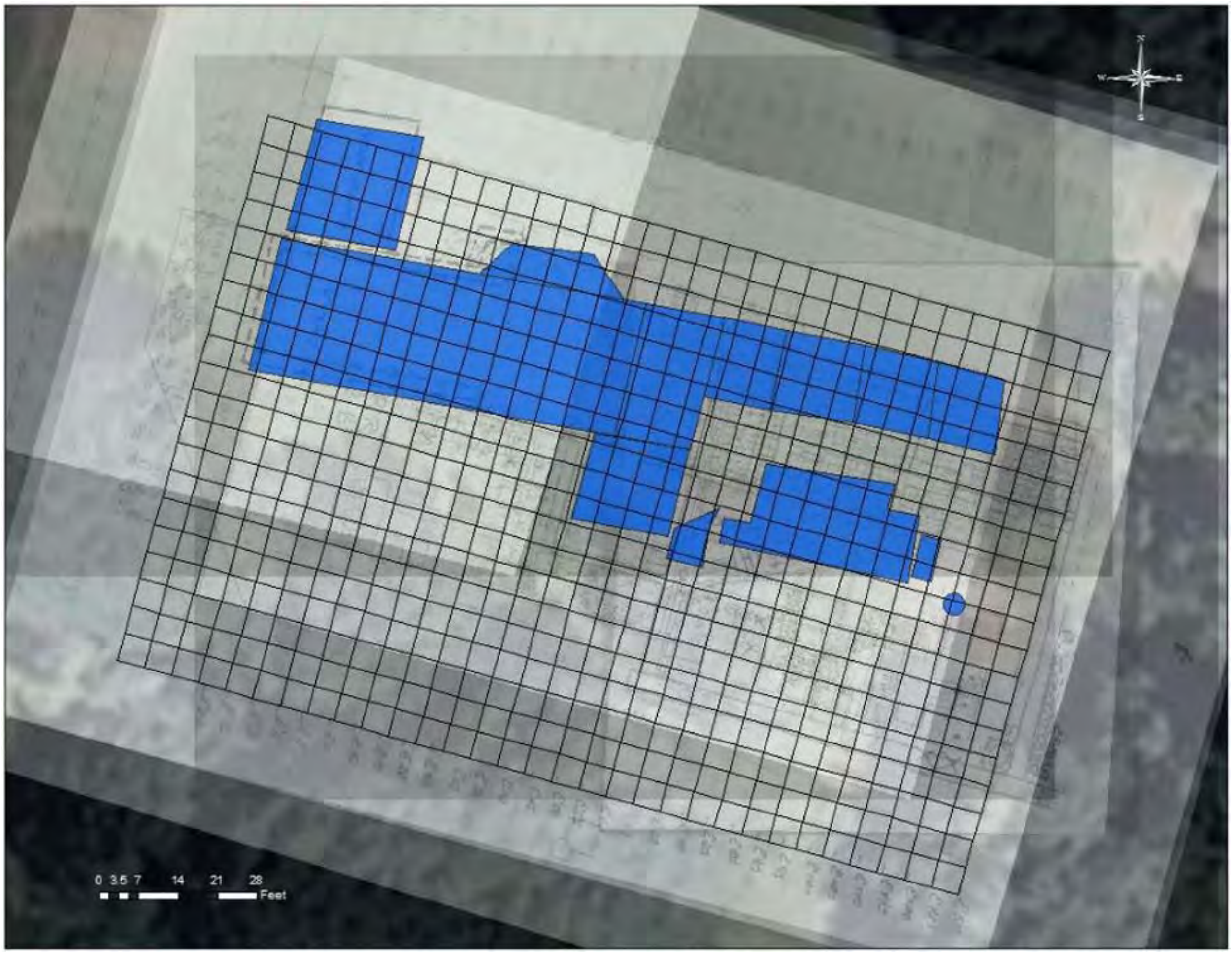

Figure 4. Using the composite maps, a floor plan feature (highlighted in blue) was created to reflect the excavated rooms of the Presidio Chapel.

artifact catalogs and populated by corresponding artifact information based on unit and level (depth). With the visual site skeleton complete, we advanced to the management stage where the units were populated with attribute information and basic experimental queries could be explored.

Management

The data used for the management phase also came from student archaeological field journals, student reports, site records, and field notes from the project dated between the years 1965 and 1976. The physical artifact collection and digital catalog, which includes the Access and Excel inventory list of the San Diego Presidio Chapel Complex, were made available through SDSU's Collections Management Department (Pham and Sanchez 2011). The non-archaeological GIS data sets, such as the base map and LIDAR, were obtained from ESRI, San Diego Association of Governments (SANDAG), and the United States Geological Survey (USGS). All GIS data sets and information pertaining to the project were converted into compatible formats and imported into the Presidio geodatabase.

Beginning with this mass data, we created artifact tables organized by excavation level. With the data stored and organized in a geodatabase, we could then preform a "one-to-many relationship," linking the artifact tables with the corresponding unit and level in the excavation grid. In doing this, we effectively linked the attribute tables of our excavation grids to the artifact database, allowing for the display of all artifact information within a defined unit within any of the 13 excavation levels. The "one-

Figure 5. Native American Burial locations depicted by level. The spatial distribution as indicated by the different colored squares, illustrates that Native American burials were located outside of the Chapel.

to-many relationship" allowed for the single-unit spatial data to be linked to multiple artifacts from the corresponding artifact table, an essential framework characteristic for later querying and analysis capabilities. GIS thus provides the necessary methodological tools for facilitating both a comprehensive visualization of the Royal Presidio excavations, and for managing a robust catalog of artifacts and information within a single database (Williams 2004).

Analysis

With a basic 2-D stratigraphic site reconstruction, we were able to perform spatial queries based on attribute characteristics, location, and depth. Even at this level of analysis, because of the unique composition of the site model, detailed insights could be gleaned from various basic queries. For example, a basic query could be run to display all known Native American burials that occurred at the site over time. The map legend helps to communicate the temporal element by identifying the various levels in which the burials occur, while the map indicates their locations. Furthermore, the spatial distribution illustrated through this query shows us that no Native American burials occurred within the Chapel itself (Figure 5). While other maps and journals indicate that multiple individuals were found buried under the floors of the Chapel, the insights provided by the GIS display suggest that these individuals were of European descent. It can be assumed that the Native Americans buried on the church grounds were converted Christians, but this map tells us that there were still limitations on where these Christianized Native Americans could be interred (Larkin 1968). This provides important insights not only into past behaviors, but also into past ideologies, details of social organization, and issues of inequality. These subject matters are often the focus of archaeological investigations, yet they are also some of the most difficult cultural aspects to recover from the physical archaeological record. Obviously this phenomenon requires further research and investigation before any conclusions are made regarding the burial restrictions of Christianized Native Americans and the San Diego Presidio. The value of the GIS model, however, is in its ability to display the data in a way that these phenomena can initially be recognized. In this way, the model should be seen as a catalyst for displaying patterns, generating questions, and facilitating further research.

This GIS model also allows for the simultaneous investigation of multiple variables and their relation to each other. The above example explicates how GIS can be utilized to uncover and display burial information, but the applicability does not end there. The Native American Graves Protection and Repatriation Act (NAGPRA) requires that all artifacts associated with Native American burials be subject to repatriation (Fagan 2006). Because the Presidio Chapel excavation was completed before the implementation of NAGPRA, many sensitive artifacts may not be stored or labeled appropriately as burial goods. The GIS model, however, facilitates a solution to this problem through its ability to query multiple variables. In this case, a simple query can be constructed to display units where a particular artifact type (or all artifacts) *and* a Native American burial are located. This facilitates a more efficient repatriation process by quickly displaying all units and levels in which artifacts are associated with Native American remains. Since the digital artifact catalog is linked directly to the spatial model, the query can also display the corresponding artifact catalog information in tabular form. With a few carefully designed queries, one can display all units, levels, and associated artifacts subject to further investigation of repatriation eligibility. By exporting previous selection queries as new, individual layers, one can then run multiple queries to determine correlations between the various artifacts being investigated.

Similarly, queries can also be created to display which artifacts are found within discrete features of the chapel. Using ArcCatalog 10, shapefiles were created to represent individual rooms within the chapel (Room A, Room 1, Sacristy, etc.). The creation of these shapefiles provides the user the ability to query various attributes of the data within different rooms. For example, locations of religious medallions can be identified within specific locations within the chapel, such as the nave (Figure 6). However, the ability to locate artifacts within specific rooms is somewhat restricted by the room features' idealized nature; the shapefile polygons were drawn by referencing composite sketches created during the excavation of the Presidio Chapel. An improvement to the efficacy of this search query would be to create additional features representing structures such as the chapel walls, cemetery boundaries and other pertinent spatial attributes that can aid in displaying associations between artifacts and features within the chapel complex.

Where applicable, queries can also be designed to display artifact density data. Choropleth maps, where values are displayed with a corresponding symbol or color, are valuable analytical maps that are currently underutilized in archaeology. Continuing with the previous example, queries can easily display burial density per unit. The resulting choropleth map not only illustrates units with burials, but how many burials were recorded in each unit (Figure 7). This information better displays information regarding burial-intensive areas, and possible cemetery locations, than the previous basic queries. For example, the burial-density choropleth map clearly shows two distinct burial areas: one inside the Chapel, east of the small apse, and another exterior to the Chapel, south of the central nave. The distinction between burials within and exterior to the Chapel is notable. The spatial location and singular nature of the burials within the Chapel supports the notion that these were important elite individuals. This is corroborated by historical documents that indicate that it "once was common practice to bury outstanding persons in a church" (Larkin 1968:8). While the choropleth map is useful in indicating heavily utilized burial areas, it is equally important in its ability to depict areas devoid of burials. Based on individual research questions,

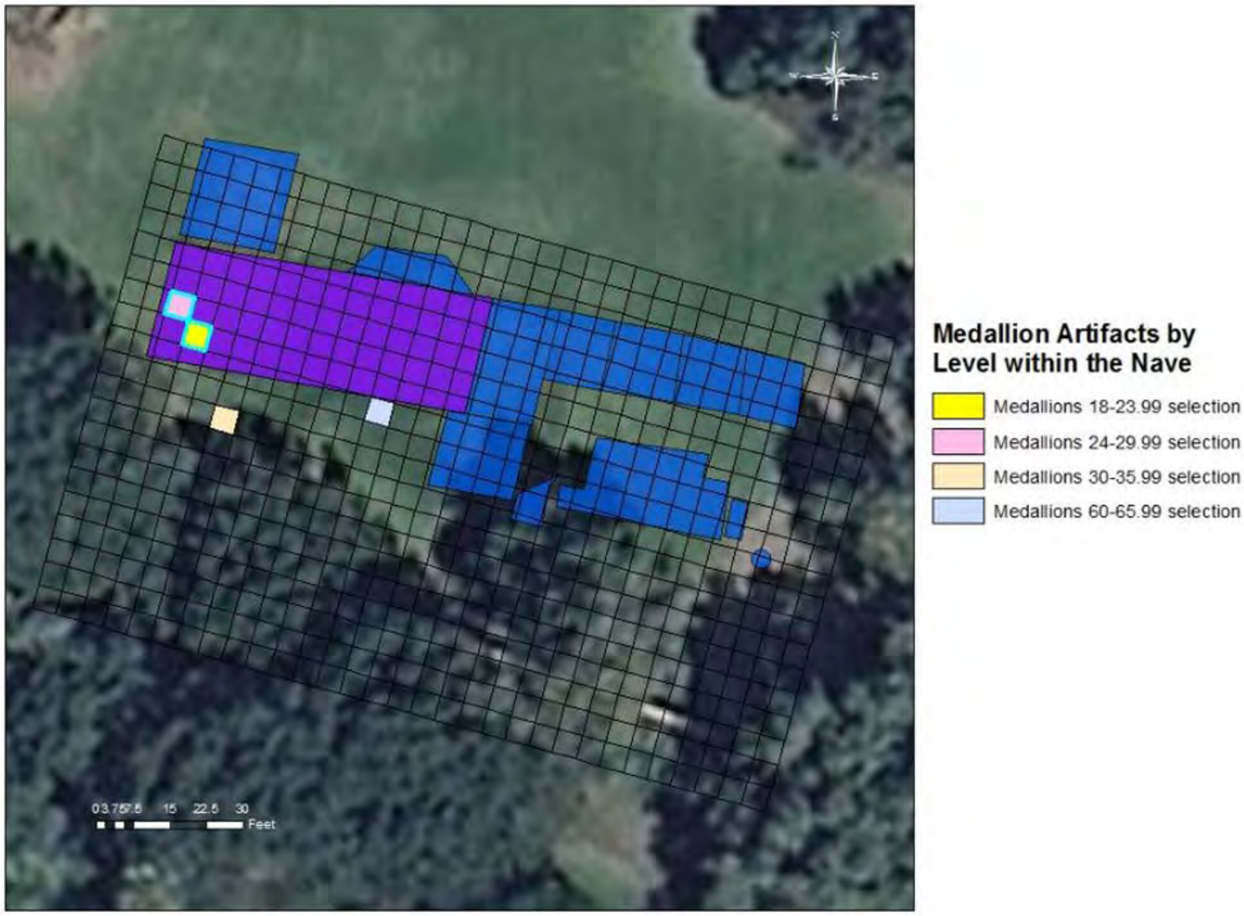

Figure 6. Medallion artifacts by level (highlighted in light blue), located within the Chapel's nave (highlighted in purple).

this map could greatly aide in the determination of future excavation sites that would be less likely to disturb human remains.

While the choropleth map helps to display the relative density of artifact distribution, it does very little to help the reader understand temporal aspects and artifact relationships. In fact, the limited ability to identify temporal associations between artifacts is a major limitation of 2-D maps in archaeological analysis (Harris and Lock 1996). One way to visually represent artifacts in both temporal and spatial dimensions is through the construction of 3-D map displays.

Utilizing ESRI ArcScene software, we were able to virtually reconstruct the arbitrary 6 in. levels with the corresponding units and associated artifacts in three dimensions. Using elevation markers obtained from the LIDAR data, we recreated the excavation levels corresponding to actual elevation data (Figure 8). At this point, basic queries could again be run to determine both spatial and chronological associations that were not visible in the 2-D map displays (Figure 9).

Choropleth maps, similar to those created in 2-D, can also be constructed in 3-D. When utilizing burial information, the result is an informative map depicting the relative density of burials in relation to other cells in both areal and depositional dimensions. While informative, this 3-D density map is still an abstraction (Figure 10). The exact location of the burials within units cannot be inferred from the GIS data.

Some of the limitations of the 3-D burial density model can be overcome by focusing on select attributes. After conducting definition queries on the burial data, we created distinct layers from the

Figure 7. Choropleth map depicting burial density per unit.

resulting selection. We then used the tool "Feature to 3-D Attribute" on these layers. Using these selected layers as inputs, we created 3-D-compatible shapefiles which were then imported into ArcScene. The result is a 3-D model that overcame the previous visual limitations while maintaining the informative characteristics and manipulability of the preceding 2-D model. The attribute outputs were extruded to give the illusion of stacked units and draped over Presidio LIDAR data to provide a base elevation reference (Figure 11). This 3-D representation allows for a more accurate reconstruction of the excavation site and provides better visualizations of provenience, depth, and spatial relationships, as well as heterogeneity between attributes and queries. Overall, the resulting 3-D model provides an interactive framework capable of spatially illustrating detailed aspects of the Presidio Chapel Complex Project's collection at SDSU.

DISCUSSION

The performance of various 2-D and 3-D spatial analyses demonstrates the value of GIS in this archaeological investigation. Beginning with the creation of a more accurate floor plan, we were able to determine the location and depth of burials and various artifact types. Queries displayed select attributes and allowed for the juxtaposition of numerous variables. The overall flexibility of the graphic display

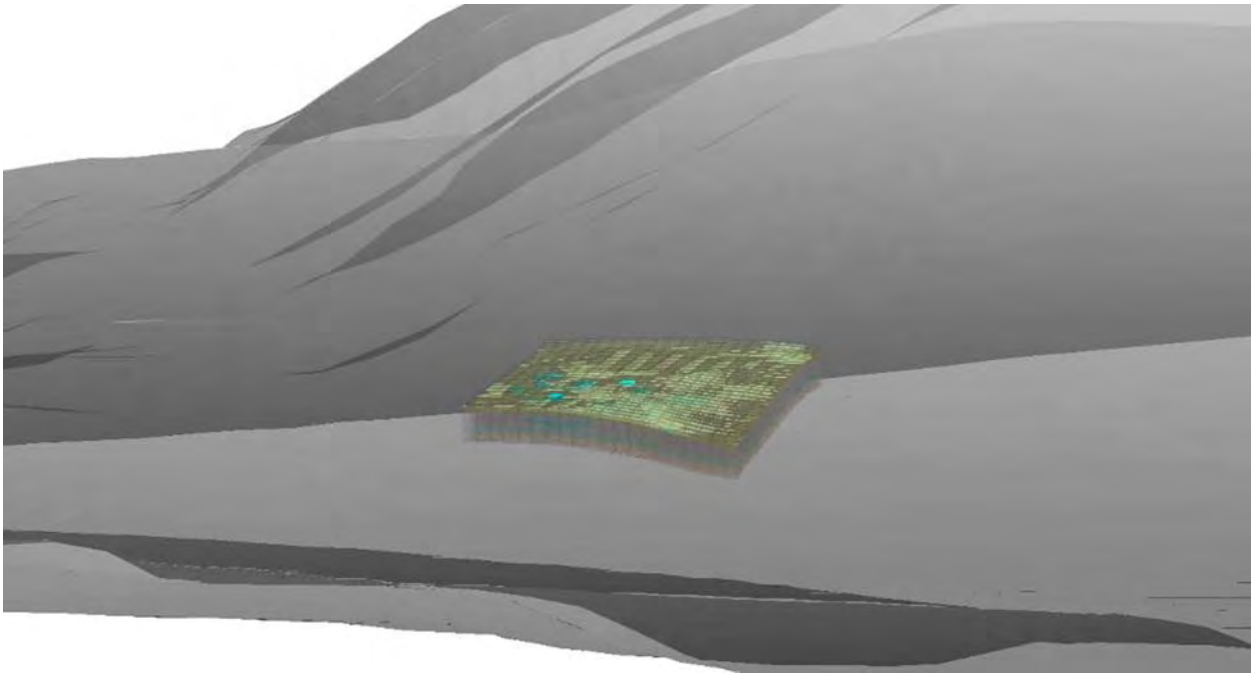

Figure 8. Excavation levels draped over LIDAR elevation data.

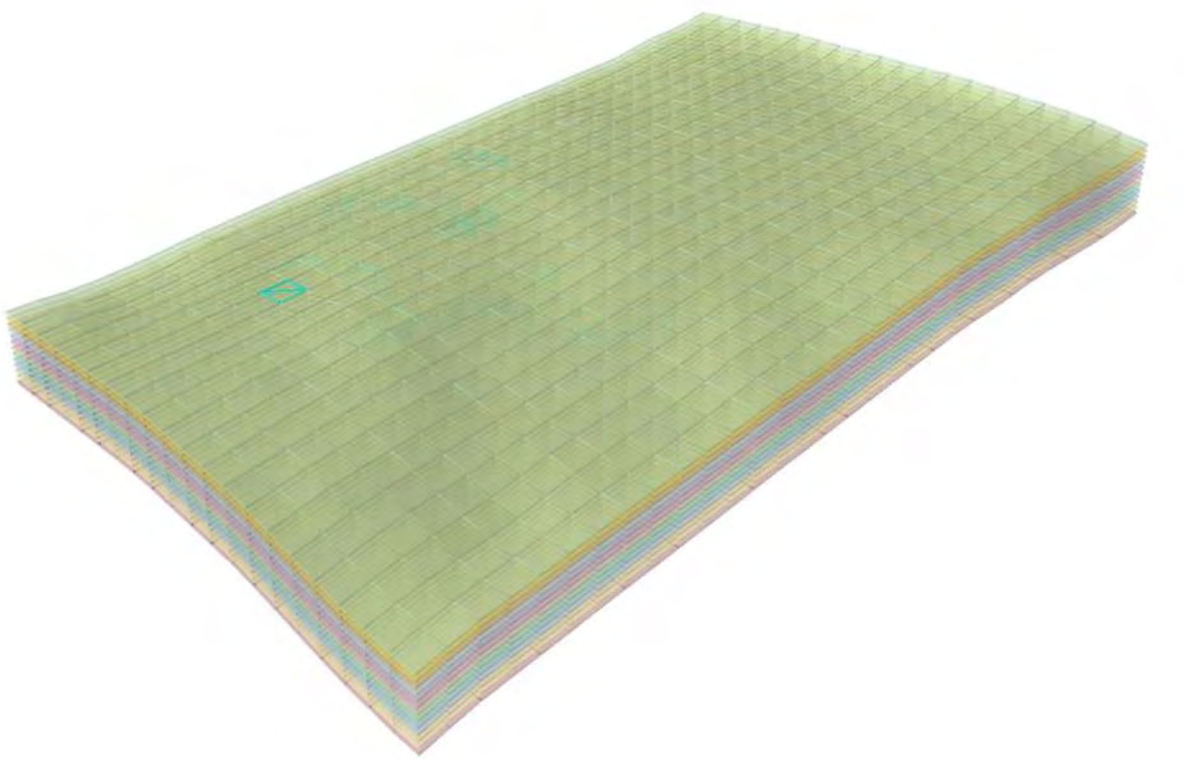

Figure 9. 3-D model of the Presidio excavation grid highlighting the spatial and temporal locations of all burial locations within each excavation level.

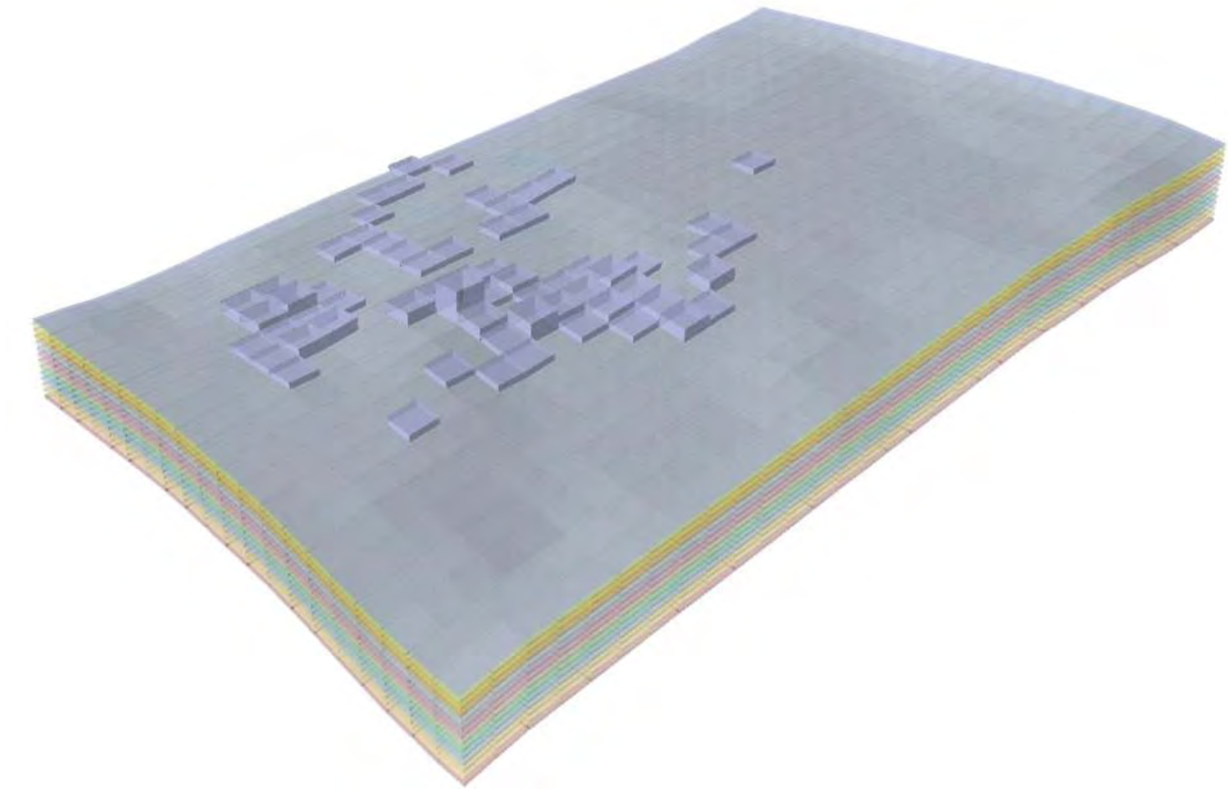

Figure 10. 3-D choropleth map draped over the excavation grid.

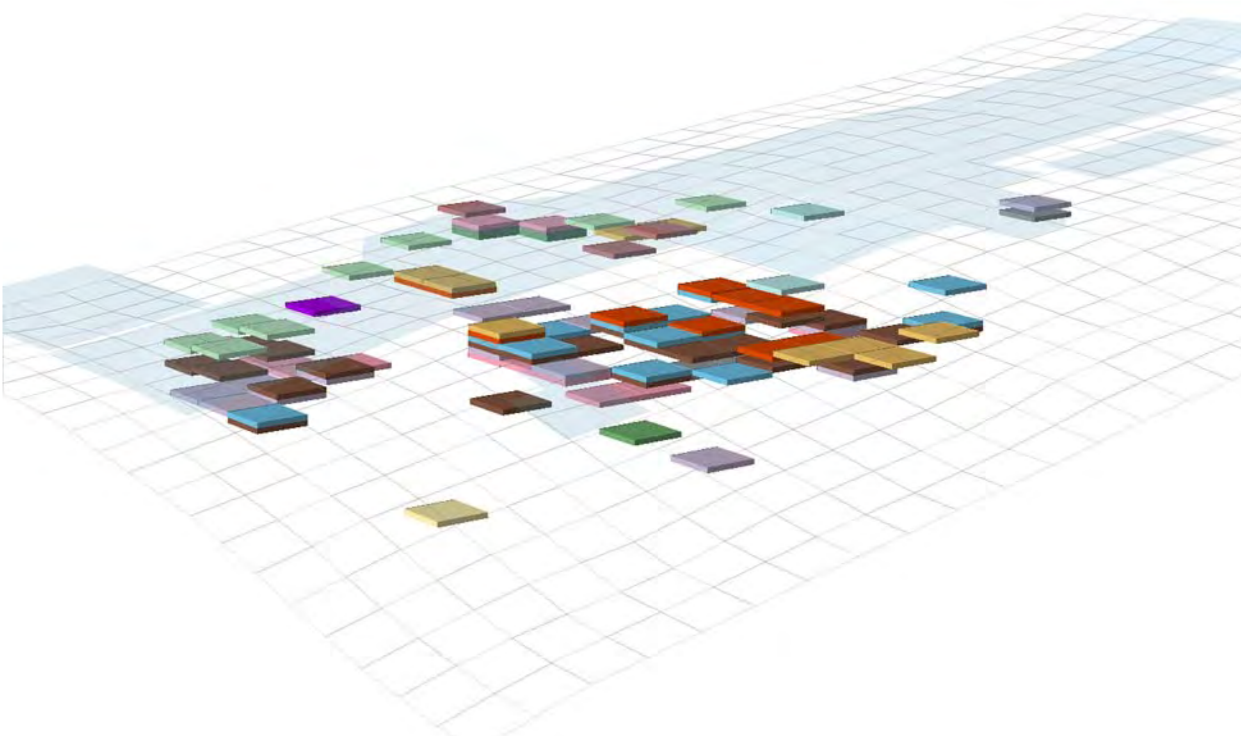

Figure 11. Extruded attributes draped over LIDAR data illustrating the spatial and temporal locations of all burials excavated at the Chapel Complex Project.

allows for a wide range of analyses that help the researcher to recognize distributions, patterns, and associations. Thus, the model proves to be a powerful tool in generating, as well as answering, a wide range of research questions. Overall, this analysis has shown how valuable information can be gleaned from the two- and three-dimensional GIS processes of visualization, management, and analysis of archaeological data.

The potential of this project does not end with a functional site model. The flexibility of the model and the ease of editing GIS data allows for the model to be constantly updated as new information is revealed. While the model is valuable in current and future Presidio Chapel archaeological research, the findings and insights of future studies can be re-incorporated into the GIS model.

Finally, the model illustrates a method for meaningful archaeological research that can be carried out without the physical handling of artifactual material. This is crucial when working with sensitive data, such as human remains, that may be off-limits to physical research or inaccessible due to repatriation. A completely noninvasive and non-destructive technique such as GIS intra-site modeling is, and will continue to be, instrumental in overcoming these barriers to research. Similarly, digital GIS models allow researchers in different areas, without direct access to the site, archaeological material, or catalogs, to access the data. The model we have provided illustrates the ways in which GIS is applicable to archaeology beyond a macro-regional approach. Focusing on data from excavations of the Presidio Chapel that occurred several decades ago, we have demonstrated a potential use of GIS methods in a post-excavation and site-specific context. It is our intent that characteristics such as data organization and manipulation, as well as flexibility and ease of sharing, will allow for the use of this GIS model in future Presidio Chapel research and advance the use of GIS in archaeology in general.

REFERENCES CITED

Barbolla, Diane E.
1993 Alta California Troops: Acculturation and Material Wealth in a Presidio and Mission Context, 1769-1810. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Riverside.

Beddow, Donna
1999 Site Inventory Report: SDI-0038, CAL E 4:14, SDSU-0400 Site Inventory Report. Manuscript on file, San Diego State University Collections Management Program, San Diego State University.

Brockington, Donald L., and Ray Brandes
1965 The First Season's Work at the "Silent City": A Preliminary Report to the Membership on the Archaeological and Historical Investigations at the Royal Presidio of San Diego. *Journal of San Diego History* 11(4).

Colston, Stephen A. (editor)
1982 Approaches to Historical Archaeology: The Case of the Royal Presidio of San Diego. Manuscript on file, San Diego History Research Center, San Diego State University.

Craig, Nathan, and Mark Aldenderfer
2003 Preliminary Stages in the Development of a Real-Time Digital Data Recording System for Archaeological Excavation using ArcView GIS 3.1. *Journal of GIS in Archaeology* 1:11-22.

Ebert, David
2004 Applications of Archaeological GIS. *Canadian Journal of Archaeology* 28:319-341.

Ezell, Greta, and Paul Ezell
1986 Vallejo's Plan of the San Diego Presidio. *Journal of San Diego History* 32(3):193.

Ezell, Paul
1976 The Excavation Program at the San Diego Presidio. *The Journal of San Diego History* 22(4):1-20.

Fagan, Brian M.
2006 *Archaeology: A Brief Introduction*. Pearson Education, Upper Saddle River, New Jersey.

Harris, Trevor M., and Gary R. Lock
1996 Multi-dimensional GIS: Exploratory Approaches to Spatial and Temporal Relationships within Archaeological Stratigraphy. In *Interfacing the Past: Computer Applications and Quantitative Methods in Archaeology*, edited by H. Kamermans and K. Fennema, pp. 307-316. Analecta Praehistorica Leindensia, Vol. 28, No.2. Leiden University Press, Leiden, Netherlands.

Howard, Jeffrey A.
1975 Description of Human Remains from the Presidio, San Diego. Unpublished Master's thesis, Department of Anthropology, San Diego State University.

Larkin, Rita.
1968 A Landscape of the Past: The Story of the Royal Presidio Excavations. *Journal of San Diego History* 4(4):1-13.

Lister, Boyd W.
1969 Excavation of Site CAL E 4:14 Archaeological Field Methods Spring 1969. Manuscript on file, San Diego State University Collections Management Program, San Diego State University.

Loughlin, Barbara
1972 Excavation of Site CAL E 4:14 Archaeological Field Methods Spring 1972. Manuscript on file, San Diego State University Collections Management Program, San Diego State University.

Mallios, Seth, Hillary Sweeney, David Caterino, Jamie Lennox, Destiny Larberg, Scott Mattingly, and David Lewis
2008 The Whaley House Historical Archaeology Project: Archaeological Excavations at the Whaley House in San Diego, California, an Interim Technical Report for the 2007 Field Season. Manuscript on file, Department of Anthropology, San Diego State University.

McCoy, Mark D., and Thegn N. Ladefoged
2009 New Developments in the Use of Spatial Technology in Archaeology. *Journal of Archaeological Research* 17:263-295.

Moyes, Holley
2002 The Use of GIS in the Spatial Analysis of an Archaeological Cave Site. *Journal of Cave and Karst Studies* 64(1):9-16.

Myers, Beverly A.
1970 Excavation of Site CAL E 4:14 Archaeological Field Methods Spring 1970. Manuscript on file, San Diego State University Collections Management Program, San Diego State University.

Pham, Angela, and Lourdes Sanchez
2011 Site Report: SDI-0038, SDSU-0400, San Diego Presidio CAL E 4:14. Manuscript on file, San Diego State University Collections Management Program, San Diego State University.

United States Geological Survey
2011 USGS Center for LIDAR Information Coordination and Knowledge. Electronic document, http://lidar.cr.usgs.gov/, accessed January 15, 2011.

Wheatley, David, and Mark Gillings
2002 *Spatial Technology and Archaeology: The Archaeological Applications of GIS*. Taylor and Francis, New York.

Williams, Jack S.
2004 San Diego Presidio: A Vanished Military Community of Upper California. *Historical Archaeology* 38(3):121-134.