Development and Automation of an Interactive, Multi-scale, Image-based Commercial Real Estate Application for Use on the Internet

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Development and Automation of an Interactive, Multi-scale, Image-based Commercial Real Estate Application for Use on the Internet

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# Table of Contents

Executive Summary ................................................................................................................. iv  
1.0 Introduction ......................................................................................................................... 1  
    1.1 Overview of Company .................................................................................................... 1  
    1.2 The ARC Partnership .................................................................................................. 1  
2.0 Project Implementation ....................................................................................................... 2  
    2.1 Goals and Objectives.................................................................................................... 2  
    2.2 ARC Project ................................................................................................................ 2  
3.0 Data Acquisition and Processing......................................................................................... 3  
    3.1 Satellite Imagery ........................................................................................................ 3  
    3.2 Real Estate Index Data ............................................................................................... 4  
    3.3 Geographic and Socioeconomic Data ........................................................................ 5  
4.0 Application Development ................................................................................................... 5  
    4.1 LoCRE Web Application ............................................................................................ 5  
    4.2 LoCRE Desktop Application ...................................................................................... 9  
5.0 Results ............................................................................................................................... 12  
6.0 Conclusion ......................................................................................................................... 12  
7.0 Bibliography ...................................................................................................................... 13  

# Figures

Figure 1. Locator of Commercial Real Estate (LoCRE) Version 1.0 application banner. ....... 3  
Figure 2. 1993 Landsat image for a multi-county area in New Mexico................................. 4  
Figure 3. Geocoded industrial, retail, and office sites in the Albuquerque metro area. .......... 7  
Figure 4. Example of Retail Data base Query form. ............................................................... 8  
Figure 5. Example of sites meeting the retail search criteria. ............................................... 8  
Figure 6. Example of change detection—building footprints in blue are existing and  
        building footprints in gold were constructed between 1996 and 1998.......................... 10  
Figure 7. Regional image of Albuquerque acquired by Landsat Thematic Mapper in 1993. . 11
Executive Summary

Building Interests, Inc.; its subsidiary, Commercial Real Estate Index (CREI) Research; and Planning Technologies, LLC, have formed a partnership with the Earth Data Analysis Center at the University of New Mexico, an Affiliated Research Center (ARC) for the National Aeronautics and Space Administration. As a result of this ARC contract, the project partners have developed an Internet-based mapping and analysis prototype application. This interactive, multi-scale, image-based commercial real estate application is an integration of a commercial real estate data base with multi-scaled imagery and other sources of geographic, demographic, and economic data. Key features of the Internet application include interactive, dynamic mapping and customized querying and reporting capabilities.

The project team designed and developed a two-part prototype application, Locator of Commercial Real Estate (LoCRE Version 1.0), that includes 1) a web-based application to pique the interest of Internet clientele, and 2) a more robust PC application to be used for consulting with clients at Building Interests’ Headquarters Office. The application was developed using state-of-the-art tools: image processing was performed on ERDAS; images were compressed with MrSID (a registered trademark of LizardTech, Inc.); and geospatial analysis and mapping were done using ArcView™ and Internet Map Server™ technology. The programming was completed using a combination of Avenue™ and Visual Basic™.

The LoCRE includes the collection, integration, and unification of disparate data sets, including the CREI Research proprietary data base containing commercial real estate and other geographic data, such as the Middle Rio Grande Council of Governments socioeconomic data sets, and multi-resolution imagery. The Internet-based application has a dual focus: 1) on the development of specialized query and reporting tools to select sites of interest from the data base and to automatically generate summary information; and 2) on the development of query tools to allow users to interactively map sites of interest in response to spatial and non-spatial queries using multi-resolution imagery.

Landsat Thematic Mapper™ imagery provides a regional picture of Albuquerque and the surrounding urban areas, including areas of high growth, and those sectors proposed for commercial development. Clearly illustrating specific buildings and their spatial relationships to open space and urban infrastructure is an important feature to real estate clients. One important component of the CREI Research Map prototype application is the ability to view change in areas of development. Identifying changes and trends within the city, in the urban infill, and at the urban fringe will benefit commercial real estate leasing and development plans. Based on this prototype, the classification of high-resolution multispectral imagery (1998 Airborne Terrestrial Applications Sensor and 1996 digital orthophotography) for identification of open space and for determining recent changes was highly effective in the rapidly growing areas of Albuquerque.

The project team produced a prototype Internet application utilizing remote sensing and geographic information system tools, such as Internet Map Server, to relate and display real estate data over the Web, as well as a more robust application for person-to-person real estate
query, mapping, and analysis. A beta version of the prototype application is expected to be available to users for field testing by February 2000. Currently, Building Interests, Inc., is developing a business plan and seeking additional funding sources to launch the LoCRE Version 1.0 application.
1.0 Introduction

1.1 Overview of Company

Building Interests, Inc., and its subsidiary, Commercial Real Estate Index (CREI) Research, are major stakeholders in the real estate arena in New Mexico. CREI Research was founded in 1997 to promote the exchange of information between real estate professionals and to report locally on commercial real estate trends with in-depth analysis and clarity. CREI Research publishes quarterly reports on commercial real estate activity in the Albuquerque metropolitan area, specifically for three sectors: retail, industrial, and office markets. This hardcopy report covers recent and historical trends in the local marketplace. The company also maintains a proprietary data base of commercial real estate space. Subscriptions provide the funding for the data base and report operations. Recently, the company began distributing the data base on CD-ROM.

Building Interests is partnering with Planning Technologies, LLC, for future maintenance of the application and software upgrades as needed. Planning Technologies specializes in the application of advanced technologies on behalf of urban planning, transportation planning, and economic development. Planning Technologies is expert in the use of geographic information systems (GIS), which provide planners, analysts, and managers with the ability to analyze data spatially. The essence of urban planning, transportation planning, real estate, and economic development is geographical. Therefore, it makes sense that the next evolution of the technology will incorporate imagery. Analysts who make use of imagery with geographic tools to investigate their environment work faster, can work smarter, and communicate more effectively.

1.2 The ARC Partnership

Building Interests, Inc., CREI Research, and Planning Technologies, LLC, are partners with the NASA Affiliated Research Center (ARC) at the Earth Data Analysis Center (EDAC), University of New Mexico. The partners have joined forces to construct an Internet-based mapping and analysis application that will effect several technological advances for exchanging information between real estate professionals by integration of a commercial real estate data base with multi-scaled imagery and other sources of geographic, demographic, and economic data. Key features of this Internet prototypical application include interactive, dynamic mapping and customized querying and reporting capabilities. The application will incorporate multi-resolution imagery, CREI Research’s proprietary data base, and other sources of demographic and socioeconomic information.

The goal of the ARC partnership was to assist Building Interests and CREI Research in stimulating a paradigm shift in their respective professional environments by making use of spatial technology in a Web-based application and by commercializing the results of the project. Once developed, Building Interests can take the application to other cities with minimal modification.
2.0 Project Implementation

Building Interests, CREI Research, and EDAC adopted a work plan for completion of the prototype before the end of 1999. A team including Bruce Marvick from Building Interests, Inc., David Laney from CREI Research, and Noreen Breeding (primary programmer) and Shirley Baros (GIS Program Manager) from EDAC identified and researched data sources, programming design, and production schedules. Building on extensive GIS experience, the project team designed a two-part application: the Web-based component was designed to pique the interest of Internet clientele, whereas the more robust desktop application was developed for person-to-person consulting with clients at Building Interests’ Headquarters Office. Throughout the project, the programming team met every two weeks with other project partners to refine this prototypical application. A knowledgeable technical group comprising staff from EDAC, CREI Research, and Planning Technologies made valuable recommendations and reviewed the prototype.

2.1 Goals and Objectives

The goal of the ARC partnership project was for Building Interests and its subsidiary, CREI Research, to develop the pertinent spatial technology and then to make the technology available to their respective professional environments through innovative Web-based and Internet-accessible applications. To achieve this goal, a prototype application called Locator of Commercial Real Estate (LoCRE) was developed. The first of two objectives was to develop a Web-based application with limited query and search capability; the second objective was to develop a fully functional PC desktop application. ArcView™ software by Environmental Systems Research Institute (ESRI) was selected. ArcView enables creation of spatial data and allows display, query, and spatial analysis in a Windows-type environment. The software can also be customized with its internal programming language and other software, such as Visual Basic, to perform predefined functions so that the user need not be an expert in operating ArcView. An ArcView enhancement, the Internet Map Server, allows maps displayed in ArcView to be served to the Internet.

2.2 ARC Project

State-of-the-art tools were employed to develop the web application. Image processing was performed on ERDAS IMAGINE™. Geospatial analysis and mapping were done using ESRI software, specifically ArcView and Internet Map Server (IMS) technology. Other software components included Microsoft Visual BASIC (vB) and Hypertext Markup Language (HTML).

Prior to designing the application, relevant data were collected, normalized, and integrated. These data included the CREI Research proprietary data base of commercial real estate, the Middle Rio Grande Council of Governments (MRGCOG) socioeconomic data sets, other geographic data, and multi-resolution imagery. The dynamic, web-based application has a dual focus: (1) to develop specialized querying and reporting tools to select sites of interest from the data base and to automatically generate summary information, and (2) to develop query tools that allow users to map sites of interest interactively in response to spatial and
non-spatial queries, using multi-resolution imagery. The desktop application is more robust than the Web version because there is greater access to the GIS tools for query, analysis, and mapping, and there are more detailed data themes. Figure 1 shows the application banner for LoCRE Version 1.0.

Figure 1. Locator of Commercial Real Estate (LoCRE) Version 1.0 application banner.

3.0 Data Acquisition and Processing

3.1 Satellite Imagery

Landsat Thematic Mapper imagery with 30-meter spatial resolution provides a regional picture of the multi-county area in New Mexico (Figure 2). The image provides a geographical perspective for investors unfamiliar with the area. Clearly illustrating specific buildings and their spatial relationships to open space and urban infrastructure is important. Therefore, higher spatial resolution imagery of 1 to 5 meters has been evaluated for building locations and for their relationship to surrounding features. The critical benefit of employing imagery in the prototype is to detect change in areas being developed. Identifying changes and trends within the city, in urban infill, and at the urban fringe benefits commercial real
estate leasing and development plans. To demonstrate this benefit, high-resolution multispectral imagery was interpreted for an area in the northern part of Albuquerque to identify open space and to delineate areas of recent growth. The resulting data were included in the desktop application as a view that can be queried and manipulated so that CREI Research partners can provide an example of how imagery can be processed to detect change in rapid growth areas.

Figure 2. 1993 Landsat image for a multi-county area in New Mexico.

3.2 Real Estate Index Data

CREI Research publishes quarterly reports for the Office, Retail, and Industrial markets in the Albuquerque metropolitan area. The results of a survey conducted with the cooperation of commercial real estate brokers, asset managers, and property owners are posted on the CREI Research website (www.albq-properties.com); the full reports are available in both hard copy and on CD-ROM, allowing multiple search parameters and comparative property reports.
CREI Research market reports are drawn from office buildings throughout the metropolitan area that are 10,000 square feet or larger and are classified as lease properties. Average high and low rents are the average asking rents and are based on a Full Service or Gross Lease structure. Quarterly Absorption is the statistical measurement of change in overall square footage available from quarter to quarter in a building or sub-market; i.e., positive absorption demonstrates that there has been a decline of space available in a particular building or sub-market. Year-to-date Absorption is a longer-range statistical measurement that tracks the change of available square footage from the previous year's fourth quarter to the present quarter. This report demonstrates possible long-term trends and the degree of change. The full reports include building-by-building detail, such as current available space, current asking rental rates, GPS coordinates, building amenities, and the leasing company and agent currently representing the property.

3.3 Geographic and Socioeconomic Data

Geographic and socioeconomic data were obtained from the Bernalillo County Public Works Department. The geographic data include street centerline network with address ranges, public utilities, traffic volumes, parcels, land use, and other businesses. On December 16, 1999, the Public Service Company of New Mexico provided geographic data for electric and gas distribution lines for the fast growth sample area. This sample area is along Jefferson Street from I-25 to Alameda Blvd. The electric and gas layers were obtained from Public Service Company of New Mexico on December 16, 1999.

4.0 Application Development

The LoCRE prototype enables query, display, and analysis of CREI Research data via the web and a desktop application. One of the most significant accomplishments of the LoCRE application is the ability to map and preview the real estate data with imagery over the web.

4.1 LoCRE Web Application

ArcView software was selected as a custom package for the LoCRE Web application. This software enables creation of spatial data and allows display, query, and spatial analysis in a Windows-type environment. ArcView can also be customized using Visual Basic to perform predefined functions so that the user need not be expert at operating ArcView. An ArcView enhancement, the Internet Map Server, allows maps to be served to the Internet.

The first step in the project was to create spatial data sets of points for all sites recorded in the three real estate data bases: industrial, retail, and office. These data sets were created in ArcView by means of geocoding – also called address matching – whereby addresses contained in a single field in a data base are matched record-by-record against an existing spatial data set containing individual addresses or address ranges along streets. A point is created for each matching record, and the data base is attached to the new spatial data set. The data set for Bernalillo County local streets was used as the base for geocoding.
The next step was to display the real estate points in relation to spatial data pertinent to the real estate selection process, such as streets, utilities, traffic volumes, parcels, land use, and other businesses (Figure 3). Most of these data, except for the satellite images, were obtained from the Bernalillo County Public Works Department. The data were assembled by theme into several ArcView views. “View1” is dedicated to Internet service and contains the layers needed for the Internet maps, such as points for the real estate sites, major roads, local streets, parcels, land use, a 5-meter satellite image, and airports. All of the themes, except the real estate sites, are scaled; that is, they are set to show at a certain maximum scale so that they will not display until the user zooms in to an individual site. This scaling was done to avoid cluttering the display and to ensure the fastest display time.

Once View1 has been created, the Internet page can be constructed. The page consists of two frames: one for the map and one for the real estate data base query form and query results. ArcView IMS is employed as the link between ArcView and the Internet. IMS exists in four different configurations, only one of which can be used at a time, and is compatible with Microsoft™ browsers or with Netscape®. IMS comes with a ready-to-use Java applet but can be used without the applet by writing Avenue scripts and HTML code. Avenue is the object-oriented programming language native to ArcView. For this project, it was decided to bypass the applet and write Avenue code aimed at the Microsoft browsers.

Sample scripts provided in ArcView Help Contents were modified to display maps. The maps on the Internet are basically .jpg images of View1 from the ArcView project. The image itself serves as the “submit” button for an HTML form that operates the radio buttons for the functions pan, zoom in, zoom out, full extent, and identify. Clicking on the map sends a URL to ArcView that is parsed by an Avenue script. The script that performs the required action is activated and sent the coordinates for the map extent. A series of scripts executes the desired actions on View1 in ArcView; then a new .jpg is created from the view and is sent to the Internet within an HTML form.

The query form is an HTML document sent to the server by ArcView. Queries are performed using Avenue scripts that also write HTML code to display the results. The design of these result displays is based on the displays contained on the CD-ROM that CREI Research publishes for its customers.
Figure 3. Geocoded industrial, retail, and office sites in the Albuquerque metro area.

Figure 4 is an example of a query performed on the retail database within the LoCRE application. On the Retail Database Query form, the user is prompted to enter parameters, such as center name, market area, available square feet, low rental, or high rental information. The result of the query, as shown in Figure 5, provides the user with detailed information on the retail locations.
Figure 4. Example of Retail Database Query form.

Figure 5. Example of sites meeting the retail search criteria.
A button was added to the standard ArcView graphical user interface (GUI) to allow the user to maintain the ArcView project without outside assistance. Real estate databases are updated quarterly, and this new button automatically geocodes a new real estate database and adds it to View1 as a point theme. For the automatic process to work, the data must be in a .dbf format that contains specific fields with specific names. The data in the fields must also be formatted to meet prescribed guidelines for decimal precision and consistency. The final requirement for the Internet application is that the pictures be in a .jpg format and that they correspond to each building and its identification code.

4.2 LoCRE Desktop Application

The LoCRE desktop application consists of geographic data, imagery, and tabular data that are assembled by theme into seven ArcView “views.” As described in Section 1.1, “View1” is dedicated to Internet service and contains the layers needed for the Internet maps. The other views have been constructed for use within the desktop version of LoCRE and are titled “Composite View,” “Infrastructure,” “Land Use,” “Regional,” “Socio-economic and Demographic by DAZ,” “Traffic Counts,” and “Change Detection.”

“Infrastructure” shows the street centerline network, railroads, water lines, sewer lines, storm lines and drains, drainage for the entire county, and electric and gas distribution lines for the fast-growth sample area. This sample area is along Jefferson Street from I-25 to Alameda Boulevard. The electric and gas layers were obtained from Public Service Company of New Mexico on December 16, 1999.

For the sample area, the “Change Detection” view provides the client with an example of image interpretation of change over time. Two images covering the area of interest in north Albuquerque were used in the change analysis. This of Albuquerque is subject to expansion and in the last several years has changed from being relatively undeveloped to being largely occupied with industrial sites, warehouses, and business complexes. One of the images was from a U.S. Geological Service Digital Orthophoto Quad (DOQ) acquired in October 1996. This 3-meter spatial resolution image was reprojected to State Plane Projection, Zone 4751, 1983 North American Datum, 1980 Geodetic Reference Spheroid. The other image was from an aerial photo acquired from Stennis Space Center as part of an Airborne Terrestrial Applications Sensor overflight in October 1998. The Stennis image was ortho-corrected to the same projection and spatial resolution as the DOQ. A new layer containing building footprints for 1996 was created via on-screen digitizing from the 1996 DOQ image. This new layer of building footprints was compared to the 1998 image. Based on visual interpretation, a second layer was created showing the new construction that had taken place during the past two years. Figure 6 shows a combination of new and existing building footprints with the 1998 image and major roads.
Figure 6. Example of change detection: building footprints in blue preexisted and building footprints in gold were constructed between 1996 and 1998.

The “Regional” view in Figure 7 encompasses an area extending roughly 10 miles north and south of the Bernalillo County border, east to Sandia Mountain Crest and west to the Rio Puerco drainage. City and airport points, major road lines, and boundaries for school districts, senate and house legislative districts, land ownership, and national parks are displayed against a Landsat TM image backdrop. The vector layers on this view were all obtained from the RGIS Clearinghouse.

The “Socio-economic” view shows selected census data by data analysis zone. The zones are colored to show population by race, projected population in 2020, school enrollment, and employment by industry. Numbers of vehicles per day and speed limits are shown for major streets in the “Traffic Counts” view. “Land Use” shows property parcels with land use classified into 13 categories.
Five views serve as repositories for background data that can be selected to create new views showing just the layers of interest for a particular application. “Composite View” contains the real estate sites plus infrastructure, land use, and traffic counts so that the user can see a site and the surrounding facilities.

To aid the inexperienced user, ArcView was customized to enable certain repetitive operations to be completed by clicking a single button rather than by repeating a multi-step process. A standard map layout was created so that a map of any selected site can easily be created and printed. A menu for selecting and opening views was added to the standard ArcView GUI. Also, a simple query form selects a real estate site by one or two criteria and then zooms to its location on the “Composite View.” Customization was accomplished by writing programs in ArcView’s Avenue programming language and by attaching these programs to newly created menus and buttons.
5.0 Results

This ARC project has produced the working prototype LoCRE by integrating a commercial real estate data base with multi-scaled imagery and other sources of geographic, demographic, and socioeconomic data. LoCRE is an interactive, multi-scale, image-based commercial real estate application with two components: an Internet-accessible real estate client interface and an office desktop application. Key features of the Internet component include interactive, dynamic mapping and customized querying and reporting capabilities via the Web. Key features of the desktop component include multiple views with detailed layers, such as infrastructure, land use, multi-scale imagery, socioeconomic and demographic data, traffic counts, and change detection. LoCRE enables creation of spatial data and allows display, query, spatial analysis, and automatic map generation in a Windows-type environment.

Success Metrics:


The prototype performs its designed functions well, and CREI Research is proceeding with demonstrations and review of its operations. Potential markets have been identified and Building Interests, Inc., is developing a business plan and seeking additional funding to launch the LoCRE application.

2. Estimate of potential revenue or development of new lines of business for Building Interests, Inc., CREI Research, and Planning Technologies LLC.

Early evaluation indicates market potential for a second-generation model with enhanced capabilities and functions. It is too early to project the full development of the market revenue from the system. However, a business plan currently in formulation tentatively identifies costs for the first year of marketing and production.

3. Establishment of a joint venture between Building Interests, Inc., and Planning Technologies, LLC, to commercialize the results.

Building Interests met in early November with the Board of Directors for Planning Technologies and submitted a proposed work plan and business agreement, which is currently under review.

6.0 Conclusion

LoCRE is a customized real estate research, planning, and management tool utilizing several query forms and multi-scaled imagery within a geographic information system environment.
LoCRE was designed with two applications in mind: a web-based application and a more robust desktop application. LoCRE uses the same set of views to accomplish the Internet and the desktop application needs so that as data are updated, modifications to the views need only be done once. Using this technique, the upkeep of the data and the applications is greatly simplified. The web-based tool will be accessible to Internet subscribers through the CREI Research site; the more robust desktop application will be used by real estate market researchers and will reside in the headquarters office.

A plan for marketing LoCRE is in progress. CREI Research plans to use LoCRE Version 1.0 to aid in an Albuquerque property selection and management process for a Native American group located in Alaska. Through the Web, CREI Research can interface with the Alaska client and provide imagery and geospatial data “on-the-fly” for Albuquerque, and soon for other major metropolitan cites. The application package will also be marketed for use by other commercial sectors interested in real estate research, planning, and management, such as organizations and public agencies that could use the application as a tool for economic development.

7.0 Bibliography


