REAL ESTATE ANALYSES USING GEOGRAPHIC DATA

New information management technologies and systems are powerful real estate analysis tools.

by Robert H. Pittman and Maury Seldin, CRE

Location is over-talked about and under-analyzed. Everyone knows it is important, but few really conduct the analyses which assess the productivity potential of a site with the rigor required to justify confidence in the real estate decision.

Appraisers pay lip service to location analyses in arriving at value estimates. Appraisal standards require the three approaches to value to be preceded by material on location. Mostly, however, this material is descriptive rather than analytical. Even when the material is analytical, it usually is not linked with the valuation process by a line of reasoning. The "now therefore" conclusion in general represents a giant leap of faith.

Logic holds that the demand analyses will show the relationship between employment as the engine of the local economy and demand for a particular type of property services. The line of reasoning traces the impact of the employment increases on demands for a particular type of space and then disaggregates the total to infer demand by particular market segments. It then assesses the current competitive position of the subject among the other projects providing space or in the construction pipeline to provide space. The result is absorption in the submarket in which the property is most competitive.

Changes in absorption are triggered by changes in demand and/or supply conditions. Price changes then result from changed absorption and underlying supply conditions influencing land available for development to meet changing demand requirements.

Investors would do well to invest in locations which get better, not the best location. The best location already commands the premium price which reflects the competitive advantage. The location which gets better will appreciate substantially more than those locations which already have arrived.[1]

The market analyst forecasts future income and values and then discounts the expected appreciation. In an efficient market all one gets is prevailing rate of return for taking the risk. But real estate markets are not very efficient. Therefore, the superior knowledge about the

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future, accompanied by better or luckier guesses, will produce superior results.

Analytical Models

In order to deal with any analysis, one needs a model. Essentially, a model is a set of relationships. The simplest of models is a descriptive model for competitive analyses. The decision maker simply obtains a description of what is happening, especially the successful projects, and then emulates them. The difficulty is, of course, that by the time the new product hits the market, conditions could have changed and what was successful before may not be successful in a changing environment.

At the other extreme is the econometric model. Rather than being simplistic, it is quite sophisticated. It may combine a demand model, a supply model and a price model. The combination may then be used to forecast changes in price and inventory with the resultant absorption. Unfortunately, the models are so data hungry and the availability of data is so sparse that the models are difficult to apply to situations requiring a timely real estate decision.

The judgmental model is the middle ground. It has the advantage of being able to forecast turning points which descriptive models do not. But its data requirements are not as great as the econometric models because the analyst may insert judgments to bridge the data gaps. The result is a line of reasoning which makes sense. How good the resultant forecast is depends in some measure on the data and in some measure on the judgment, providing the model itself makes sense.[2]

Data

The numbers are critical to any analysis. The key to data is quantitative adequacy and qualitative sufficiency.[3] That means one needs enough numbers to run the model and the accuracy of the numbers must be sufficient for the analysis at hand. Data-gathering efforts then should focus on the most relevant data, not that most readily obtainable. The readily obtainable syndrome explains why some appraisal and market analysts have lots of data but weak lines of reasoning.

Perspective

Any perspective needs a line of reasoning. The model is the heart of that line of reasoning. When a potential course of action is outlined, a model may be used to forecast the outcome of that course of action.

Outlining the potential course of action is what is required to get analyses suitable to the perspective. If one really had confidence in being able to accurately forecast the outcome of a course of action all the time, he would need no defense from potential error. But some crystal balls cloud up from time to time.

Strategy may be used to deal with the uncertainty. A strategy is a set of defensive policies. Policies are guides to action. Defensive policies are guides to action designed to protect from unfavorable events which may or may not develop. Development of the strategy thus requires risk assessment.

Risk Assessment

Risk assessment is often thought of as assessing the potential variability in the numbers. "What if" in a spreadsheet analysis provides an excellent example of risk assessment. If a series of ranges is used for each number, then one can look at a distribution of potential outcomes.

If probability can be assigned to each potential expected values of a variable, then the most likely outcome and risk can be rigorously quantified with good results, assuming the quality of the input was high.

Geographic Data

Traditional Analyses

Geographic information, in traditional real estate analysis, is generally in the form of a series of maps displaying physical and economic data. The maps generally show the location of the subject parcel, competitive parcels, market areas and local economy. Data for such factors as the analyst sees as important also may be mapped.

These maps may be thought of as showing spatial relationships and differences in characteristics of subareas. The underlying concern, however, is the set of linkages between the subject property and activities at other locations.

Linkages refer to movements between points.[4] The movements are generally thought of as movements of goods or people. People choose to reside in reasonable proximity to the location of their work and to places where they spend their time and money. Retail outlets locate close to their customers. Thus, retail store location analysis is very much a geographic analysis. Manufacturers locate to be close to their sources of material when the material is expensive to move. They also consider labor availability and conditions. Thus, the location analysis is also a geographic analysis.

Warehouses locate where it is cost effective to be near distribution outlets and sources of supply. The means of access by relevant transportation modes is critical. Again, this is a geographic analysis. The typical view of these analyses is generally just a location analysis.

Systematic Analysis

A systematic analysis is about to be suggested. It focuses on small area analysis as the most relevant geographic area to be used for market analyses, appraisals and decision analyses such as feasibility, underwriting and investment analyses.

The focal point for any real estate decision maker ultimately gets to the parcel level. But the key to the analysis of that parcel is the set of parcels with which it competes.

Those competitive parcels are in locations proximate to the subject because it is the same set of linkages which is of concern. Thus, the first two steps in geographic analysis are (1) locate the parcel on a map and (2) define the area of competition.

The area of competition is the market area or the submarket area. For residences, this is thought of as neighborhood analysis or an analysis which covers an aggregation of neighborhoods. For retail, the focal point goes to

trade areas, but the analysis encompasses enough competitive retail outlets to get market share. For office, it goes to office districts in which there are commonalities of functions and linkages.

It is the absorption of space, be it residential, retail or office, within the small area—a submarket—which is the critical analysis. The competitive position of the subject as compared with the other projects is the usual focal point.

What is frequently missed in the traditional analysis is the rigor of the market analysis for the submarket in focusing on the share of the submarket considering its unique linkages and functions.

A systematic analysis that disaggregates demand to the local level can provide the rigor that deals with the linkages and functions. However, developing the rigor of the analysis requires a geographic information system (GIS).

An analysis of the supply, including the pipeline of new projects for the area, also requires a geographic information system. In an earlier era, this could simply be information on 3" × 5" index cards with one card for each project and a pin on the map to show the location of the project. That visual image is very useful but simplistic considering the level of detail required for comprehensive analyses.

Geographic Information Systems

An information system is an integrated set of operations in which information is collected, stored and retrieved for use. A geographic information system is an information system which is spatially referenced.

The output of a geographic information system may be a map or a series of maps and the underlying data which may be arranged as a spatial spreadsheet. The system may be coupled with analytical models which process the spatially referenced data in the line of reasoning to forecast the outcome of a course of action. These analytical economic models may be integrated with analytical geographic models to provide a hybrid model useful for forecasting outcomes of courses of action. They are variations of judgmental or econometric models which integrate spatial analyses with economic analysis and provide the results in a spatial or geographic form as well as the numeric form usually used by the economic models.

Local Government

Local governments utilize geographic information systems to plan for the location of public facilities, to dispatch emergency vehicles, to value property for tax assessment purposes and to accomplish a whole range of other tasks for which the spatial dimension is critical.

The spatial dimension represents some aspect of linkage. Dispatching emergency vehicles is a clear case. So is planning the location of development. But there is a significant difference between these two examples.

The location of events which requires dispatch of emergency vehicles, e.g., traffic accidents, is generally independent of the location of dispatch centers. The location of development, by way of contrast, significantly is dependent on the location of public facilities.

The influence of the provision of facilities is critical because the availability of facilities affects the developability of the site. But development is generally market driven, with developability as a constraint.[5] Provision of facilities is a necessary but not sufficient condition for development to occur.

Local government and other regulatory authorities in their programs of providing facilities will constrain the market to develop in the locations as zoned, assuming that the required facilities will be available. Government authorities can work symbiotically with the market, or they can fight market forces. Resistance to market forces will drive development to the next best area, i.e., less desirable areas, with the result that increasing premiums will be paid for the best areas. The less efficient the system, the bigger the premiums for the better locations; hence the greater the profits for the locations which get better.

A geographic information system can be an integral part of a forecast of the location of development irrespective of whether the public sector or the private sector is making the forecast. While there are transportation models which may be used to forecast the location of development, they typically do not contain the variables to get the best forecast for changing land use.

Forecasting The Location Of Development

While local government may forecast the location of development, it is not the sole forecaster. Private sector decision makers make their forecasts as part of their decision making process.

The judgmental model may be integrated with a geographic information system to forecast the location of development. Such a model starts with a classification of space uses and moves to an absorption analysis.

If all sites in the relevant local economy are classified as to use and intensity of use, then each parcel may be classified as developed, underdeveloped, developing, developable or not yet developable. A potential supply picture then is created in the form of a map. A geographic information system is required to do this.

For every relevant classification, the judgment model may go through disaggregation to a submarket; the geographic information system may be used to define these market areas.

The supply pipeline also may be analyzed to indicate the quantity of structures in process, i.e., at some stage of the development process. This is in addition to those pipelines of land on which structures may be erected. The key stages in the process may be marked as permits, starts and completions.

Obviously, local government has the economies of scale for the most cost-effective analyses. But the various units of government as well as utilities, whether public or private, may not have an integrated system of analyses. Often, the zoning departments, public facility providers

and tax assessors maintain their separate information systems. These plans and forecasts, however, may be integrated by one of the agencies or by private sectors if they have the data and the geographic information system capability. Thus, while an agency may maintain its own information system, other agencies may tap into the data bank in order to use relevant data for their analyses.

Technical Aspects

Computer technology has moved geographic information systems from the era of the 3" × 5" cards with severely limited amounts of data to computers with humongous databases. The initial difficulty has been that it also requires humongous computers.

Recent developments have permitted the shift of geographic information systems to personal computers. State-of-the-art PCs now have the capacity that previously was available only with mainframes. Plus, the era of the quadtree format has arrived.

To understand quadtree, it is useful to understand rasters and vectors.

Rasters

A raster system utilizes a grid arrangement in which each square is in or out of an encompassed polygon. The lines that draw the polygon are thus the outer lines of the outer squares. A line for a road may be drawn by marking the appropriate squares. The connection of the squares then represents the path of the road. Alternatively stated, the polygon may be drawn by marking all squares within the polygon as in and all squares outside the polygon as out. Those squares partially in and partially out may be marked in, and the path of the boundary is marked by these squares. Obviously, depending on the size of the squares, the polygon represented by the raster will have some distortion. The smaller the squares, the less the distortion (Exhibit I).

EXHIBIT I
Rasters

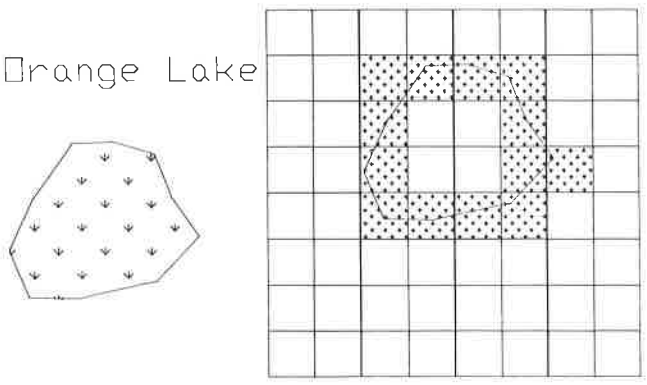
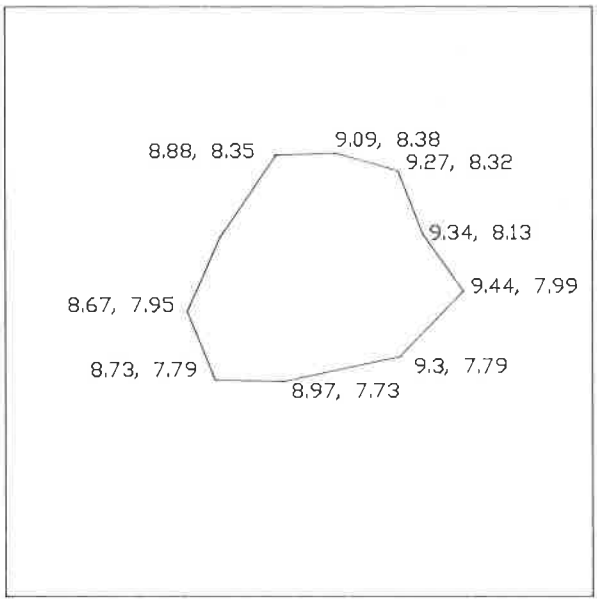


EXHIBIT II
Vectors



Vectors

A vector system of drawing a map is simply putting points on a map and connecting them. This process can be done by copying a map with an electronic device to note the location of the points. One can take maps of different scales and copy the points on a common map by using longitude and latitude as coordinates. The process is simple but tedious. The result is a map of lines for roads or other line networks or polygons for sites, census tracts, planning districts or counties or any other encompassed geographical area. This level of detail is very important for certain kinds of maps, e.g., parcel maps and utility lines. For other kinds of maps, an approximation is sufficient (Exhibit II).

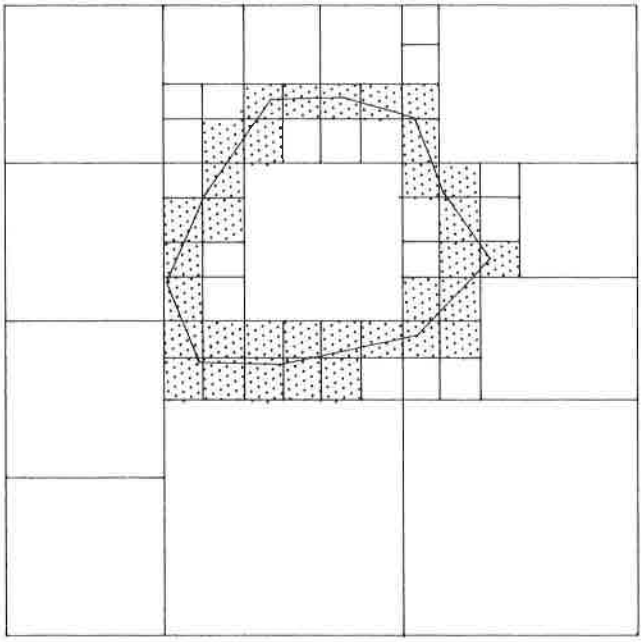
Quadtree

Making the squares smaller is done by dividing each raster into fourths, i.e., the squares become quads. This may be done in successive steps until the size is small enough for the purpose. The problem is that dividing all the squares into quads until the desired resolution is reached eats up a lot of computer capacity. The quadtree format divides only those squares which have a need for greater resolution. All the squares that are in or out of the polygons are not subdivided (Exhibit III).

Software

SPANS has this capability of quadtree built into it. SPANS, the acronym for Spatial Analysis System, is produced by Tydac Technologies, Inc. SPANS also is compatible with Lotus 1-2-3, DBase III and other spreadsheet software. The combination of software thus permits financial spreadsheets and spatial spreadsheets to be integrated.

EXHIBIT III
Quadtree



Currently, we are working on a template of applications for tailored software for particular types of real estate analysis.

The following discussion indicates emerging applications using state-of-the-art technology being simplified for wider use. The technology being discussed is doable, but its wider application requires some refinement. Nevertheless, understanding the approach will enhance decision making even without directly using state-of-the-art technology. Simply understanding the concepts will enhance the analyst's skill.

Real Estate Analysis

The real estate analyst needs some economy of scale to utilize the systematic approach. A great deal depends upon what local government already provides in the way of information systems. But, in any case, it probably does not pay for the private sector real estate analyst to develop a system for a single set of decisions or projects unless the scale is as great as a new town or a major employment center. What does make sense is an ongoing system available to many decision makers over time, probably from a central non-government source such as a university real estate center or a privately owned company.

From a practical point of view, we are not looking at the ultimate in real estate analysis, only the enhancement. The quality of real estate analysis can be significantly enhanced by using geographic information systems or by applying the approaches suggested in the following discussion. These build upon what we have available (which differ by local areas) and move toward what is envisioned as an ideal system.

Structuring The Question

Structuring the question is the most critical step in any analysis. Indeed, it is the foundation of real estate counseling and decision making. One way to approach the structuring of the question is to divide the approach into three parts: first, the situation as to a property; second, the situation of the decision maker; and third, the delineation of the decision to be made and the analyses which will aid in the decision making process.

One may have a particular parcel in mind for acquisition or disposition or for development or financing. The characteristics of the property are important in the analysis as are the linkages with market areas. This is ordinarily dealt with as a property description.

The vantage point may be the buyer, seller, developer or lender. As a buyer in search of a site, a set of characteristics is being sought. The prospect is sorting out the parcels. A seller, on the other hand, is segmenting the buyers. A lender is one who may wish to evaluate potential profit for a particular type of property or a location at which sites are available.

The question will direct the analyst to a particular type of analysis, but it should be in the context of the structure.

Decide On The Analytical Techniques

The analytical model to be selected depends on the property type and the analytical techniques. But there is one situation and the decision models generally fall into categories designed to answer questions as follows: (1) Does society need it? (2) What is it worth? and (3) Is it for me? The discussion which follows discusses analytical technology using geographic data.

Market Studies

Local Economy

The local economy is clearly the engine of demand for real estate, be it office, residential or industrial. The key is analysis by submarkets. It is necessary to understand the economy down to the detailed micro-submarket area. One of the best ways to understand the economy at that level of detail is with a geographic information system. Imagine a system that would go down to the census block level to display and analyze geo-coded data on employment, household income and other information so you could quickly analyze the local economy from the block level up. This would be an extremely powerful tool for local economic analysis which would feed into the demand for real estate. Because the local economic analysis could be done at the very disaggregated block level, real estate demand at the submarket level could be much better delineated.

A geographic information system can facilitate this micro-analysis of urban economies which in turn enables the analyst to perform a much improved micro-analysis of real estate submarkets. The 1990 U.S. Census will use the TIGER System (Topologically Integrated Geographically Encoded Reference System) which will enable spatially referenced census data on income, age, sex, households,

etc., to be quickly integrated into a geographic information system.

When you aggregate statistics and analysis to the metropolitan statistical area (MSA) level, e.g., Chicago, you lose sight of what is happening in the submarkets. For example, the North Loop submarket in Chicago may be equal in market size to the size of many second- and third-tier cities. But until the disaggregate information is available to let you do the submarket analysis, an investment opportunity may be missed. Analysis of local economies and real estate markets may be enhanced using a geographic information system and TIGER files. One may hone in specifically on hundreds of submarkets in MSAs throughout the country. This would enable investors and developers to pick submarkets that will give them the overall highest return. A geographic information system can help do this, and it will be a significant improvement in the way the local economy and real estate submarkets are assessed, identified and analyzed.

Market Analyses

In strict definitional terms, market analyses are nonsite-specific market studies which assess societal needs for a type of real estate space as measured in the marketplace. A geographic information system can be used in many ways to do nonsite-specific market analyses. Nonsite-specific market analysis can be divided into the planning stage, analysis of the local economy and the market analysis stage.[6]

The first phase in nonsite-specific analysis is planning. When planning, a key step is delineation of the market area. A geographic information system can be very helpful here. In the case of retail analysis, the market area is a trade area, and a geographic information system can be very helpful here as well. In particular, hybrid gravity and geographic information system models can define retail trade areas very accurately. In the housing market, neighborhoods often are identified as market areas, and they are delineated by socioeconomic characteristics and linkages. Once again, a geographic information system can be useful in this analysis in the way described above by using TIGER files and other information to pinpoint the socioeconomic characteristics of a given neighborhood and the surrounding neighborhoods.

In determining linkages, a geographic information system can be particularly valuable in distance measurements. Travel time (hence, linkage) is not just a simple function of linear distance. It depends on road congestion and the road network. Geographic information system models can incorporate these variables and arrive at travel time and linkages.

Another part of nonsite-specific market analysis in the planning stage is market segmentation. Market segments are identified using categories of consumer characteristics, including demographic, social, economic and psychographic. We have discussed already the ability of a geographic information system in the analysis of economic and demographic/social characteristics, but it can also be used to analyze psychographic characteristics. Often, psychographic characteristics are derived from surveys of consumer attitudes, preference patterns, etc., as a function of socioeconomic status, age, sex, etc. With a geographic information system containing data on demographic/social and economic characteristics, one may derive psychographic characteristics, such as owner/renter preference, lifestyle choice, amenities, etc., and map them.

The second phase in nonsite-specific market analysis is analysis of the local economy. The first step here is to analyze demographic data for the entire market and for each submarket. We already have discussed how geographic information systems can analyze submarkets (down to the block level) in terms of age, sex, marital status, etc. Previously, we discussed a system in which demographic data was analyzed at the minute block level and then aggregated upward to identify submarkets. The same approach may be taken with purchasing power, expenditure patterns and sales levels.

In phase three of the market analysis, one must equate demand with supply. We have talked about some components of demand, but a geographic information system can also help with supply components. Supply is a function of developable land and units that are in the pipeline under construction. A geographic information system can help with this pipeline analysis by mapping and assessing where available land is relative to the submarket, and it also can be used to map and analyze properties that are currently under construction with building permit information.

After completing demand and supply forecasts in nonsite-specific market analyses, the analyst must match demand and supply. If this is done in a very aggregated way at the MSA level, the analysis may show that demand equals supply for a particular product when, in fact, there is much imbalance at the submarket level. This goes back to what we discussed already in terms of analyzing the submarket as opposed to the total market. By matching segmented demand forecasts to each component of supply at the submarket level, one can then build up to a total aggregated demand/supply analysis which adequately reflects activity at the submarket level. For example, a totally aggregated demand/supply forecast for Class A office space in Chicago may show that existing supply equals projected demand for the next few years. However, there may be submarkets that are in supply/demand imbalance, and this will be identified with the geographic information system-based submarket analysis.

Absorption Analysis

There is a time dimension in market analysis which relates to a quantity of space which will be taken at prevailing prices. This is referred to as absorption. The absorption may be for a large market area such as a metropolitan statistical area, and a part of that area, e.g., a county, or a small area such as a submarket, which is smaller than a county. Such submarkets are usually small enough to identify a particular class of property with which a subject property is competing. It is this last subarea which is the critical area of analysis because it

contains the competitive properties of a subject property. As such, one may focus on the absorption of that class of properties, however it is defined.

A good absorption analysis should be predicated upon a submarket analysis. The analyst should disaggregate the market by tenure, location, price range and product type. The way to forecast absorption turning points is to do this disaggregate analysis. For example, the absorption of a particular product in market A will change based on changes in the situation in contiguous market B under a situation of some substitutability. This brings up a very interesting, but sometimes overlooked, phenomenon. Submarket analyses do not end with the individual analysis of 20 different markets. An aggregate real estate market is a general equilibrium system as opposed to a partial equilibrium system. The partial equilibrium analysis can be done for each submarket, but then the general equilibrium analysis must also be done when putting the submarkets together. To go through a comprehensive analysis of submarket A for absorption, one must look at the situation in the surrounding submarkets. To get this totally comprehensive approach—a general equilibrium, spatial submarket approach to real estate analysis—one can use a geographic information system. It is a very powerful tool for performing this analysis because the submarkets are linked together very strongly from a spatial dimension.

Marketability Analyses

Marketability analyses are site-specific analyses. The question focuses upon the absorption of space in a specific property for a specific use. The key in the analysis is to identify the potential competitive projects and then see how these various projects divide up the aggregate of the submarket.

Appraisals

The appraisal process requires identifying comparables and adjusting for differences. A geographic information system can be a valuable tool in this analysis. In an appraisal, after one adjusts for financing terms and conditions of sale to obtain the market-adjusted indicated sale price of the comparable property, one must then adjust for location and physical characteristics to obtain the indicated sale price of the subject property. The process requires dealing with comparabilities. A geographic information system can help in adjusting for locational attributes of comparables. Since the value of the structure—residential, office or retail—is a function of location and linkages, a geographic information system is an excellent way to analyze these many complex linkages and arrive at better assessments of comparability and more accurate adjustments. A good geographic information system, with proper data specifying location of other parcels and features such as infrastructure, can identify whether prospective comparable properties are truly comparable in terms of location and linkages. For example, in a residential appraisal situation, a comparable house may be analyzed in terms of distance to shopping, schools, transportation arteries, etc. In addition, the characteristics of the neighborhood can be analyzed with a geographic information system. Income data and other economic characteristics of the neighborhood and surrounding neighborhoods can be pinpointed better with a geographic information system than with a windshield survey or secondary statistical research methodology.

Conclusion

Geographic information systems previously were built using mylar overlays for the relevant data layers and for storing the data in hard copy. Now, the new technologies and systems described in this article represent a giant leap in this powerful real estate analysis tool. With new geocoded census data, the adoption of geographic information system technology in real estate analysis and other areas will be accelerated.

Computerization has progressed to better handle the data in order to rely less on hard copy transfer and calculations. Computer mapping has progressed so that it is easier to spatially represent locational attributes. That is progress and the entry into a new era.

In this new era, the data and the economic models will be integrated to handle the data into the geographic information systems which have capability for spatial analysis. Thus, the end result is a hybrid model that combines economic analysis and geographic information systems which provide increased *analytical capability.*

Competent real estate analysts should be aware of these concepts because understanding the concepts will help shape the analyses. State-of-the-art analysts should avail themselves of this new tool, just as they have availed themselves of computers. This more powerful tool will enable higher quality analyses, and we certainly need to conduct higher quality analyses to make better real estate decisions.

NOTES

1. See Seldin, Maury, *Real Estate Investment for Profit through Appreciation* (Reston, Virginia: Reston Publishing Company/Prentice Hall) 1980, pp. 134-6. The concept is also discussed in Seldin, Maury, Swesnik, Richard H., *Real Estate Investment Strategy,* third edition, (New York: John Wiley & Sons) 1985.
2. For a discussion of models, especially the judgmental model, see Seldin, Maury and Hysom, John, "Enhancing the Quality of Real Estate Decisions by Use of the Judgmental Model," *Research on Real Estate* monograph series, Vol. III, Kapplin, Steven D. (ed), in press.
3. Seldin, Maury, "Criteria for Evaluation Appraisals," *The Appraisal Journal,* Oct 1959.
4. See Carn, Rabianski, Racster, Seldin, *Real Estate Market Analysis: Techniques and Applications,* (Englewood, New Jersey: Prentice-Hall, 1988) pp. 99-100.
5. See Seldin, Maury, *Land Investment* (Homewood, IL: Dow Jones-Irwin, Inc.) 1975, pp. 99-112.
6. For a detailed discussion, see Carn, Neil G. and Rabianski, Joseph, in *Real Estate Analyses,* edited by Seldin, Maury and Boykin, James (Homewood, IL: Dow Jones-Irwin, Inc.) 1990, pp. 45-80; also appearing in *The Real Estate Handbook,* second edition, edited by Seldin, Maury and Boykin, James (Homewood, IL: Dow Jones-Irwin, Inc.) 1990.