Educating Multi-Disciplined Experts in GIS-Based Global Valuation Methods

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Abstract

Educating Multi-Disciplined Experts for GIS-Based Global Valuation Modeling

Globalization has resulted in 1,000 billion euro in real estate assets to be valued annually. The financial sector has reached the stage where reliable real estate valuation methods are sorely needed for financial transactions and accounting. GIScience is a technology that can be used to provide global transparency and confidence. A new GIS-based valuation paradigm has been developed that utilizes suitability studies and agent-based micro-simulation models. It could provide a global best practice methodology that also deals with sustainability. GIS could also provide risk assessment methods that will be needed for banking, required as a result of the Basel Accord.

Leading 1960s educators warned that rapidly growing knowledge in urban land economics, urban economics, regional science, and many other areas are essential in understanding complexities that shape present and future values of real estate. How will academia prepare specialists in the model building needed to update 70+ year old methodologies?

Educating Multi-Disciplined Experts for GIS-Based Global Valuation Modeling

1.1 Impetus for the Research: A Growing Global Need for Risk Analysis and Reliability

Raymond Trotz, Director, at HypoVereinsbank AG, and a representative from Germany on the International Valuation Standards Committee (IVSC) Management Board, spoke on the significance of real estate valuation to the financial sector with emphasis on calculating the mortgage lending value or a value at risk approach. He estimated that 1,000 billion euro in global direct and indirect real estate volume to be valued each year in the financial sector. If only 10% of these valuations were incorrect due to poor valuation standards, lack of market knowledge, or poor training in real estate valuation, the 'damage' to the global economy would be in about 100 billion euro year on year.

Clearly, there is a need for the utmost in professional competence for the international valuation of real estate. Review of appraisals required after the U.S. bank failures, a decade or so ago, found what were often wide differences in the appraised value of the same asset at the same point in time by multiple appraisers. A study by Weber (2004B) was made by in order to find the causes of these differences in estimates of value. This study was made in an attempt to have appraisers provide the types of information and analyses that was required for greater accuracy so that the future appraisals would be more reliable.

Most of this appraisal error resulted from shortcomings in a few key parts of the appraisal process. It was found that the major reason for significant differences in the value of income property was the selection of significantly differing capitalization rates by different appraisers. Even if adequate sales were available in the subject market area, they might reflect a 'bubble', as was the case San Francisco a few years ago. A very significant risk to a lender is the possibility that the 'market' is also incorrect and that cap rates used by market participants are much lower than what they should be in relation to the most likely future trend in rents for the local market.

The search for reliable and unreliable valuation methods was also conducted in the United Kingdom. A significant problem that was noted by England (2000) has been the inability to forecast the relative rates of sales penetration from large new discount shopping centres versus existing smaller town centres, leading to blighted town centres. The problem arose from a lack of reliability in methods of spatial interaction modelling that is required for reliable marketability studies. This was the same problem with Hollywood & Highland, new shopping centre in the United States, which suffered a $400 million loss last year as a result of this type of problem.

The IVSC assisted Mr. Pomerleano, Lead Financial Specialist, The World Bank. with the preparation of his paper delivered to the annual seminar, cosponsored by the Federal Reserve Bank of Chicago and the World Bank. The principal IVSC objectives are to:

- Formulate and publish, in the public interest, valuation Standards and procedural guidance for the valuation of assets for use in financial statements, and to promote their worldwide acceptance and observance
- To harmonize Standards among the world's states, and to make disclosures of differences in standards statements and/or applications of Standards as they occur. It is a particular goal of IVSC that international valuation Standards be recognised in statements of international accounting and other reporting standards, and that Valuers recognise what is needed from them under the standards of other professional disciplines.

The Collapse of Confidence in Financial Reporting vs. Valuation Inconsistency

Sayce (2003) has found that there are other factors that also result in a global need for accurate valuation of real estate, i.e. for accounting and other purposes, in what she refers to as a "Post-Enron world":

The collapse of confidence in standards of financial reporting, consequent on the Enron and WorldCom corporations has affected corporate bodies and their advisers, and there are now widespread Governmental pressures for more stringent controls over practice to prevent deception and even fraudulent activities.

A summary of valuation methodologies used in Europe by McParland et al (2002) has recently been made available that can be used for comparison to the American methodologies. Current appraisal Practices in Sweden, the Netherlands, Germany and France have been reviewed by the authors via interviews with 110 Valuers. The authors analyzed the potential for harmonized standards in Europe by comparing standards used in the above four countries, all potential users of the TEGOVA (The European Group of Valuers Associations) standards that were revised in 2000. A cross national comparative analysis of valuation standards contributes to a greater understanding of the issues and problems facing the harmonization process.

There is much inconsistency in valuation methods within Europe. Some countries rely on the cost approach, while others use one to three approaches for valuing real estate. The conclusion is: Clearly, the global community is far from utilizing consistent valuation procedures.

TEGOVA: Specific Items Requested for Consideration in Risk Analysis

A description of European mortgage securitisation and its implications for appraisals (2002) was prepared by Verband Deutscher Hypothekenbanken, an association of German mortgage banks. The Association states that valuers dealing with property valuation for securitisation purposes need to focus on market and property-related risk criteria of the mortgage assets. The aim is to provide originators, rating agencies and MBS-investors with transparency regarding both market and sustainable net asset values for individual properties and/or portfolios and market and property risk details, thus facilitating the structuring of mortgage loan portfolios, portfolio ratings and investor decisions. The association mentioned that it is necessary to define a set of detailed criteria allowing the determination of the risk profile of the underlying property assets.

Six "risk buckets" (**Figure 1**) were described (non-yellow portion) as being suitable to accurately reflect the long term quality grade of a property and to calculate its net asset value for securitisation purposes. The types of risks of concern that were noted in the association's report on securitization are market, location, property related, partnership, fiscal & legal, and financial.

The contention of this paper is that most real estate appraisers have not been trained in such risk analysis and that appraisal education, as taught in the U.S. and most countries, is not designed to provide such risk analysis. The purpose of this paper is to research methodologies in the literature and to provide suggestions regarding how these shortcomings can be resolved.

The focus of this research is on the valuation of developmental land and complex commercial / income properties. A potential need for global financing could be for the redevelopment of the many military bases in the U.S. An example is provided as a case study property for which the suggested methodologies can be applied.

Commercial Property Criteria	Today v. 10 Years	Geographic Level of Agent-Based Modeling					Method of Quantification*
		Modeling Level:	Macro	Meso	Meso/Micro	Micro	
Long-term Influenc	**Item**	**Indicator**	**Country**	**Region**	**Market**	**Site**	**GIS Tool**
	Inhabitants	Number	X		X		Microsimulation
	Development of the Population	Changes in %	X		X		Microsimulation
	Structure of the sector	good/average/bad	X		X		Microsimulation
	Growth opportunities of the sectors	good/average/bad	X		X		Microsimulation
Regional environmental/soil risk							
	Endangered by high water	Yes/no		X			Map Layers
	Endangered by earthquakes	Yes/no		X			Map Layers
	Possibility of soil sinking	Yes/no		X			Map Layers
Market structure/size/dynamic				Market Delineation/justification?			Exploratory Data
Maket cycle with respect to rent		Boom/Recession			X		Exploratory Data
Volatility		Coefficient of variation			X		Exploratory Data
Vacancy		Rate			X		Exploratory Data
Location & site criteria							
Connection to transport facilities		Motorway/Train/Aircraft/Ship				X	Drive-Time Analysis
Building suitable to location		Yes/no				X	Suitability Study
Local competition/catchment area		strong/average/low				X	Exploratory Data
Attractiveness of the branch		high/average/low				X	Conjoint/Gravity
Use of land suitable to the location		yes/no				X	Suitability Study
Quality of the land (contaminaion)		yes/no				X	Exploratory Data
Emission		yes/no				X	Kriging

*** GIS assisted methods that could be used to quantify each item of risk**

Figure 1. Source: Weber: Adapted from TEGOVA - GIS Assisted Risk Analysis

The research starts with a description of the history and anticipated future needs of those that need to be educated for real estate development and investment, termed the New Property Professional. The search of the literature then starts its focus on real estate valuation, particularly the valuation of developmental land and complex income property, both of which require large amounts of capital. The quantification of risk for these real estate loans requires market analysis in order to deal properly with the uncertainty involved in many of the items listed above.

The conclusion of this paper is that real estate appraisal needs to provide transparency that readily shows objective analysis via scientific-types of models with results that can be replicated and verified by other interested parties. The opinion has been formed that transparency could be best provided via GIS and that the requisite models can be best provided by GIScience in conjunction with methods of survey research

1.2 An Example of Valuation Problems that Need to be Solved

There has been a trend in the United States towards turning military facilities over to adjacent cities for redevelopment into civilian uses. News articles note a wave of base closures dates from 1988, when the Defense Department established a Defense Base Closure and Realignment Commission, calling for rounds of base closure and reuse programs in 1991, 1993, and 1995.

The agencies involved have noted that the appraisal of military bases has been found to be unreliable, even when assuming away the complexities that result from soil contamination. The Department of Defense (DOD) sought legislation that would no longer require appraisals for Economic Development Conveyances (EDC), a process developed for transferring land to local

communities following a military base closure. In testimony before a House Armed Services subcommittee, an official from DOD slammed the appraisal process, "and from this protracted and contentious and fundamentally inexact quote 'science' of estimating fair market value, then we usually arrive at our economic deals that returns far, far less." DOD wanted to end the EDC process by transferring property to local redevelopment authorities without consideration, provided the property is used for job creation. The finding was in their favor. The Department of Defense is no longer required to obtain appraisals for these conveyances as a result.

One such site is being used as a case study in order to illustrate the need for, and application of, a more robust set of analytical techniques. The land use plan below (**Figure 2**) is for a site in Orange County, adjacent to the south of Los Angeles. The entire project had been held up because a school agency that was to receive some of the acreage had found what they consider to be serious soil contamination under the portion of the acreage that was to be deeded to them.

Assumptions: G - Biologically valuable habitat
C = Major retail
A = Apartment
B = Business park

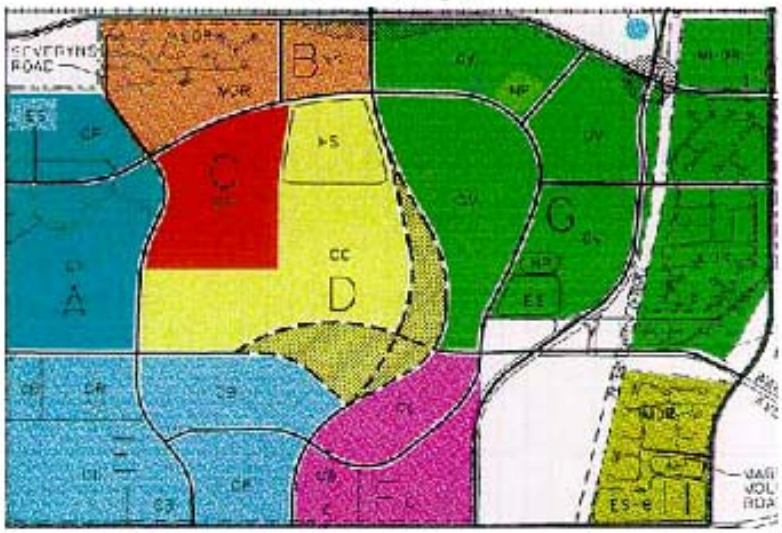


Figure 2. Land Use Plan - Redevelopment of a Military Base Source: Weber

A recent report in the California Real Estate Journal (2004) of pollution on the former El Toro Marine base noted that federal law prohibits the Navy from selling land that is polluted or said to be polluted. Only 202 acres of the 4,700 acre property has been cleared to be sold in its entirety. The accepted U.S. model for the valuation of such developable land that is described on page 24 of this paper shows that things that delay the development, leasing and sale of such land reduces its value.. This reduction would be over and above any costs due to the contamination per se. Issues like these result in these properties being highly complex from a valuation standpoint.

The assumptions listed above the graphic are used to relate the use of GIS-assisted methodologies to such a property. Step 1 – Productivity Analysis, in the addendum, describes how GIS can be used to value Area G, above, if it were found to be valuable habitat. The remaining examples in the other Steps in the addendum are focused on developing retail land, but can also be relevant to the development land for apartment or business park development as well.

The Urban Land Institute published a monograph in 1972 on the analysis of such large land holdings. It used a present value method of analysis of proposed development. Development has become much more complex and time consuming since then. A more recent publication of theirs by Schmitz and Brett (2001) provides a case study on market analysis that should be done prior to the simulation of the mixed-use development.

Weber (2001B) presented a paper using a land residual technique similar to the one described in Weber (1990) with the probabilistic approach by Lieblich (1995), and Coughlin (1995) in order to update the methodologies espoused by the Urban Land Institute in 1972. The apartment, industrial and office markets were discussed in the context of the valuation of contaminated acreage for a multi or mixed-use development.

Werner (2004) noted that hundreds of cities will be competing to save their military bases and the thousands of jobs that are at risk as the Pentagon decides which of the nations 425 military bases, including 61 in California, to put on the chopping block next year as part of its 25% reduction in capacity. Highest & best use studies will be needed to recycle this acreage as profitably as possible, in order to mitigate the losses to the local economies from the military cutbacks.

It would be in the best interest of the appraisal community to develop skills similar to those in the planning community so they could work together in determining these highest and best uses of this acreage. It will be noted later in a discussion of GIS planning models that appraisers could be particularly useful to the planning community by helping to calibrate econometric planning models by using data on the priced paid for real estate.

A problem that has to be addressed in appraisal is its reliability, which will be noted from various parts of the literature. The problem results from appraisal being based on numerous subjective judgements said to be based on the experience of the appraiser. These subjective judgments have also been an issue in U.S. courts, with expert witnesses on opposing sides of an issue testifying to vastly differing interpretations of the same set of data.

The problem was addressed by a Supreme Court case known as Daubert (1993). The result was that subjective judgements used by expert witnesses in court needed to be supported instead by the use of the scientific process in order for the testimony to be admitted. This is the reason for the focus on analytical methods that incorporate the scientific process.

Geographic Information Systems and Science, by Longley et al (2001) discussed the use of GIS as GIScience. The authors note that:

The philosophy of the authors differs from perhaps 100 other books on GIS since most books on GIS are written by GIS staff in junior and mid-level jobs. The authors think that there is too much emphasis on the technical aspects of GIS. They see GIS as providing a gateway to science and problem-solving, saying that science underpins successful applications. "It is a foolish individual who sees it only as commodity like baked beans or shaving foam. Its value relies upon its coverage and on the strengths of its representation of diversity, up on its truth within a constrained definition of that word, and it availability."

The philosophy expressed above is the reason for exploring the use of GIS as GIScience to find out if it can provide more reliability to the appraisal process.

1.3 Real Estate Education Throughout the World: Past, Present and Future

The above heading is also the title of Volume 7 of Research Issues in Real Estate, which was sponsored by the European Business School and the American Real Estate Society. Chapter 1 is Requisite *Knowledge for Effective Property Involvements in the Global Context*. In this chapter, Roulac (2002) notes that traditional real estate education is biased towards a limited and culturally narrow, even parochial view of the world. As a result, graduates of current real estate programs are unlikely to possess the required knowledge for effective global investments.

He also notes that there are more pressures for professionalism on the part of those delivering real estate services and a need to "bridge" the traditional world of property and the cultures of the new participants as a result of the recognition of real estate as an investment in the global community.

Also noted is a need for a cohesive and coherent framework to enable participants to comprehend the overall collection of data and its relationships that comprise the property discipline. Since the property has moved from a transaction orientation to a strategic orientation, superior rewards will result from superior knowledge of the property and the ability to act on that knowledge. He notes the importance of framing this knowledge from macro to micro in a global context.

The concepts of place (land) and space (improvements thereon) determine the knowledge that is required. Education for facility management is should be much different from that for investment management. Historically, real estate education in the U.S. has been in the business or finance department, whereas Europe and the U.K. view it from a surveying or building context. Roulac lists the following disciplines (**Table 1**), and more, as required foundations for real estate specialist

Table 1. Fundamental Disciplines for Real Estate Involvement Source: Roulac, altered by Weber

Accounting	Investment
Managerial Accounting	Land Economics
Appraisal and Valuation	Landscape
Architecture	Law
Behavioral Economics	Management
Computer Science	Management Science
Computer Technology	Marketing
Construction Management	Planning and Control Systems
Decision Science	Political Science
Decision Theory	Project Management
Environmental Science	Psychology
Economics	Public Administration
Managerial Economics	Quantitative Methods
Engineering	Regional (and Urban) Planning Theory
Finance	Sales
Geography	Science
History	Sociology
History if Design	Strategy
History of Science	Statistics
Information Theory	Transportation
Institutional Economics	Urban Land Economics

Roulac, Graaskamp, Diaz are listed as thought leaders that have challenged the focus on finance in real estate education in the U.S., but also notes that those in the United Kingdom School of the Built Environment, with its heavy emphasis on the classical surveying curriculum, might benefit from some education in business administration. Students on either country could be blissfully ignorant of the subject of geography and how it relates to real property, particularly the concept of place that is so important to understanding the uniqueness of location and its importance. Some real estate education programs in Europe seek to bridge the gaps between the three disciplines.

Economic activity is increasingly affected by social values and societal patterns. Fewer goods are produced by local firms. Advances in information and telecommunications dramatically increase the economy, portability, power and accessibility of information. Technological change alters the patterns of organization, leading to different forms of living and working – all having major implications for property demand.

The requisite knowledge for the property discipline is reflected in the different paradigms that are in a position to deal with it, such as economics, finance, geography, engineering, highest and best use, city planning, brokerage, legal, and a multi-disciplinary approach. As Roulac states:

Effective property involvement employs multiple perspectives and skill sets to address the crucial questions for effective property involvements, and applies the capacity to reframe problems, select appropriate methodologies and tools, gather the requisite information, and be self-educating to learn what one needs to know to address the problems one encounters

Roulac concludes that one must simultaneously be - and provide the perspective of - historian, behaviourist, global citizen, urban planner, geographer, business strategist, futurist, political economist, information specialist. for one to be effective in property involvements, and that the property professional in the property sector will balance and integrate the following attributes:

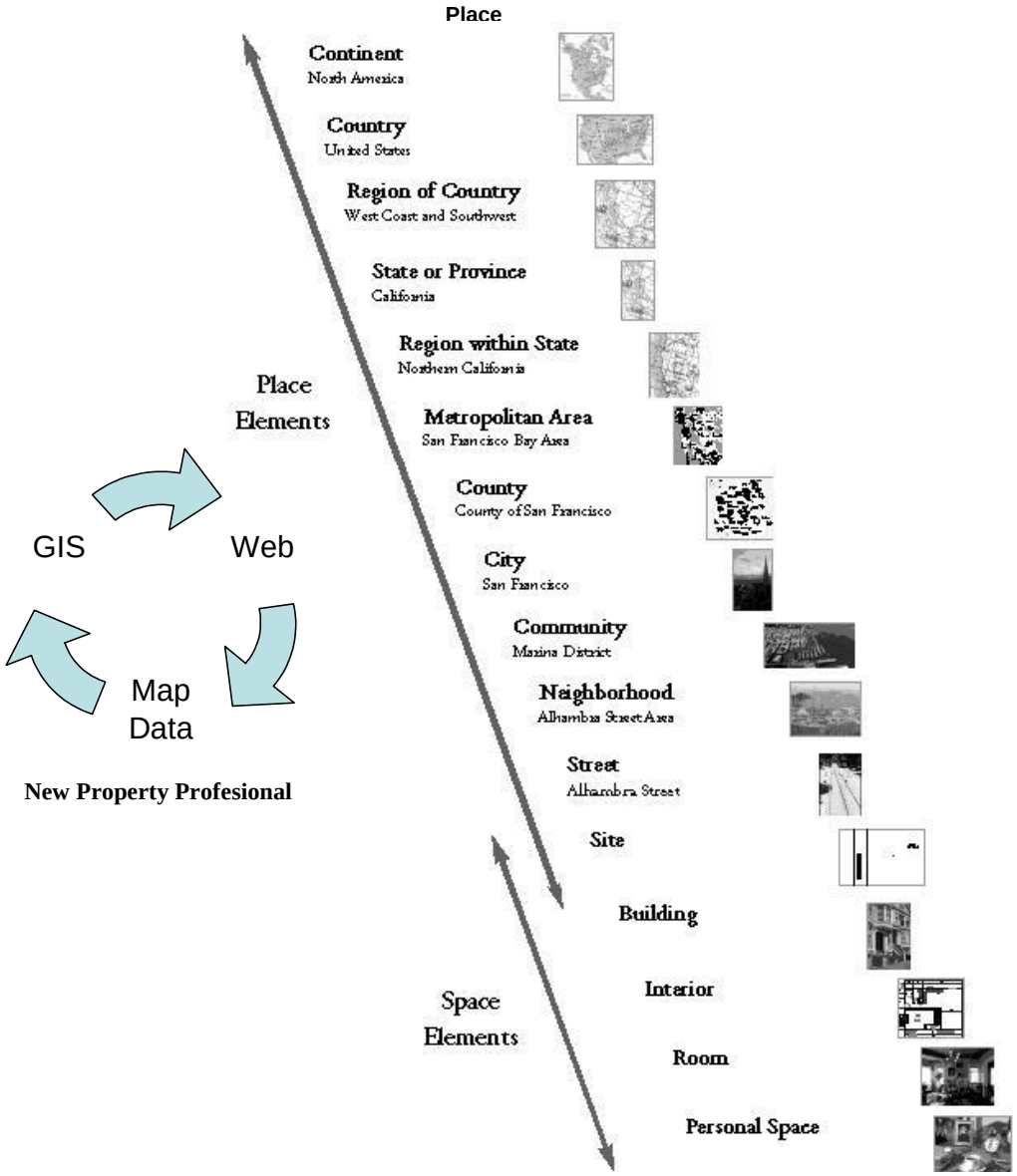
Thrall (2002) defines business geography as the process of integrating geographic analysis, reasoning, and technology for the improvement of the business judgmental decision, stating that market analysis is central to the evaluation of risk. He uses the term business geography as being interchangeable with market analysis and that real market analysis has been a jack-of-all-trades, all things to all people. It has been financial analysis, urban planning, and building construction cost estimation, even law and construction management as practiced by some firms. Each is important to the real estate decision; but to be proficient, specialists in those areas will certainly agree that each requires very specific and very deep knowledge bases. Today the depth of knowledge required, and the expectations of the marketplace for professional high-level proficiency, precludes one from becoming a master of each and all.

Finally, he states that "the market analyst's completed report is invaluable input to subsequent risk management evaluation of the proposed project's feasibility, financial viability, and manageability. The risk manager takes the market analyst's report and assembles the information along with reports from other advisors to determine expected value of the project to the investors: namely, what are the risks and what are the rewards from the investment?"

TEGOVA seems to think of an appraiser as a “new property professional” / risk manager, but few appraisers are trained in substantive market analysis. In order for an appraiser to provide risk analysis, it would be best if he or she were an expert in the use of GIS (**Figure 3**) so that the valuer will be able to collaborate with other GIS-proficient specialists in other disciplines.

Figure 3. Linking New Property Professionals: GIS Collaboration and Modeling Via the Internet

Discipline
Accounting
Managerial Accounting
Appraisal and Valuation
Architecture
Archaeology
Behavioral Economics
Computer Science
Computer Technology
Construction Management
Decision Science
Decision Theory
Ethics
Environmental Science
Economics
Managerial Economics
Engineering
Finance
Geography
History
History if Design
History of Science
Humanities
Information Theory
Institutional Economics
Investment
Land Economics
Landscape
Law
Management
Management Science
Marketing
Philosophy
Planning and Control Systems
Political Science
Project Management
Psychology
Public Administration
Quantitative Methods
Regional (and Urban) Planning Theory
Religious Studies
Sales
Science
Sociology
Spirituality
Strategy
Statistics
Transportation
Urban Land Economics



Source: Roulac, Appended and Altered by Weber

1.4 Research Approach

The contention of this paper is that real estate appraisers should be the most logical candidates for providing the risk analysis that is badly needed for financing complex real estate assets. As Roulac has noted, real estate education has historically been deficient in most places in the world. If an appraiser is going to truly understand the risk involved in valuing major investment property it seems as though he or she should be as well educated as the "New Property Professional".

Appraisal education, as taught in the U.S. and most countries, is more of a trade-school type of how-to-do training.. The purpose of this paper is to research a number of disciplines and their analytical methodologies in order to find out if they possess techniques that are suitable for real estate risk analysis and valuation.

The aim of this research is to assess the role of GIS in integrating the scientific process with the appraisal process, in an attempt to increase the reliability of appraisal. The purpose is to enhance market analysis as part of the estimation of the highest and best use of land. The primary application of the research will be the analysis of large scale redevelopment projects.

It is anticipated that this aim will be fulfilled by the following objectives:

1. To evaluate of the literature on:
    - Decision theory, value, economics and highest and best use
    - Market, marketability and feasibility analysis
    - Institutional real estate investment and development
    - Planning support systems
2. To provide a critical evaluation of the procedures currently in use by appraisers, particularly as they relate to the components of highest and best use analysis as required by standards of professional appraisal practice and client needs.
3. To demonstrate how GIS models can resolve shortcomings found by comparing conventional to GIS-assisted procedures utilizing a Six-Step procedure of market analysis. These six-steps best summarize the various steps that the literature states should be taken for substantive highest and best use, market, and marketability analyses.
4. To test GIS-assisted procedures for their apparent effectiveness by using statistical methods.
5. To assess how the application of GIS procedures for the analysis of residential, office and industrial markets can be integrated into an overall model of urban growth that also incorporates agent-based modelling, where a person can be represented as an object-oriented computer-simulated entity

The overall research approach (**Figure 4**) has been outlined in the exhibit below:

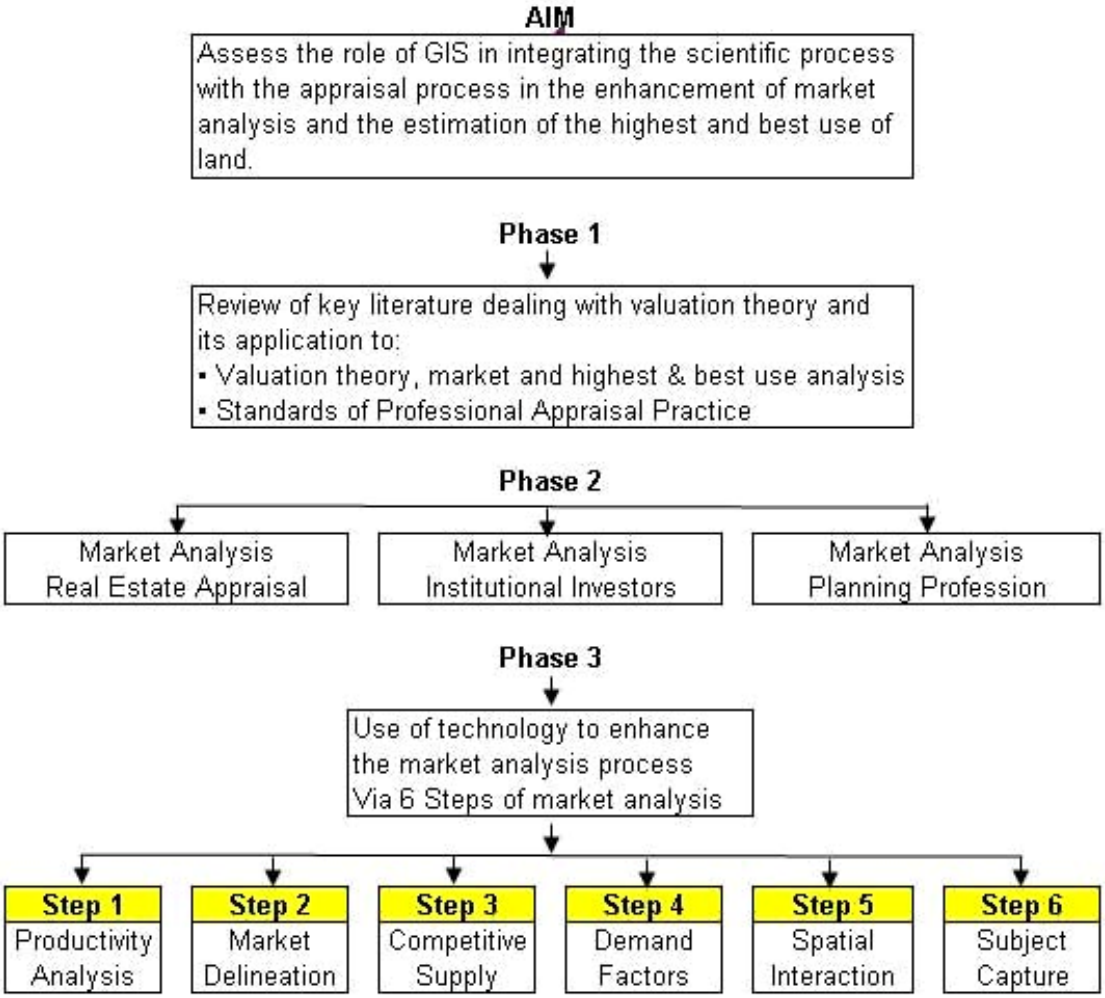


Figure 4. Research Approach

The methods used to carry out the research include three key phases involving desk and primary research.

- Phase 1 involves a review and analysis of developments in valuation theory and secondly an investigation into the procedures required by American and international standards of professional appraisal practice.

- Phase 2 discusses the shortcomings in Phase 1 in relation to developments in market analysis theory recently used by some appraisers, institutional investors and planners. The methods of investors and planners are incorporated into a Six-Step methodology recently called for by some clients.

- Phase 3 uses case studies to show how GIS can enhance the market analysis process by its use in the Six-Step process. Phase 3 also integrates the Six-Step process into an overall GIS model of urban simulation.

Phases in the Research Approach

Phase 1: Summary of a Review of the Literature

1.5 A Search of the Literature Relative to Valuation

Canone and Macdonald (2003) provide a thorough discussion of the historical evolution of the theory of value, "or the lack thereof". Their main point it that competence supposes that there is a professional foundation which includes a solid understanding of theory and also its historical development. Their review of the literature shows that, for real estate appraisal, there is a relative absence of such a theoretical foundation. Their conclusion is that "appraisers face a challenge due to the need to create basic laws and principles as a foundation so that the field can progress from an art to a science so their trade can progress to a profession".

Their comprehensive review of the literature (A detailed scrutiny of over one hundred major North American real estate handbooks and real estate appraisal manuals, treatises and anthologies from 1903 through the next 100 years) attempts to answer a number of questions.

- Why does the literature deals insignificantly with the concepts of value?
- Why did a parallel survey of academic thesis and dissertations reveal similar neglect?
- How did this state of affairs come about?

The answer found is that fundamental aspects of value have not been discussed in classrooms because it has little or no foundation in the literature. Real estate appraisal has been under fire on many occasions because of its poor reliability. The review of the literature revealed to the authors that the state of affairs in appraisal practice is a result of the way that evaluation is taught and of the way research is directed.

The first university scholar said by the authors to become interested in the practice of valuation was Guiseppe Medeci, who was considered to be one of the great theoreticians of appraisal. Medeci renounced any theory of value and raised appraisal to a science through the merits of its own methodology, asserting that:

If by science we understand that code of laws presented by phenomenon of nature and facts of human life…the possibility that real property valuation can assume the cloak of science is excluded…for the simple reason that the facts of appraisal do not exist…If instead of considering science to be only in the object where in the research terminates, we consider the method to be followed, then the answer is valuation has a method with teaches the procedure to be followed whereby to establish the equivalent monetary value of specific economic goods…It seems clear that the foundation of the doctrine of appraisal is its method."

There was no epistemological reason for dealing with value theory or its history since valuation was scientific in its own right. The authors' conclusion was also summarized by Schultz in 1948. "Future progress in the field of valuation is not on further development of mathematical process; it will be in the discovery and applications between man and his environment." Their review proposes a new science named "Timology", or the "doctrine of value". The word is based on the Greek word timi, or value. Timology would be divided into the following five disciplines.

1. Timography or the study of the concept of economic value and its derivatives
2. Timonomy or the study of the laws and principles of economic value

3. Timotistics or the theoretical study of the formation of any particular economic value due to the action of law and principles of value upon its concept
4. Timometry, (today's appraisal), or formulation of the monetary equivalent of particular economic values; and
5. Epistemology or the critical analysis (origin, value, range and rank) of timology.

1.5.1 Basic Valuation Concepts

The Appraisal of Real Estate (1996), the 'bible' of American Real Estate Appraisal, notes that value is extrinsic to the commodity or good to which it is ascribed since it is created in the minds of individuals that comprise the market. This textbook notes that four interdependent economic factors are said to create value:

1. Utility-is the ability of a product to satisfy a human want, need or desire. The utility of real property ownership are derived from the bundle of rights that one possesses in the realty. A restriction on the rights that diminish the utility of the property tend to reduce its value.

2. Scarcity-is the present or anticipated supply of an item relative to the demand for it. Land is abundant, but only land that has utility and is scarce is considered to be valuable.

3. Desire-is a purchaser's wish for an item to satisfy human needs or individual wants beyond the essentials to support life.

4. Effective Purchasing Power-is the ability of an individual or group to participate in a market-that is, to acquire goods or services with cash or its equivalent.

This textbook also notes that the value of real property is the present worth of future benefits that are derived from its ownership, and that value is affected by the interaction of four basic forces that influence human activity:

1. Social trends,
2. Economic circumstances,
3. Governmental controls and regulations, and
4. Environmental conditions

There is also a wide agreement in the literature that value is based on the concept of highest and best use. The Appraisal Institute defines highest and best use in the same textbook as:

The Appraisal Institute defined highest and best use as:

The reasonably probable and legal use of vacant land or improved property, which is physically possible, appropriately supported, financially feasible, and that results in the highest value.

The Institute goes on to state that "The determination of highest and best use must be based on careful consideration, of prevailing market conditions, trends affecting market participation and change, and the existing use of the subject property. Unfortunately, many authors lament that the analysis of highest and best use in most appraisals is not much more than boilerplate that has been used since the 1960's.

Barrett (1979) voiced displeasure that, although there is a general agreement that the highest and best use of land should serve as the basis of value and that a comprehensive market study is necessary to make this determination; few appraisals are comprehensive market studies. Over 20 years later, most appraisals contain boilerplate quotes similar to his examples:

In the opinion of the appraiser, the highest and best use of the subject property is as currently zoned and improved (or proposed for improvement.

1.5.2 Developmental Analysis as a Test for Highest and Best Use

Kniskern (1933) referred to the need to estimate the highest and present use and consider the appropriateness of a proposed use in its relationship to the site and the surrounding properties, adding that "having determined the ideal improvement, we constructed it in theory, computing the fair justified cost of erecting such a building and then accurately estimating its net annual earning power." He recognized that the potential value of the property had to be tempered by the probability that the prescribed future use may not be achieved by stating:

The principal criteria as to the degree of influence of the future appreciated value are the rate of the changes going on, the nearness in time of those changes, as recognized in the computations, and the degree of certainty with which the changes will definitely affect the given plot. The maximum amount which may be taken into an appraisal as of the present to reflect or represent this future appreciated value would be the present worth of such a value after properly providing for interest and other carrying costs, such as taxes, if any. It may also be necessary to modify this maximum amount in accordance with the degree of certainty that this future value will or may not actually come into being.

Reliable estimates of the future appreciated value noted above are essential for proper highest and best use analysis. These estimates are the purpose of market/marketability analysis, which have not been used by appraisers. This has resulted in courts finding wide variations in appraised land value by appraisers, with the result that this type of analysis being disallowed in California courts.

1.5.3 Recommendations for Appraisal

Kinnard (1968) starts out a discussion of risk by stating that the study of real estate is essentially an attempt to understand how and why decisions affecting the use of real estate resources can be improved. These decisions are subject to risk, since the future can never be known with certainty. Some of the components of future market conditions which provide uncertainty are changes in technology, tastes, political affairs, employment and income.

Techniques for the reduction of uncertainty and risk are discussed, noting that risk can be reduced by the application of systematic techniques of decision-making, especially with the assistance of skilled and knowledgeable real estate specialists. Some of his comments follow:

Probably the most dramatic and potentially exciting possibilities lie in the applications of computer technology to data gathering, storage, retrieval, and analysis. Computer statistics and Bayesian statistics provide opportunities to apply quantitative methods and qualitative standards of judgment (quantitatively developed) to real estate decisions, freeing them from reliance on essentially intuitive judgments...and… Both private and public real estate decisions, especially those involving large-scale projects such as New Town developments, can be aided by the use of computers and mathematical models through a technique known as simulation. (An example provided was the San Francisco Bay Area Simulation Survey) The technique is quite expensive, demanding and time consuming, but it offers the community or large developer the opportunity of testing results under a wide variety of differing assumptions.

Ratcliff (1969) answers the question of whether the appraiser is a professional or not, noting:

Who would judge him to be a true professional if he is unfamiliar with the substantial recent literature in urban economics, regional science, location theory, decision-theory, urban land economics, management science, statistics, probability analysis, computer applications and simulation models? All and more of these modern developments have direct application to appraisal and real estate investment analysis and have the potential for aiding the appraiser in providing truly professional service to his client and guiding him toward sounder decisions.

It is a conservative statement to state that appraisers who still cling to the three approaches are thirty years out of date. (i.e., a toolkit circa 1939) Appraisers and counsellors who are unfamiliar with probability theory and decision theory are at least ten years out of date.

Smith (1977) noted the "propensity of equally well-qualified appraisers to arrive at substantially different value conclusions for the same property has been noted both inside and outside the profession". He stated that "the inability of appraisers to produce consistent value conclusions is why the accounting profession has refused to adopt current market value as the basis for financial accounting".

1.5.4 Academic Literature Regarding Market and Highest & Best Use Analysis

Real Estate Research Issues, Volume 1 (1994) consisted of essays in honor of James E. Graaskamp. It was published by the American Real Estate Society, an organization of academic and investment real estate professionals from the nations leading universities, investment advisory firms and real estate pension fund managers. It is a counterpart to ERES, the European Real Estate Society in Europe and sister societies throughout the world.

Professor Graaskamp developed the University of Wisconsin-Madison Real Estate Department into what many in the industry considered the finest in the United States. Over the "Graaskamp" years, the university produced about 900 real estate graduates, mostly at the graduate level. He studied under Ratcliff for his doctorate and both emphasized the urban land economics approach to appraisal that emphasized spatial demand analysis versus the asset based demand analysis that "created the current glut" that characterized U.S realty markets in the early 1990's. His focus was on the fundamentals determine the success or failure of market participants.

Graaskamp assembled a multidisciplinary pool of faculty members, each of which had expertise in a specific discipline ranging from demography to civil engineering. He was a believer in the importance of multidisciplinary research that was pragmatically relevant. His focus was on market analysis and trade area delineation that are critical to market analysis for real estate.

Grisson and Liu (1994) debate therein whether or not real estate can qualify as a discipline, i.e. a functional area of study, or if it should remain simply a collection of trade preparation courses. They provide arguments that the spatial dimension of real estate must be integrated into the financial perspective in order to understand market fundamentals and quote Graaskamp in saying that risk analysis and management is the philosophical basis of the feasibility process. They note that the concept of real estate analysis as applied economics indicates the importance of an aggregative spatial paradigm to the analysis of values, returns, and risk in real estate markets. The (urban) structural schools are linked by empirical studies identifying parameters impacting real estate values in delineated areas of a city. The study of urban structure and its dynamics, they conclude, are important given the significance of externalities to real estate value.

Clapp et al start out by quoting Kuhn in defining a paradigm as a scientific achievement that is:

Sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity. Simultaneously, is sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve.

They question whether academia in real estate should follow the classical scientific model of deductive reasoning, beginning with a theory and then deducing hypotheses that are tested with data to see if they can be falsified. This type of inquiry in economics discouraged survey research that might ask economic agents about their actual decision behaviour.

The alternative, inductive, approach begins with data and tries to find some order in it. Once the order is found, generalizations can be made which can grow into theory, which can then be tested deductively, stating that inductive and deductive modes of research may compliment each other. The conclusion is that the inductive approach taken in regional science is more amenable to solving problems that entail complexity theory by finding regular patterns of behaviour. Their conclusion is that academia should be focused on teaching students how to solve contemporary problems and that; as a result, a variety of disciplined approaches would be best.

Research should be focused on demonstrating excellence in a new, more inclusive paradigm focused on problem solving in real estate.

1.5.5 Reconciling the Appraisal Model with the Academic Model

The historic appraisal model relies on the use of comparable sales in order to the value of the rights in real estate. This value is said to be created in the minds of individuals that comprise the market. It will be noted later in this paper that institutional real estate advisors subscribe to the academic view of highest and best use, not the appraisal view.

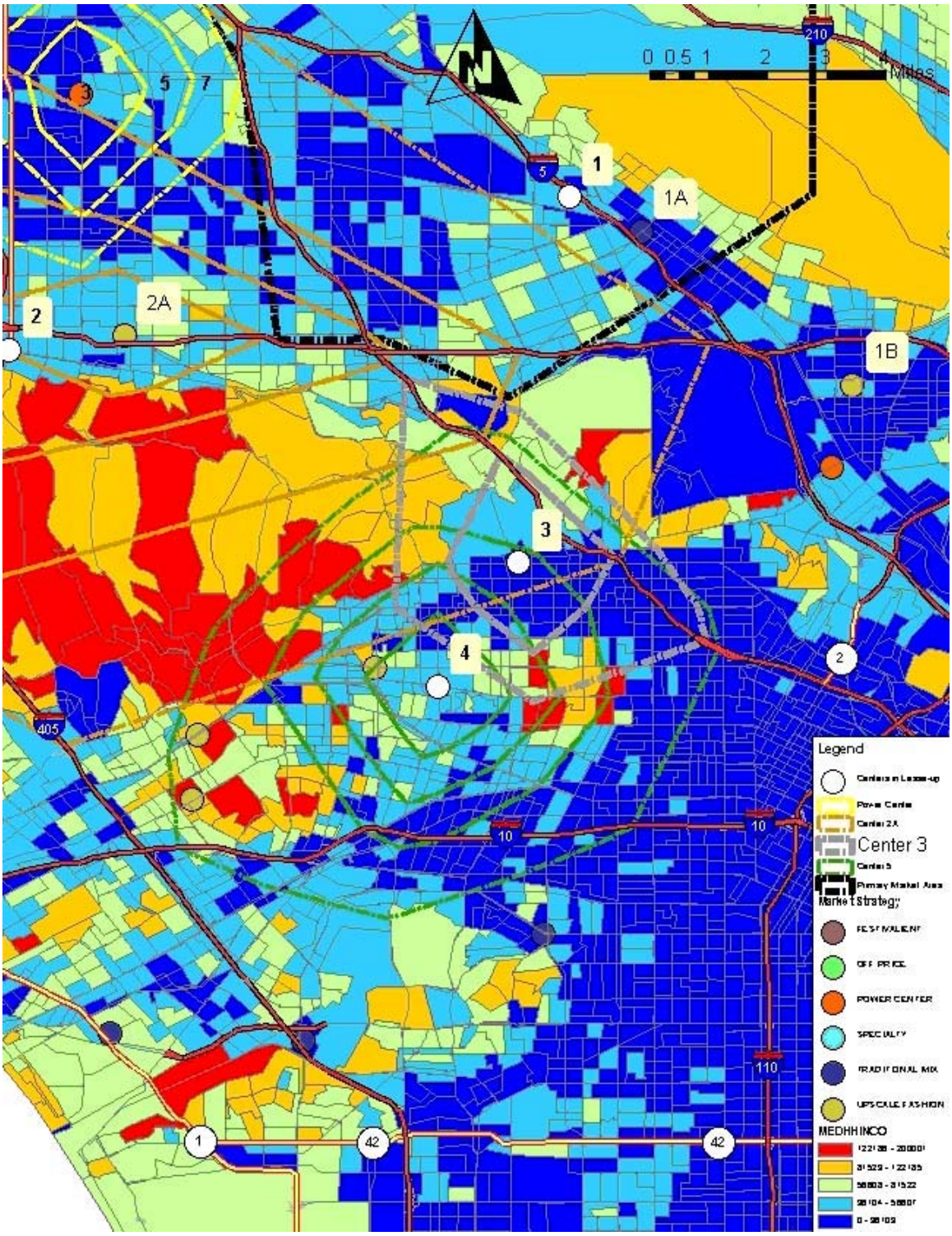
The view of highest and best use from both academia and the planning profession does not rely on comparable sales. Consider the property in the Los Angeles area that was redeveloped into the Hollywood and Highland retail center. The institutional advisor / developer would predicate the retail value of the site on the sales volume that is attainable by the best mix of tenants at this exact location. The sales volume of tenants, in general, sets the level of rent that they can pay.

The amount that the "market" would pay for this site, for retail use, results from the capitalization of net income from the property subsequent to its development and leasing. This income is based on the upper limit to retail rent that can be attained at this location. The literature from both the investment management and planning professions acknowledge that estimating retail sales (or the attainable retail rent) is a spatial interaction problem. The literature also shows that the scientific process is used to estimate future sales that will result from spatial interaction. This estimation problem does not only apply to proposed retail construction. Weber (2003) showed how reduced retails sales at an existing mall from new competition resulted in substantially lowering its value.

The problem with the appraisal model is that the more real estate differs from the typical cookie-cutter residential subdivision, the less likely that comparable market data will provide any valid inference to the value of physically similar property at a different location. Problems resulting from the appraiser's comparable model are pointed out in more detail by Myers and Beck, below.

The map on the next page (Map 1) illustrates how different future sales can be, due in large part to site and attributes of adjacent sites. No comparable sale is likely to reflect the same sales potential as the Hollywood and Highland site, or its competitor, the Grove, located a few miles away.

Map 1: An Example of the Unique Market Areas of Redevelopable Real Estate



Source: Weber (MHHI=Median Household Income, stippled polygons are drive times)

Phase 2 – Market Analysis

Graaskamp often referred to real estate problem solving as amounting to the solution of one of two types of problems: A-The search for a site for a specific use or B-The search for a use for a specific site. The solution to a Type-A problem with GIS is very similar to what is commonly referred to as a GIS suitability study. The addition of geoprocessing to ArcGIS 9 is a major enhancement for this type of spatial analysis. The documentation on the use of ArcGIS 9 provides an excellent example of the use of GIS to solve problem A-the search for the best site.

An example of Problem B was provided by the "four corners" exhibit used by Weber (1997) in a discussion on the valuation of contaminated land. Let's say that four physically identical sites comprise the four corners of an intersection (**Figure 5**) and are all undeveloped or nominally improved with parking lots. If the southeast corner, sells for $20 million for the development of a new mid-rise office building and an appraiser is asked to appraise the parcel at the northwest corner, chances are he or she will use the sale of the identical parcel at the southeast corner as a "comp" and appraiser the northwest corner for $20 million also.

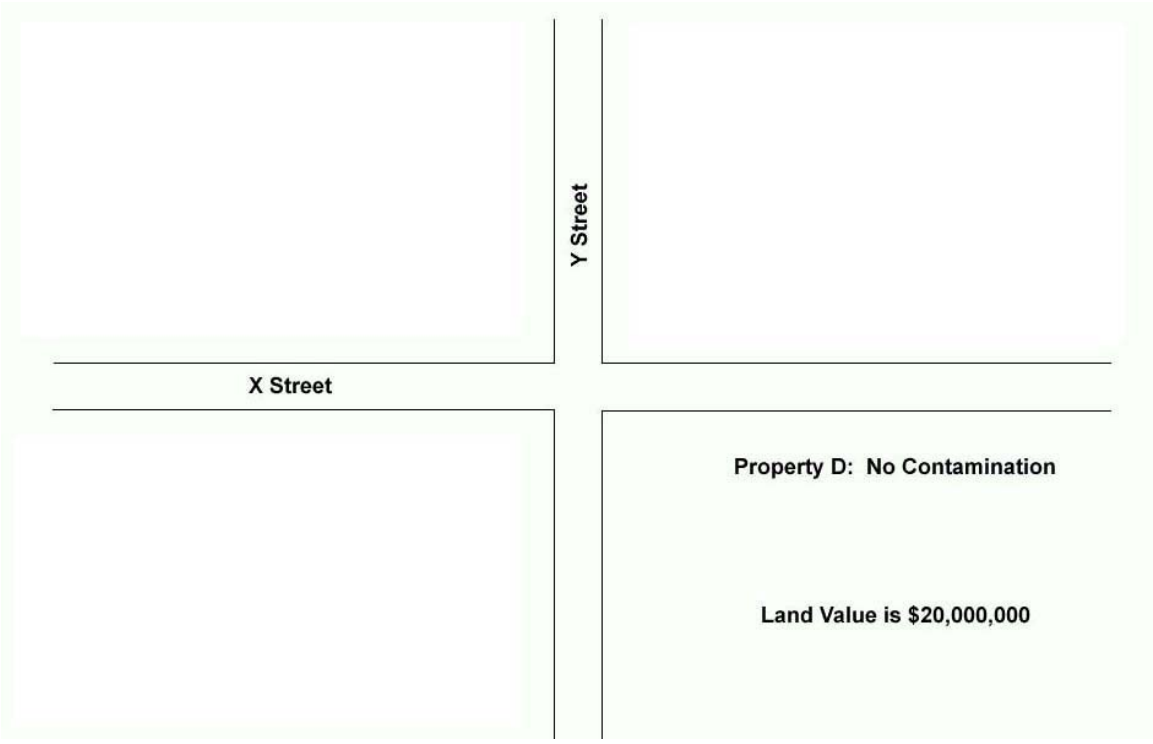


Figure 5. Four Vacant Corners and Only Demand for One - Source: Weber

But what if the local office market peaked and there was inadequate demand for the office building? The local business cycle could turn downward with the result that it will now take 3-5 years for the cyclical office employment to return to the level at which there is adequate demand to warrant the development of the southeast corner. It may take five additional years for office demand to increase to the point at which the parcel at the northwest corner of this intersection has office development as its highest and best use. This simple example provides an example of why there is often poor reliability of land appraisals that are done without adequate market analysis.

1.6 Market Analysis – Real Estate Appraisal

Real estate market analysis is often deficient. Myers and Beck (1994) note two major problems found in most market studies. One results from a relative lack of usable market data and the other is a lack of rigorous and defensible methods for the analysis of the limited market data that is available, stating that, "At the most basic level, it is clear that market studies suffer from an inherently weak and indefensible logic.

The authors also provide a simplistic, four quadrant analysis (**Figure 6)** to illustrate the logic that needs to be addressed to solve two related problems. The first is how to span the gap between the current or historic market data and the future of the local market. The second is how to define a relationship between the market and an individual property.

	Present	**Future**
Overall **(MACRO)** Market Average	Square 3 **Historical and Current** Absorption Vacancies Rents Values Cap Rates	Square 2 **Future Marketwide** Absorption Vacancies Rents Values Cap Rates
Subject Trade Area **(MICRO)**	**Present** Square 1 **Historical / Current Subject Property** Absorption Vacancies Rents Values Cap Rates **Starting Position**	**Future** Square 4 **Future Subject** Absorption Vacancies Rents Values Cap Rates **TheGoal**

Figure 6. Interrelating the Two Essential Dimensions of Market Studies
Source: Weber, Adapted from Myers and Beck

From our observation of practice, the great majority of market studies have failed to adequately address these two fundamental problems; hence the studies have been unable to relate a rational, coherent, and logically defensible analytical flow.

.The Present – Future Problem

The key problem in a market study is how to forecast the future outcome of a subject property if all of the market experience is current or historical. Forecasting is essential because properties cannot be brought to market overnight. The problem is how to craft a future outcome from present data. The present value of a property is based on an estimate of future returns. Lack of attention to forecasting has been identified as a major weakness of market and feasibility studies. As the authors note, ten pounds of current facts do not automatically yield an ounce of wisdom about the future.

The Macro-Micro Problem

The second problem in most market studies is reported result from most of the data being about the market in general, but do not analyze the prospects for a given property in light of this market.

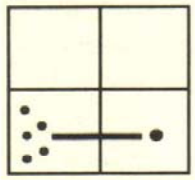
Appraisers address this problem by analyzing comparable properties deemed to be similar to the subject property. The recent history of these comparables is assumed to represent the subject property. The failing of this method is that it ignores the future by concentrating only on recent experience. Others seek to apply average market forecasts to all specific properties in a market area. The failure is that this ignores the differential prospects facing specific properties.

It is noted that three sets of related data are required for each of the "four squares" that are used to link the two dimensions. Most of the data lies in the upper-right square, i.d. present macro, with data on current and historical market conditions. The goal of the market study should be to reach the lower-right square, dealing with future micro, in order to forecast the future prospects for a specific property within its submarket. This data consist of supply data (the characteristics of subject property, comparables, and the market as a whole), demand characteristics (that detail tenants in the subject, comparables, and the market as a whole. Forecasts of demand are typically inferred from variables such as changes in employment, population, and their future space needs. The third set of variables consist of absorption, vacancies, and resultant market rents, with result from the interaction of supply and demand. These rents and vacancy are the determinants of the value of the subject property.

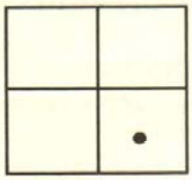
Every market study is said to concoct a method for bridging the gapes between the for squares, but that the quantitative analysis that should tie together this information in an explicit model typically only utilizes data from one or two of the squares.

The authors provide what they say are most likely logical structures (**Figure 7)** for relating the data by the use of the figure below.

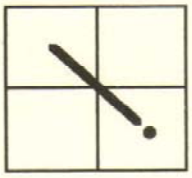
The Appraiser's Comparable Model
Appraisers estimate the value of a property based on recent salling prices for a set of comparables. A direct connection is drawn between the recent experience and the near future, ignoring broader market trends and forecasts.



The Ideal Conditions Model
The analyst simply assumes that the property will operate with a given vacany level and with given annual incrases in rents, a method commonly empoyed in pro-formas. (National Surveys) No real data are used about current or forecasted conditions.



The Constant Conditions Model
Current market-wide conditions are assumed to apply to the subject.property in the future. No forecast information is used. (Apartment cap rates have never been above 9%)



The Average Market Forecast Model
Average forecasts for the market as a whole are assumed to apply to the subject property. Information on segmentation or the current relation of the propertyto the market is not factored in.

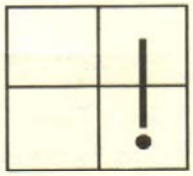


Figure 7. Common Incorrect Logical Structures in Market Analysis
Source: Weber, Adapted from Myers and Beck

The “appraiser’s comparable” model uses recent information on comparable sales, a very limited form of “analysis”. In this model the appraiser assumes not only that supply/demand conditions are the same between the respective sub-markets of the comparables and the subject, but also that their future supply and demand conditions will also be the same. A similar situation results from the addition of a macro market study that fails to quantitatively relate macro supply and demand conditions to specific properties on a micro basis. This problem is known as the spatial allocation problem that was the topic for the doctoral dissertation of England (2000)

England expressed the opinion that spatial interaction models have not been accurate enough for use in warning planners of the chances of retail oversupply as a result of "big box" development. He noted the problem in the U.K. in which large retail buildings, also referred to as “category killers”, created a competitive oversupply of space within a local market area in which other retail centers could not compete. This resulted in businesses that failed due to inadequate sales, leading to blighted town centers, smaller retail formats that were conveniently developed close to larger population concentrations.

Meyers and Beck suggested a six-step method that could be used to solve the two problems. It started with Step One being a detailed inventory of the attributes of the property to be appraised, in a fashion similar to the methodology suggested by Graaskamp. The authors provided an example from the apartment market, but went on to note that retail or office/industrial studies might require different specific methods.

At about the same time, Fanning et al (1994) provided a textbook on highest and best use and market analysis for use in real estate appraisal. It also describes a six-step approach to market / marketability analysis. Marketability analysis is the study of how a specific property is likely to fare in light of the forecasted conditions of the overall market. Their Step 1 also begins with the detailed analysis of the attributes of the property, noting that these attributes specify the extent of the market, both geographically and by market segment. Step 2 is devoted to the delineation of the geographic extent of the market.

1.6.1 Real Estate Market Analysis and Valuation - an International Perspective

McParland et al (2002) summarized European appraisal methods based on their interviews of 110 valuers from Sweden, the Netherlands, Germany and France. This paper analysed the potential for harmonized standards in Europe by comparing standards used in the above four countries, all potential users of the TEGOVA (The European Group of Valuers Associations) standards that were revised in 2000. A cross national comparative analysis of valuation standards contributes to a greater understanding of the problems facing the harmonisation process.

Education

Valuers do not follow the same academic training in these countries in order to qualify as a valuer. The majority of Swedish valuers in the survey (81 per cent) have a real estate degree from the Royal Institute of Technology in Stockholm. An important factor is that the valuation content of this course is extensively influenced by American real estate theory.

University of Amsterdam provides a Masters in Real Estate in Investment and Property Studies (MRE). In Germany the European Business School (EBS) provides valuers with the opportunity to undertake postgraduate degrees in real estate. There is a lack of legal regulation regarding the qualification as a valuer in Germany though the law does indicate that persons describing themselves as valuers must have a certain minimum degree of proficiency, which does not necessarily guarantee dependable valuations.

The education of "sworn valuers" in Germany usually relates to building, architecture or land surveying rather than core valuation skills. Sworn valuers are rarely involved in real estate agency services, so they may have difficulty when trying to gather transactional information or gaining a true understanding of the forces driving price making.

French valuers concentrates upon the technical or legal background rather than real estate. This education system is often criticised for its lack of focus upon property issues as a result.

National Valuation Techniques

German valuers (74.2 per cent) use the capitalisation method since there is a lack of market information and the capitalisation approach is easy to implement and less complicated than exercising the Discounted Cash Flow (DCF).

The use of the capitalisation approach is also very popular in France (57.9 per cent of respondents). French valuers also prefer to use this method since they perceive it to be easier to carry out than DCF.

The Dutch respondents (42.9%) prefer to use the capitalisation method, but they also typically use a discounted cash flow as a backup method. The development of the ROZ/IPD index has had a salient affect upon the usage of the capitalisation approach by Dutch valuers since valuations which are to be included in the index are required to use either the capitalisation or DCF methods.

Swedish valuers normally adopt a hybrid of the net capitalisation approach and cash flow analysis since all aspects of the property are considered through the implementation of this method and since clients are used to the capitalisation approach and expect to always find it in valuation reports.

The comparative method as a valuation approach finds more favour with Swedish and Dutch respondents than it does with German and French Valuers. It is likely that use of the comparative method is popular in Sweden due to the high level of property market transparency as a result of the Land Data Bank System. Many French and German respondents express concern that the comparative approach is sometimes difficult to carry out due to a lack of market information.

The majority of Swedish (65.6 per cent) and Dutch (57.1 per cent) valuers prefer to use the discounted cash flow method of valuation. Swedish valuers began using the method from the early 1990s and Dutch valuers favoured the approach from approximately 1995. In both countries the primary reason that discounted cash flow has risen in popularity stems from its adoption as the method promoted by both the Swedish and ROZ/IPD index. All properties which are to be included in the Swedish index must be valued using a cash flow whereas all properties in the Dutch index must be valued using a cash flow or the capitalisation approach. A negative aspect of the use of discounted cash flow identified by some Dutch interviewees is that a degree of caution needs to be exercised in its application, as values have to be justified by identifying yields and explaining what the yields represent.

The opinion of some German sworn valuers that it is not appropriate for valuers to forecast values into the future. Furthermore, it is argued that many German clients do not request the use of cash flows but prefer to use the capitalisation approach. German sworn valuers are legally required to undertake investment valuations using the cost approach. However the survey results indicate that the cost approach is not the favoured valuation method.

The main reason that French valuers do not want to use discounted cash flows is their reluctance to make future projections. The central premise in France is that the forecasting of future rental levels is exceptionally hard to accomplish.

Standards of Professional Appraisal Practice

The harmonisation of European valuation standards gained momentum during the 1990s primarily due to the intensification and enhancement of cross border property investment. Four main themes that are pivotal aspects of the harmonisation of standards debate: valuer education and professional training, valuation techniques adopted and prevailing national standards. Overall, there is no individual technique which is used extensively throughout all of the survey countries. Instead, valuers pinpoint a range of factors that influence their choice of preferred valuation technique. Client requirements are often a key determinant effecting the choice of valuation techniques by valuers. The comparative approach is favoured in countries where market data is readily available.

Problems Resulting from a Lack of International Best Practices

The primary purpose of valuation standards is to provide clients and valuers with an understanding of the concepts of value. It is important that valuation standards evolve to fulfil their role within the valuation process. There is a need for valuation standards as a direct result of the internationalisation of business and increasing levels of cross border property investment. Research indicates that there is limited progress on the harmonisation of standards in Europe.Fraser and Worzala (1994) discussed the ideas of Graaskamp on the practice of appraisal. They help to explain why appraisal has not adopted the models developed by the academic community, with the result that most appraisers still use the 75-year old Appraiser's Comparable Model to appraise even the most complex assets.

Why, asked Graaskamp, will a lender pay 1% of value to protect a property from fire damage, but but will not pay 1% to insure that a property will properly will be sufficiently leased-up to reach rental levels required to make investment profitable? He then concluded something must be awry and asserted that lenders were more concerned about obtaining a fee for making a loan than in ensuring th long-term viability of the project and ultimate payback of the loan. Directly quoting Graaskamp, the authors stated The appraisal process has become … subverted by the investment industry that is protecting the fees of the loan officer rather than the funds of the saver."

A government appointed subcommittee headed by Congressman Barnard reported that collateral overvaluations of $3 billion were found in 25% of the loans made by federally insured savings and loans and that FDIC loan losses of between $750 million and $1 billion were found to be due to appraisal malpractice. The Barnhard report found that part of the problem could be attributed to "client advocacy appraising," requiring the production of figures to "make the deal work." The disciplinary hearings against 1,600 members of a group of appraisers resulted in only 40 suspensions.

Graaskamp (1986) started out by noting that issues or questions for which appraisal serves as an important benchmark are becoming continually more complex. He underscores the importance of appraisal for society in dealing with a number of critically important issues, but seems to lament that institutional economics limit appraisal innovation. Four possible hypotheses are presented as reasons why appraisal models have not advanced:

- Institutional economics of appraisal organizations are counter to reform
- Consumers of appraisal services may feel that appraisal models are no longer relevant

- Consumers of appraisal services may have a vested interest in exploiting the potential sophistry of historical appraisal models to arbitrage between models for lenders and decision models of value for investors
- Appraisers have proven invulnerable to damages caused by their malfeasance

Graaskamp notes that the knowledgeable purchasers of appraisal services have generally found it useful to exploit the semantics of appraisals in order to obtain values supportable of their objectives, stating that:

The American business ethic finds it acceptable behaviour to shop among appraisers for price and a predetermined bias toward a high or low value conclusion, not to mention editing the final report indirectly by withholding payment for services (which still happens after FIRREA).

Earlier federal attempts at solving the problems with appraisal were contained in Federal Home Loan Bank Board (FHLBB) Memorandums R41a, R41b, and R41c. R41c required the types of analysis recommended above by Myers and Beck. It called for marketability studies that would provide substantive support for the absorption of tenant space within proposed shopping centers and for the absorption of land within larger residential developments. Frazer and Worzala noted that intense lobbying by the real estate appraisal and brokerage industry resulted in the original R41 regulations being replaced by a system of new policies and procedures at insured institutions.

An Attempt as Best Practices for Developable Acreage

The Appraisal Standards for Land-Secured Financings (1996) (ASLSF), issued by the California Debt and Investment Advisory Commission, provides standards for the determination of value-to-lien ratios that may be adopted by local governments in compliance with California Code. This document recommends what is best described as an R41c type of developmental analysis as a method for estimating the value of undeveloped or partially developed land in a community facility district. It also calls for the analysis of marketability and feasibility of proposed construction that is adequate to support an estimate of the rate of absorption of the development being built, in accordance with the recommendations of Myers and Beck.

The developmental approach to supporting opinions of highest and best use has been discussed in the appraisal literature for many years, as noted above by Kniskern. An essential requirement for this method to provide realistic results is the marketability study that deals with the issues stated by Myers and Beck, but as these authors point out, appraisers simply rely on 'comps', so they do not have the experience requisite for accurate demand modeling As a result, California courts have disallowed the use of developmental analysis by appraisers (1992) when they found major differences in the value of the same parcel by two appraisers using this method..

A graphic (**Figure 8)** is provided in the ASLSF that demonstrates one method of determining value based upon a discounted cash flow. This methodology is common in other areas of finance, including capital financing.

<u>ASLSF recommends that an absorption study be used as the basis for determining cash flows from the sale or transfer of properties in a community facility district</u>. Examples shown in the document typically refer to development of residential acreage, since this has been the most frequent type of development utilizing Mello-Roos financing. The California Debt and Investment Advisory Commission verified that cash flows derived from commercial and industrial development also may be modelled over time

Discounted Cash Flow Analysis of Construction Cost, Absorption, Lease-up, and Subsequent Sale of Property Under Development

Discounted Cash Flow Analysis

$$PV = \frac{CF_0}{1+r_0} + \frac{CF_1}{1+r1} + \frac{CF_2}{1+r2} \ldots\ldots + \frac{CF_n}{1+r_n}$$

E,G,:	Development / Redevelopment $ Dev't Cost$_0$	+	Development / Redevelopment $ Dev't Cost$_1$	+	Income from Absorption $ Lease NOI	+	Income From Sale (Built & Leased) $ Reversion

Where:

PV = The Present Value of the Outflows for Cost and Inflows from Rents & Sale of Developed Property
CF = Net Cash Flow per Absorption Period
r = Discount Rate
n = Final Cash Flow From the Sale of the Leased Development

Figure 8. Source: Weber: Adapted from Pg. 19 of California Debt Advisory Commission

ASLSF states that, in theory, a developer would be willing to pay this amount (PV) for the property in return for the opportunity to develop it and earn these cash flows through the sale of the finished product. (Note: the discount rate used in the ASLSF is purely hypothetical and provided for the purposes of example only. It is not to be understood as a standard or as a measure of suitability when applying the discounted cash flow model to an appraisal problem.) The discussion on page 18 of ASLSF shows why these discounted cash flow studies rely on marketability studies in order to provide empirical support for cash flow analysis of development and lease-up of property. This type of support is also required by IVS and the Uniform Standards of Professional Appraisal Practice. (USPAP).

Graaskamp described the inability of appraisers to support such cash flows as follows:

They [appraisers] are encouraged to do that [hide behind hypothetical assumptions] by a lending fraternity that is antiappraisal. An appraisal can cool the deal as far as the lending officer is concerned and there is considerable bias against the appraiser unless he is a controllable appraiser.

Examples of hypothetical assumptions are the requirement by lenders that an appraiser assume that a proposed project has been completed prior to construction so that appraisers don't have to worry about future supply and demand, absorption and rents that Myers and Beck state are so critical for the risk analysis that foreign lenders want. Another prevalent assumption is that a property with known soil and groundwater contamination is not really contaminated.

These best practices are sought in places like the U.K., as may be noted by the work of England (2000). The requests of German mortgage bankers at noted by TEGOVA (2002) suggests a need for best practices for real estate risk analysis, versus lender philosophies of the past..

The inability if U.S. appraisers to deal with the risks of reality as a result of the above constraints posed by lenders, lawyers, and governmental officials have crippled American appraisers so that their stage of economic reality is still circa 1930. R41c has been replaced with the Uniform Standards of Professional Appraisal Practice, which does not deal with prescriptive items such as best practices, so nothing is likely to change in the U.S. International valuation standards are being formed to regulate appraisal activity worldwide, so best practices should be developed

1.7 Market Analysis – Institutional Investors

Institutional investors stress the need for in-depth market analysis as the best method to use for risk analysis. Investment in land also requires developmental analysis in order to price the land properly in light of changing employment and demographic conditions.

Kateley (1995) focused on the retail sector in his discussion of market analysis and its importance for risk analysis. A key difference for retail market analysis is that the retail sector has two markets to attract and retain: the retailers and the shoppers. His group of four factors to consider for supply and demand analysis are:

1 - The extent of the trade area and the expenditure potential of its residents
2 - The competitive alignment of other shopping centers that offer similar merchandise.
3 - The tenancy and merchandise mix, as well as the locational orientation to potential shoppers.
4 - The management and operation of the center as a merchandising venture.

Kateley discusses important considerations that determine the all-important level of retail sales at a shopping center:

The extent of the trade are depends on the type of merchandise in the center, accessibility, drive time, and the intercepting competition. Outlet centers near tourist attractions may have huge trade areas. These trade areas do not consist of perfect circles of three-to-five mile radii, although these simplistic methods are often used. They are irregular in shapes that reflect physical and psychological barriers, drive times and competition. The number of individuals and households in the trade area, their income levels, and their pattern of spending for different categories of retail goods comprise the three indicators of trade area potential. Many complicated statistical refinements, and much experienced judgment, are required to assess expenditure potential.

He notes that there are many rules of thumb and simulations such as gravity and spatial interaction models that are used to forecast retail sales, but states that there is considerable evidence, based on shopping center failures and retailer bankruptcy that suggest that industry standards, models, and rules of thumb do not work His comments parallel Lachman's:.

Changing demographics and shifts in lifestyles, attitudes, and behaviors are the causal factors behind the fact that old rules of thumb and industry standards no longer work well. The major population changes include (1) the middle-aging of the population as the nearly 80 million baby boomers enter their high earning years; (2) the rise of non-traditional households, especially singles living alone, single parents with children, and empty-nesters; and (3) the emergence of multi-ethnic and multiracial majorities in many cities as Asians, Hispanic, and African-American households increase. In terms of lifestyle, many families have two wage earners but less time to shop. These and other changes have complicated trade area analysis. The trickiest part of the equation, translating disposable income into expenditure estimates for each category of retail spending, is rendered more difficult than in the past when mass market assumptions could be used. Looking forward, retail markets will be much more highly segmented, and retail investment will have to adjust for the additional risks that will be encountered.

In dealing with the supply side, it is noted that the trade area retail potential is shared by competitive shopping centers and that the capture of a center is based on its location, access and drawing power in relation to these competitors.

Kateley provides a graphic that illustrates the conceptual complexity of changing economic and demographic factors. It shows that the sales performance of retailers is important to their solvency as a participant, as underscored by Graaskamp. Retailers have fixed costs that require varying levels of sales, based on the types of merchandise they sell, in order to at least break-even, or tenant turnover and vacancy will occur. Sales are a function of economic conditions; demographic factors, shopper preferences (psychographics), and competition will the added complexity of competition that is always changing in response to these changing variables.

Sweet (1995) is an institutional real estate advisor that discussed methodology used for land investment. He starts out by saying that land investment is an inexact science, noting that when the highest and best of use of land is development or redevelopment, land value is viewed as a residual value. That is, land value represents the difference between the capitalized value of the income stream generated by the improvements and the costs (including the developer's overhead and profit) of putting the improvements in place, as adjusted by the project's perceived riskiness.

He notes that the land investment process is complex and uncertain. Although supply typically changes relatively slowly, the demand for the improved property can change rapidly as a result of socioeconomic factors. Since demand is a function of the potential use of a site, the end user ultimately determines its value.

In describing the land investment process, he starts out by noting that successful land investment relies heavily on an ability to collect and organize vast amounts of information that is necessary to understand and analyze geographic areas and their sub-markets, stating that the competitive edge goes to the investor who has the largest pool of accurate information and knows how to organize it. Knowledge is the key. Investors should monitor every detail of each growing community or metropolitan area where they own land or actively seek to acquire it. Creating a comprehensive land research library of aerial photographs, maps, and files fuels the acquisition process. Land investment should tap the power of state-of-the-art computer software specifically designed to track information based on geographic location. Such software can organize text information by map location, making land searches and information gathering faster and more efficient (via GIS-note the similarity between his philosophy and that of Kinnard).

The conclusion is that land has the potential to create great wealth or great disaster, in that value can change quickly. It demands detailed study and a broad knowledge of markets and a comprehensive understanding of the factors influencing the successful development of land. The world is in a constant state of change, so the key is to know more than anyone else so quick decisions can be made from a position of strength.

Coughlin, (1995) at Copely Real Estate Advisors, discussed real estate development from the perspective of an institutional real estate advisor. He starts out by noting that investment in existing, leased real estate can be subject to significant fluctuations in value, but that real estate development is more volatile than leased assets since it contains much more uncertainty. He quotes Dr. Graaskamp, saying that:

Real estate can be defined generally as space delineated by man relative to a fixed geography intended to contain an activity for a specific period of time...the real estate development process involves three major groups: a consumer group, a production group and a public infrastructure group.

The confluence of these major groups in the context of fixed geography presents a series of inherent risks. These risks are examined at the various stages of the development process (land

assembly, product design, product leasing and management, and the space-time market) He describes the risks found in each of these stages and identifies important property/market characteristics that must be reviewed in the process of undertaking real estate development.

In the second or pre-development stage, Coughlin notes a myriad of uncertainties such as market timing, market demand, rental rates, sales prices and environmental issues. “It is critical that the ultimate use and anticipated returns be assessed in this stage”.

The product definition starts with development design by defining market need and how it will be met, which is typically done through the use of a series of feasibility studies. The first one is a market overview, which is then followed by the identification of a more definitive strategic plan. The nature and extent of the feasibility study can vary widely. One of the components of the feasibility study is a market study, which also vary significantly in their complexity and sophistication.

Reinforcing the concern with the high risk of development, Coughlin presents a Monte Carlo simulation of the distributions of the results of development in terms of probability distributions of income, property value and development profit. He terms this as a "simplified illustration", so the use of Monte Carlo should not be thought of as an atypical method of quantifying the risk of future income streams.

Dewberry and Davis list what they consider necessary members of a land development team for the typical land development project:

- Client
- Financial institution
- Land surveyor
- Civil engineer
- Landscape architect
- Architect
- P:roject designer
- Attorney (land use and other)
- Urban planner
- Transportation planner
- Environmental specialist
- Market analyst/researcher
- Real estate broker
- Real estate specialist
- Economist
- Geotechnical engineer / geologist
- Structural engineer
- Archaeologists
- Public approval agencies
- Citizens
- Others (e.g. sociologists, recreational specialists, , other engineers, architects)

Why aren’t appraisers in the list? A common comment is that they are only called after to “bless” values once they have been decided upon by the above group. All of the above have to deal with spatial geographic information, which underscores the benefit of using GIS..

1.8 Market Analysis – The Planning Profession

England's (2000) doctoral thesis examined retail demand models that could be used to quantify the impact that new development was likely to have on the established retail cores of older cities. England expressed the opinion that spatial interaction models have not been accurate enough for use in warning planners of the chances of retail oversupply as a result of "big box" development.

The planning community has been modeling the changing demographics and shifts in lifestyles, attitudes, and behaviors that Kately says are the causal factors for changing demand that result in rules of thumb no longer working. This is done with GIS by a method of microsimulation known as agent-based modeling. This is the concept of object-oriented programming where neighborhoods have been modeled as objects and where agents are programmed to have human-like behavior, deciding where to go and what to do, based on their simulated environments. First, a historical overview.

Klosterman and Brail (2002) note that:

Planning may be thought of as a process for determining appropriate future action through a sequence of choices. To make there choices under uncertain conditions, planners need to collect comprehensive information about the past, the present, and the future. Hopkins (1981) argues, even more explicitly, that planning can be perceived as gathering information to reduce uncertainty.

As planning is always oriented towards the future, forecasting becomes a necessary part of it. Following through the planning process, planners attempt to understand and define current issues, foresee future developments, and propose feasible plans based on available information. Among the available approaches for meeting the forecasting requirements of planners, urban models can be an efficient and effective support tool.

Models that are useful in urban and regional planning must draw upon numerous perspectives, from areas such as economics, entropy/information theory, random utility theory, mathematical geography, and others. The basic intent of operational urban models is to integrate the activity systems in the urban area according to spatial interactions within a socio-economic framework.

The planning process includes a cycle of problem definition, analysis, goal formulation, operational objectives, generation of alternatives, evaluation of alternatives, and choice of alternatives. Planning Support Systems (PSS) are designed to emulate and facilitate the planning process. It has been commonly accepted that a PSS should be built on the basis of GIS. At the same time, it has also been argued that a PSS cannot consist of GIS alone. In addition to the GIS core, a PSS must also include, for example, the tools for urban and regional economic and demographic analysis and forecasting, for environmental modeling, for transportation planning, and for predicting future development and land-use patterns.

1.8.1 Scale and Generalization in Geographical Analysis

Johnston et al (1990) note that "people create structures in the context of places; those structures then condition the making of people. "In that recursive process, people and place change, continually....What we lack in these theoretical frameworks is a clear set of methodological protocols". The authors conclude that multi-level modeling, a particular form of statistical analysis, enables the consideration of context. Multi-level models operate at more than one level, so that a single model can handle the micro-scale of people and the macro-scale of places. Multi-level procedures allow relationships to vary according to context. What is required is something that preserves between-place heterogeneity and does not annihilate space as context in a single equation, which is fitted for all places and at all times.

Modeling must recognize that people make a difference and that places make a difference, so that people are reduced to statistical aggregates and places to generalizations. An example provided is tobacco consumption where there is the need to study simultaneously the micro-scale of individual characteristics and the macro-context of local cultures in which people live. These are known as contextual differences.

Context can be complicated with relationships varying in different ways. In some areas, people in general could have a high incidence of smoking, where in other areas, is it mainly the younger or older population that does most of the smoking. This concept deals with place heterogeneity.

The micro-analysis of employment in San Diego and other areas by Weber (2004B) shows that employment by submarket can be predicted with a relatively high degree of reliability by analysis of such industry groupings. There are still the other three forces that result in global economic opportunities clustering into relatively small spatial areas, as noted by DeVol (1999). Literature from planning was found to be most useful in finding models that deal with employment as well as the regulatory, environmental and demographic forces that can be very instrumental in finding out the most likely direction and concentration of urban growth.

1.8.2 A 'New Wave' of Urban Models

Torrens (2001) notes that in recent decades, geographers, economists, and sociologists have begun to work with a new class of simulation techniques that open up new and exciting possibilities for simulating systems of all descriptions, particularly, the simulation of behavioural processes and the structures that they generate. These models are in their relative infancy as applied to urban modelling and constitute a new class of simulation tools that borrow heavily from developments in geographic information science, artificial intelligence and artificial life, complexity studies, and simulation in natural sciences and social science outside of geography.

The treatment of discrete entities of urban systems; e.g., land parcels, buildings, administrative zones, households, and individuals; as objects has several advantages from a simulation standpoint. There are benefits associated with object-oriented programming (OOP) that remedy some of the deficiencies of 'traditional' models that we have already mentioned, particularly flexibility, usability, and realism. Object-oriented software has the advantage of being more realistic in terms of representing cities, housing, and households.

The basic unit in OOP is the object (as opposed to the statement or the expression in procedural software). The conceptualization of pieces of inanimate code as objects mimics the way that we think of real world objects such as dwellings and the people that inhabit them as discrete units with associated attributes and behaviours. In OOP data and behaviour are integrated (unlike the case in procedural software, where they are separate). This has the advantage of allowing model developers to focus on the program as a simulation rather than as a piece of software.

1.8.3 Cellular Automata (CA) and Multi-Agent Systems (MAS)

In terms of urban simulation, CA are perhaps best used to represent the dispersal of activity and characteristics between discrete spatial units of urban infrastructure, such as housing units or parcels of land. MAS may be more suited to simulating urban population as collectives of individuals or households with associated behaviours and traits and the capacity for spatial mobility and communication. MAS are excellent tools for representing mobile entities in urban environments, e.g., people, households, vehicles, etc. They have been used in urban contexts to simulate pedestrian movement in dense urban environments

Torrens notes that even though CA and MAS are very suitable to the simulation of urban systems and despite the fact that they offer significant advantages over 'traditional' models, there are some things that they cannot represent well, most notably systems that operate from the top down. An example is a regional econometric forecast or transportation throughout the system.

1.8.4 Hybrid Models

As Torrens also states, hybrid models are not new to urban simulation. Most operational urban models are hybrids consisting of separate modules for handling land-use (location decisions, development and redevelopment, market-clearing) and transport (potential demand and trip generation. This ability to use separate models would readily allow the implementation of the equations suggested by DiPasquale and Wheaton (1996) in their simulation of the office market.

Some of Wheaton's earlier work (1987) et al, notes that each market has its structural vacancy at which rents start to decline. This decline in rents due to vacancy would be easy to incorporate into a hybrid model; particularly one that has accepts employment forecasts for the submarket level of analysis. It could result in greater accuracy, as may be demonstrated by reference to the office markets where the internet boom had bust. Rents now had to revert to a level affordable for the previous office occupants. News articles noted that attorneys had been priced out of the West Los Angeles market by dot-coms, for example. Rents subsequently declined to their previous affordability to other local businesses. Torrens concept is that of linking what were once disparate economic and transport models.

His graphic of the land-use component of the simulation environment is divided into three sets of models: those dealing with macro-level, meso-level, and micro-level subsystems. It is noted that there are he several macro- and meso-scales models currently in existence and in operational uses in urban planning. The macro-level model deals geographically with large metropolitan regions, or collections of such regions. Employment and economic activity is handled on a socioeconomic level and is divided into only a few key sectors, while demographics are handled at the level of a few household types. As Torrens notes:

At the meso-level, the simulation is divided by activity. Land and real estate development is modeled on the demand and supply sides, with market-clearing mechanisms to reconcile the two. (hence an oversupply of space leading to vacancy can be removed by declining rents) A land-use transition model simulates the dispersal of activity in the urban infrastructure. The location decisions of households, office employment activities (finance, real estate, and insurance), and (non-service) industry are handled by meso-scale location models. The meso-scale models simulate at an intermediate level of spatial and socioeconomic resolution. Geographically, the lowest level of detail is that of the TAZ or local economic submarket (a neighborhood or district within a city, for example).

The micro-level models pick up where the meso-scale models have left off. Conceptually speaking, they take constraint values from higher-level models and 'distribute' them to entity level units of the built infrastructure or individuals. Equally, they could be formulated to operate in the opposite direction, supplying constraints for higher-level models, or perhaps work in a bi-directional fashion. The micro-scale infrastructure is represented as a CA 'landscape', which we populate with life-like agents.

DiPasquale and Wheaton (1996) note that their models only work on a macro-econometric basis. What is needed then is s method of distributing growth that is generated on a macro basis, whether it be a change in interest rates or whatever, to the submarkets. A micro-econometric

meso-level model could then be used to drive agents in regional economic clusters. This has been done by Weber (2001B) (2004B) providing submarket employment forecasts by industry groups

Torrens suggestion that urban growth models be divided into three modules that would simulate the various components of urban growth at three levels of geography is further illustrated by the graphic on the next page (**Figure 9**) which allocates population growth (a social force) from a macro model to specific submarkets (the micro-level) due to regulatory or environmental forces modeled as constraints as part of the meso level.

The uppermost level is the macro-scale component where the simulation is provided via exogenously-defined growth rates. This portion provides the basic "metabolism" for the subsequent simulation. Variables would include population change and employment trends, which could be linked to census data. The mid-level is where the meso-scale level components are located in the overall model. This level is used to confine the simulation to the submarket. This level also provides constraints to the system.

Part of the Weber thesis is to incorporate a microeconometric forecasting module into the meso level. The addition results in the ability to directly model supply and demand in Square 4 of Figure 6, as recommended by Myers and Beck. Research over the past five years has shown that submarket demand conditions often vary significantly from those on a county wide (MACRO) basis. An example is the Burbank – Glendale office market during the 1990s, when demand for offices in this area remained strong, even in relation to the Los Angeles CBD, a distance of only about 10-15 miles away.

The difference between submarket – MACRO market is even more pronounced for retail. Even though the retail market in Los Angeles has been considered healthy over the past few years, the Media City Shopping Center mall and a number of other shopping centers had major financial upheavals in the past few years.

The lower level consists of the micro-scale components that provide the simulation of the adaptive agents that react to the growth and constraints provided by the upper two levels. It consists of hybrid CA-MAS (Cellular Automata-Multi-Agent Systems) i.e. agents that have been programmed to utilize life-like behaviour, thereby predicting the spatial pattern of growth as a result of the influence of the macro and mid-level components.

Longley and Batty (1996) noted that the traditional emphasis in spatial analysis has been on adapting the linear (or non-linear) model, which is normally estimated using regression or maximum likelihood (ML) techniques, to spatial situations in which the ever-present problem of spatial autocorrelation confounds the basic statistical theory. "When it comes to routine application of linear models to geographical problems, there is still blatant disregard for the progress that has been made in adapting such models to account for spatial autocorrelation.

The use of a complex-adaptive system such as the one which is being proposed seems to obviate the concerns of the typical errors that result from the use of regression models for urban spatial analysis.

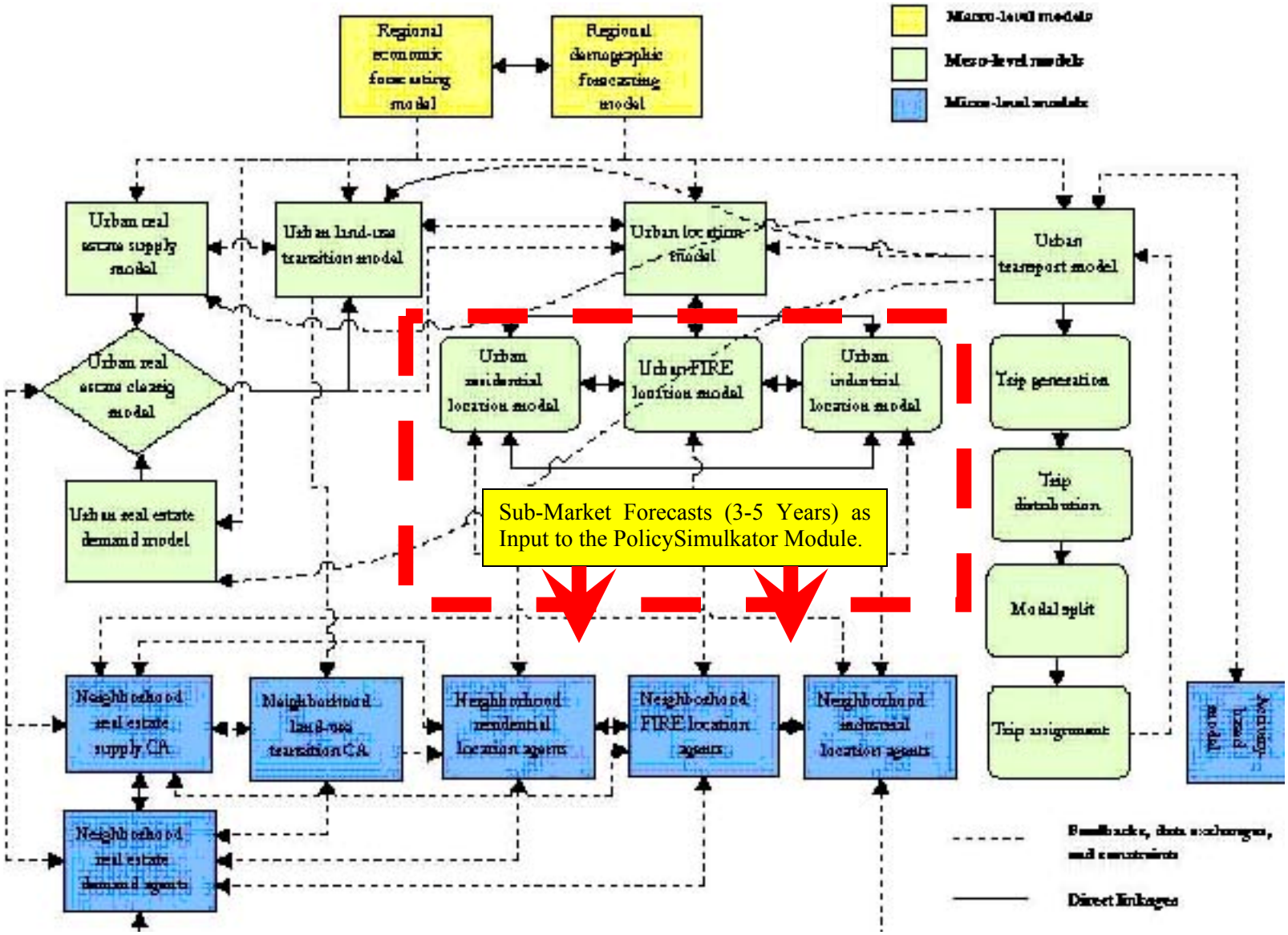


Figure 9. Torrens Model Adapted by Weber to Show Microeconometric Simulations Developed as Input to PolicySimulator

Hepple (1996) notes the wide relevance and applicability of spatial econometrics throughout the social sciences. The author's main theme is that progress in spatial econometrics should interface with all available econometric methodologies. The definition of spatial econometrics provided is that it is a branch of spatial modeling and spatial analysis that is particularly concerned with modeling socio-economic relationships using data for counties, states, regions, locations, etc. As with econometrics more widely, it focuses on the regression model and its extensions, incorporating spatial elements and tests. It is used by a wide variety of disciplines for a wide variety of applications, often by users with no direct interest in the spatial aspects of their data.

Hopkins (2002) fleshes out the concept of the sketch planning process as the basis for a Planning Support System (PSS) and discusses a geographic modelling system (GMS), which attaches systematic modelling processes to spatial objects. An urban GMS would include populations, facilities, locations, and networks. He builds on Harris's (2002) idea of sketch planning by delineating the types of activities that can lead to scenario generation and analysis.

1.8.5 The Trend in Spatial Forecasting Models Used by Planning Agencies

Some of the more recent urban models are summarized below. (Table 2)The trend since 1996 has been to include transportation planning models with regional economic models, since each type of model output has a significant effect on the outcomes of the other model.

Table 2. Comparison of Characteristics of Urban Simulation Models

Spatial forecasting models are incorporating most of the various socioeconomic variables while taking into consideration the importance of location in relation to access to transportation and other important locational attributes. Waddell (1991) had been using GIS models as part of an effort to model intra-metropolitan location decisions by major industrial categories. Zip codes are used as the determinant of spatial choice, which is estimated in a multinomial logit framework. The model shows that there is a considerable dispersion of economic activity and it predicts employment concentration by 1-digit SIC within zip codes quite well by the analysis of distances to the CBD, airport, and freeways, as well as population, their median household income and other characteristics of the population within the zip codes.

ScenarioConstructor and PolicySimulator are two modules from a three-module set known as CommunityViz. The third module, SiteBuilder 3D, is used to convert the results of the analysis from the other two models into three-dimensional models of the geography and buildings that are being modeled. The three-dimensional models would be useful for empirical support for land use decisions because it can create realistic models of proposed construction for use in choice-based conjoint models. Weber (2004B) implemented such a model for highest and best use analysis. The 3-D modeling is also useful for consensus building. See Braile at al (2002).

Table 2. Comparisons of Various Types of Urban Simulation Models Used to Forecast Urban Growth over Time

Characteristic	DRAM/EMPAL	MEPLAN-TRANUS	CUF-2	UrbanSim	Scenario Constructor	Policy Simulator
Model Structure	Spatial Interaction	Spatial Output	Input- Discrete Choice	Agent-Based Discrete Choice	User defined, this is a tool for building models by linking formulas to GIS objects.	Agent based, grid driven. Stochastic, but Scenario Coinstructor is not.
Household Location Choice	Modeled	Modeled	Not Modeled	Modeled	User defined	Modeled
Household Classification	Aggregate, 8 categories	Aggregate, User-Defined	Not Represented	Disaggregate, Income, Persons, Workers, Child	User defined (unlimited)	User ID for every agent with household reference
Employment Location Choice	Modeled	Modeled	Not Modeled	Modeled	User defined	Modeled
Employment Classification	Aggregate, 8 categories	Aggregate, User-Defined	Not Modeled	Disaggregate, 10-20 Sectors	User defined (unlimited)	Disaggregate- by LBCS code based on current town businesses
Real Estate Development	Not Modeled	Modeled	Modeled	Modeled	User defined	Modeled
Real Estate Classification	4 Land uses	Aggregate, User-Defined	7 Land Uses	24 Development Types	User defined (unlimited)	LBCS structure, function, and activity
Real Estate Measures	Acres	Acres, Units, Floorspace	Acres	Acres, Units, Floorspace	User defined (acres, sf, sm, du, FAR… whatever)	number of stories, footprint area, floor area, number of units
Real Estate Prices	Not Modeled	Modeled	Not Modeled	Modeled	User defined	Modeled
Geographic Basis	Census Tracts or Aggregates	User-Defined Zones (2-300)	Grid Cells	Grid Cells	Any vector dataset. (tracts, blocks, TAZs, parcels). Can summarize Grids (max, min, avg)	Grid cells- user defined 30-150 meters. Population = ~100,000 based on current processors.
Temporal Basis	Quasi-dynamic, Equilibrium (5-10 year steps)	Cross-Sectional, Equilibrium	Annual, Dynamic	Annual, Dynamic	User defined (decade, annual, monthly, nanosecond etc.)	Monthly
Interaction withTravel Models	Yes	Yes	No	Yes	No	Outputs are a database.
Modular Model Structure	Partial	No	No	Yes	Yes	No
Software Access	Proprietary	Proprietary	NA	Open Source	Proprietary	Proprietary

Source: UrbanSim: Modeling Urban Development for Land Use, Transportation and Environmental Planning, Waddell, University of Washington and Weber

A review of operational models for the Transit Cooperative Highway Research Program, project H-12, developed a specification for a proposed 'ideal' integrated land use and transportation model system, and assessed operational models compared to this framework, including DRAM/EMPAL, MEPLAN, TRANUS, NYMTC-LUM, MUSSA, and UrbanSim. The report concluded that UrbanSim came closest to their proposed 'ideal' specification. A more recent report by the National Cooperative Highway Research Project examined operational models and assessed their potential for use in evaluating the air quality impacts (environmental factors influencing values) of highway capacity expansion. The review of land use models included DRAM/EMPAL (ITLUP), MEPLAN, NYMTCLUM, and UrbanSim. UrbanSim was singled out as a foundation that is to be used for further development.

UrbanSim departs from aggregate economic and spatial-interaction model designs that rely on cross-sectional equilibrium. It's a disaggregate approach based on predicting changes over small time steps, as does the CUF-2 model. Unlike the CUF-2, the UrbanSim design represents the demand for real estate at each location. It makes use of agent-based simulations and the actors and choice processes that influence the patterns of urban development and real estate prices.

UrbanSim is best described as an urban simulation system that implements a series of models in order to interact with the local environment. Some of the models, such as the economic and demographic transition models, are aggregate, non-spatial models that deal with the interface to external macro-economic changes. Other components such as location choice models are discrete choice models of an agent (a household, for example) making choices about alternative locations, taking a top-down view of the metropolitan area. Two of its models deal with spatial forecasting of the local real estate market on the parcel level.

The development model takes a mostly bottom-up view, from the vantage point of a developer or land-owner at a single location (grid cell) making choices about whether to develop, and into what type of real estate. The bottom-up view in the developer model is tempered by market information that reflects the state of the market as a whole, such as vacancy rates.

The development model simulates a developer's choices about what kind of construction to undertake and where, including both new development and redevelopment of existing structures. Each year, the model iterates over all grid cells on which development is allowed and creates a list of possible transition alternatives (representing different development types), including the alternative of not developing. The probability for each alternative being chosen is calculated in a multinomial logit model. Variables included in the developer model include characteristics of the grid cell (current development, policy constraints, land and improvement value), characteristics of the site location (proximity to highways, arterials, existing and recent development), and regional accessibility to population.

The land price model simulates land prices of each grid cell as the characteristics of locations change over time. It is based on urban economic theory, which states that the value of location is capitalized into the price of land. The model is calibrated from historical data using a hedonic regression to include the effect of site, neighborhood, accessibility, and policy effects on land prices. It also allows incorporating the effects of short-term fluctuations in local and regional vacancy rates on overall land prices. Similar variables are used as in the development model. In addition to model-generated events, the system accommodates information that planners have about pending development, corporate relocations, or policy changes. A capacity has been developed to introduce user-specified events such as these into the model, both to allow planners to use available information about developments that are 'in the pipeline', and also to provide a capacity for testing the potential effects of a major project on further development and on traffic.

1.8.6 GIS Planning Models for Valuation

All but one of the models described above are far too large for use in conventional real estate appraisal. The approach taken by UrbanSim is best in that it deals with the four forces that are said to be the determinants of real estate value. Unfortunately, it is also a massive model that requires the input of may specialists, such as econometricians, planners, architects and computer programmers that are needed to put all of the theory together in an agent-based framework.

CommuintyViz is a trio of computer programs that can be used as a modelling framework for spatial forecasting. It is similar in many respects to UrbanSim... The core module is known as ScenarioConstructor. ScenarioConstructor is best described as a method of connecting a spreadsheet to the point, lines, and polygons that comprise ArcView GIS.

ScenarioConstructor is not stochastic. This module allows users to create their own formulas and assumptions explicitly. These formulas and assumptions are static over time. If the user assumes that water usage is 14 gallons per household member, then it will always be that number. If we were to add one person to the household, water usage would go up 14 gallons. PolicySimulater (PoliSim), on the other hand, is designed with assumptions, which are custom tuned for each community during the calibration process. More importantly, however, PoliSim looks at the long-term effects of changes, and how those long-term effects change over time. It would be difficult, if not impossible, for a user to create a simulation model that can represent the ability to model changes over time. PoliSim is a stochastic modelling tool designed to model change in a real estate market over time, capable of considering all four forces that affect value.

Bernard (2002) was the team leader that developed the PoliSim as a demographic, economic, and land use forecasting tool designed for small communities. It uses agent-based simulation to make its predictions, based on numerous data supplied by a user. It can be calibrated using a method that combines genetic algorithms and simulated annealing. Agents and businesses make many decisions, as illustrated in Figure 10, throughout the course of the simulation that combine to produce a realistic approximation of how a town develops. Users can then try out different local government policies to see how they might impact the development of their community.

PoliSim is similar to traditional land use models that are used to forecast population and employment for planning purposes, such as DRAM/EMPAL (Metropolis), PLUM, EMPIRIC, POLIS and others. In the planning world these models are most heavily used in support of transportation planning as they produce output necessary to run transportation models (TRANPLAN, EMME2 and others).

Technically, PoliSim is very different from these models. As described above, it is an agent-based simulation, which means that it attempts to replicate the actions of individuals in a community in order to determine a forecast for the entire community. This is called "bottom-up" forecasting. Most other models are locative or "top-down", meaning they simply allocate a predetermined number of people and jobs to small areas depending on variables like available land and past changes in employment and population.

Further, since PoliSim is stochastic, every time a simulation is run a slightly different result will occur. Most other models are deterministic and give a single answer for each simulation. While a single answer may be easier to react to, a model with a stochastic element recognizes the future is not certain and that there are many possible outcomes.

PoliSim is structurally similar to UrbanSim and TRANSIMS, the new traffic simulation initially developed by the Los Alamos National Laboratory and PriceWaterhouseCoopers (PWC) with support from the Department of Transportation, since PolicySimulator was also developed by PWC. PWC has since been acquired by IBM, which is now involved with the TRANSIMS modelling effort. The model contains data generation procedures that produce micro data representative of the community based upon the information entered into the model, which is typically census data. In doing so, it provides the input to create a population of "agents" that approximate the actual makeup of individuals and businesses in the market area.

The data required for input are a mix of historic and current data. The historic data is essential for the calibration of the model. Historic trends on job growth are mapped to some of the historic physical changes in the real estate market, so that the model knows which direction to spread future growth towards as a result of local planning and zoning restrictions. Weber (2004B) has developed a method for employment estimates; previously the major PolicySimulator problem

There are five basic input groups that are used for calibration. The base year of the forecast, demographics of the market area population (by assessor parcel number), control totals, i.e. population and income (that are used to fit the model), other input files, and miscellaneous policy simulator files. The procedure starts by having the user identify the base year, their forecast years, and their historic years. Often, base year is 2000 because of the recent availability of the 2000 census data. Historic years might be 1995 and 1990 while future years might be 2007 and 2010. The historic years the user selects should best match their available historic data. The future years the user selects should look toward the forecast horizon the user intends to forecast.

The demographics section requires information describing place-of-work jobs and the resident population of the area being modelled. Questions to be answered: How many people work in the market area? In what industries are these people employed? How many in Agriculture, Mining & Construction, Manufacturing Transportation, Communications & Utilities, Wholesale Trade, Retail Trade, Finance, Insurance & Real Estate, Services and Public Administration? Pointing the model in the right direction by a reliable short-term submarket employment forecast via OLAP, as described by Weber (2001B) could be a very important component of accuracy, especially for cyclical changes, as occurred recently in the San Francisco Bay Area.

Sitebuilder 3D is the third component. It is linked to the other two modules with the result that land use scenarios that are created as part of a highest and best use analysis can be shown in 3D. The 3D result can be viewed by prospective market participants via the Internet and thus used to obtain statistical estimates of demand for the proposed use, as illustrated by Weber (2004B)

Calibration is generally understood to be the ability to tune a parameter set so that known historic data at one point in time can be used to predict known data at another time point (**Figure 10)** Bernard pointed out that traditional techniques of reductionist scientific analysis do not always work well on a complex adaptive system. A complex adaptive system is one in which there are multiple interacting entities (a.k.a., agents), each of which are autonomous. Even a small town will have a myriad of relationships distributed across space and time. Policy Simulator uses agent-based simulation modeling as its major theoretical orientation. Agent-based simulation modelling has been used in a variety of fields for a number of different purposes, and it is now an accepted method for analysis of problems that cannot be solved effectively using traditional techniques that do not simultaneously model social, regulatory and environmental variables.

Need to Calibrate Non-Linear Models

Most Likely Types Of Microeconomic Growth → Most Likely Effect Of Property Restrictions = Most Likely Locations For New Development

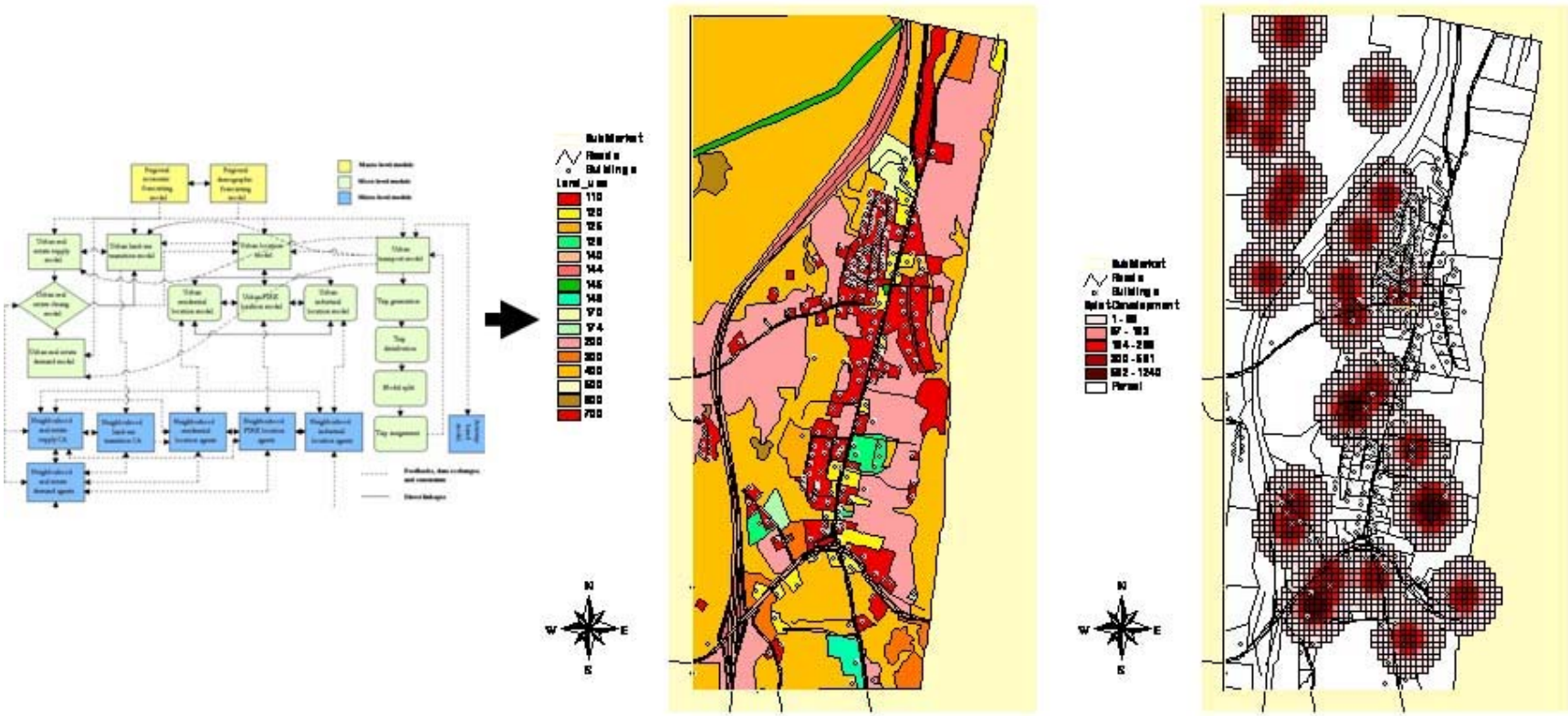


Figure 10: Integrating the Torrens model with PolicySimulator to Forecast Demand by Sub-Market Location Source: Adaptation by Weber

Any kind of mathematical modelling requires a tuning or calibration process in order for the model to function with any degree of accuracy. From linear regression to maximum likelihood estimators, models require that their parameters or coefficients be estimated in a manner that brings their predicted results in line with the expected results.

Many types of non-linear models used in planning cannot be reduced to linear form and must be calibrated using alternate methods. PoliSim is one such model. PoliSim represents a particularly difficult challenge for the process of calibration due to a number of factors relating to the nature of the simulation model. The first difference between calibrating a simple model and PoliSim is the number of parameters and outputs on which the model can calibrate. Polisim has about 30 different parameters on which users can calibrate. Many other models in econometrics, for instance, try and minimize the number of parameters in the model, so as to make the search for a solution faster. Thus, the problem space is one of high dimensionality.

Similarly, the solution space – that is, the target variables users are trying to match in the calibration process – can also be of high dimensionality. Users can choose a number of variables on which to calibrate (e.g., jobs, households, land value, etc.). Attempting to reduce the error between the predicted and actual numbers of several variables is a delicate balancing act; frequently, when one variable gets closer, the other diverges.

Third, PoliSim is a non-linear model, which means that it not necessarily possible to find the optimal set of parameters to reach the desired target results. Non-linearity is not a problem per se -- there are a number of nonlinear models in demographic, economic, and land use forecasting – but unlike some nonlinear models, it is impossible to transform or decompose the PoliSim algorithms into solvable linear equations.

Another issue is the inherent stochastic nature of the simulation engine. Each time the simulation is executed with a different random number seed, the results of the simulation are very likely to be different. This is because the simulation engine is stochastic, not deterministic. Decisions that the agents and businesses make are probabilistic – we cannot determine with certainty which way an individual will decide when confronted with a choice. Therefore, on many decisions, Polisim calculates a score for each option, and then picks a random number. Entities are more likely to choose those options with better scores, but it depends on the random number chosen.

Once calibration was complete, the community could use the best-calibrated parameter set with confidence, knowing that it had predicted accurately the actual data. Most communities do not have such data however. They are forced to calibrate using a different method. These communities would take known control total variables from 1990 (for instance) and their counterparts in 2000 and use 2000 as the "current year" and 2010 as the "forecast year". In such a case, if they did not have control total numbers for 2010, Polisim would project a 2010 estimate using a linear regression (using 1990 and 2000 numbers).

If they did have 2010 numbers, Polisim would use those. In either case, Polisim would calibrate and try to match its 2010 numbers as output by the simulation engine to those numbers in the control totals file. Certainly, choosing historic points in an atypical year (such as at the start of an economic downturn) would adversely influence the projection of future control totals. Users can best avoid this by choosing future year totals themselves, rather than having Polisim project it for them. This is the reason for using recent submarket forecasts for input to the model.

Phase III

Using the Technology to Enhance the Market Analysis Process

GIS is a subset of Geospatial Analysis, Sietzen (2004) has provided an article regarding the identification of geospatial technology as a high-growth job market for the coming decade, suggesting that the U.S. Department of Labor (DoL) is going to invest $15 billion a year to insure that a qualified U.S. workforce can keep pace with industry growth. The DoL has been working with the industry, business associations, and academic institutions to address what is considered to be a looming shortage of the geospatial workers that are needed as a result of applications of the technology outstripping the development of its workforce.

DoL interest in GIS and its related technologies results from the department's identification of the three technologies that are poised for explosive growth this decade: geospatial technologies, biotechnologies, nanotechnologies. These three technologies are now part of a long-term DoL High-Growth Jobs Initiative because of their potential to create jobs and economic growth. It is the reason for spending as much as $15 billion annually in technology education. The DoL is said to be collaborating to define job and curriculum requirements. The program is well underway and a consortium of community colleges have developed a training proposal for the workforce.

Today's $5 billion market for geospatial technologies is said to be set to explode to $30 billion in just a year. Workforce training is also in place for the National Aeronautics and Space Administration (NASA), with special emphasis on remote sensing, image processing, and interpretation. It has been noted that these technologies encompass much more than GIS software alone. It includes location tracking, GPS and other technologies.

DoL defines this industry as "an information technology field of practice that acquires, manages, interprets, integrates, displays, analyzes, or otherwise uses data focusing on geographic, temporal and spatial context." This has historically been the role of real estate appraisers and others in the real estate community.

The Jackson State Community College, in Jackson, Tennessee, and a consortium of colleges and universities throughout the country has proposed to the National Science Foundation (NSF) the Center for Geospatial Learning, which would be a virtual and a physical facility.

Fanning et al (1994) have written a book on real estate market analysis that is used by the Appraisal Institute to teach appraisers how to use market analysis as part of the appraisal process. This process contains six steps that have been outlined in Figure 2. Most of the literature for the thesis has been organized under each of these stix steps, depending on which step the analysis is most relevant for.

A very brief summary of each of the steps and the application of GIS to each of steps is summarized below. Models from the literature that are applicable to the six-step approach to market value are contained in the addendum. Models such as these could be incorporated into a groprocessing framework, resulting in a powerful application of geospatial technology for the analysis of the variables that are considered most responsible for real estate value and its changes over time.

1.9 Step 1 – Productivity Analysis

Productivity Analysis is defined as the process of identifying the productive capacity of a property to determine the real estate services it can provide. This is done by considering the attributes of the site and its improvements, concentrating on how these physical, legal, design, and locational attributes are combined to meet the needs of competitive users. Productivity analysis is required for the determination of highest and best use since it identifies the range of possible uses and relates the uses to those uses which are in demand in the specific market area of the property in question. This if very similar to a GIS suitability study.

1.9.1 Step 2 – Market Delineation

The course handbook used to educate appraisers in market and marketability analysis (1993) notes that the attributes of a property define the service that it can provide. For example, a one-acre vacant site is not physically capable of accommodating a regional shopping center, so the market analysis need not consider supply and demand on a regional basis.

1.9.2 Step 3 - Competitive Supply

The competitive supply consists of the inventory of real estate that a buyer would consider purchasing instead of the subject or a building that tenant would considering leasing instead of a property in question. Competitive supply is in the mind of these owners and occupants. GIS can be useful in defining the extent of the competitive supply by providing GIS models that can be used as part of survey research, which is discussed in more depth below.

1.9.3 Step 4 – Market Demand

The socio-economic variable in urban areas combined with highly differing levels of accessibility often results in appraiser's comparables not being comparable. The ability of GIS to create lift-like models of real estate result in its being very useful for survey research, often via the internet. GIS models of land subdivisions have been used as part of a choice-based conjoint analysis that allows the appraiser to not only statistically quantify demand, but also create demand curves.

Sawtooth Software provides very good documentation and models that can be used by someone such as an appraiser in order to do survey research that can quantify the demand for various methods of subdividing land, for example.

1.9.4 Step 5 – Spatial Interaction

Spatial interaction refers to the process by which a new development changes the behaviour of the market participants in relation to similar existing developments. Spatial interaction has been studied by researchers from many disciplines over most the 20th century and it has proven to be very difficult to predict.

GIS can again be very instrumental in developing statistical models that have varying degrees of accuracy in predicting spatial interaction. One type of retail model is based on what is referred to as the gravity principle, which states that the larger the shopping center, the wider diversity of the goods that are available for purchase and, as a result, the greater the distance and more people it will draw. An example of such a GIS model is the second one in the addendum.

1.9.5 Step 6 – Subject Capture

Subject capture is the key issue in feasibility studies. It is dependant on how many of those in the market are attracted to the property appraised, which is dependant on overall demand and how well the real estate competes on a spatial interaction basis. Discrete choice theory has proven to be a good statistical tool for quantifying capture rates (the last model in the addendum) , and GIS models are useful for visualization of competitors as part of the modelling process.

1.10 Summary and Implications

TEGOVA would like valuers to provide risk analysis as part of their process of making real estate loans and the global investment community needs reliable valuation methods.. The figure shown below (**Figure 11**) lists items of concern for commercial property.

Commercial Property Criteria	Today v. 10 Year	Geographic Level of Agent-Based Modeling					Method of Quantification*
		Modeling Level:	Macro	Meso	Meso/Micro	Micro	
Long-term Influenc	**Item**	**Indicator**	**Country**	**Region**	**Market**	**Site**	**GIS Tool**
	Inhabitants	Number	X		X		Microsimulation
	Development of the Population	Changes in %	X		X		Microsimulation
	Structure of the sector	good/average/bad	X		X		Microsimulation
	Growth opportunities of the sectors	good/average/bad	X		X		Microsimulation
Regional environmental/soil risk							
	Endangered by high water	Yes/no		X			Map Layers
	Endangered by earthquakes	Yes/no		X			Map Layers
	Possibility of soil sinking	Yes/no		X			Map Layers
Market structure/size/dynamic				Market Delineation/justification?			Exploratory Data
Maket cycle with respect to rent		Boom/Recession			X		Exploratory Data
Volatility		Coefficient of variation			X		Exploratory Data
Vacancy		Rate			X		Exploratory Data
Location & site criteria							
Connection to transport facilities		Motorway/Train/Aircraft/Ship				X	Drive-Time Analysis
Building suitable to location		Yes/no				X	Suitability Study
Local competition/catchment area		strong/average/low				X	Exploratory Data
Attractiveness of the branch		high/average/low				X	Conjoint/Gravity
Use of land suitable to the location		yes/no				X	Suitability Study
Quality of the land (contaminaion)		yes/no				X	Exploratory Data
Emission		yes/no				X	Kriging

*** GIS assisted methods that could be used to quantify each item of risk**

Figure 11. Using GIS to Quantify Financial Risk Source: Weber's Adaptation of TEGOVA

Some of the items specified for risk analysis are relatively straightforward applications of GIS, such as mapping the property location in relation to flood, seismic, and soil maps.

The areas shown in yellow have been added to the TEGOVA list as methods in which GIS could provide the information needed to assuage their concerns about the items that are listed adjacent.. A simple method of analyzing transport facilities would be a drive-time analysis. Suitability studies would be ideal GIS applications to use to find out if a building is physically suitable for a location or if a specific use of land is physically suitable from an environmental standpoint.

Roulac has noted that worldwide education in real estate has historically been inadequate, with some countries focusing on real estate from a finance or business administration standpoint while others focus on real estate from a surveying standpoint, while other countries depend only on the cost approach to value. He is calling for future education that would result in a 'renaissance man' that he terms the 'New Property Professional'.

The research by Adair et al also shows that countries such as Sweden, where 81 per cent Swedish valuers have a real estate degree from the Royal Institute of Technology in Stockholm, would be very good candidates for the more advanced applications required for complex valuations. Other countries such as Germany and France do not feel that it is appropriate to forecast future rents and

values into the future. Since Clapp et al conclude that academia should be focused on teaching students how to solve contemporary problems and that; as a result, a variety of disciplined approaches would be best, it might be best if multinational experts in disciplines that are described by Roulac and Dewberry collaborate on valuation via GIS by way of the internet.

Robbins et al (see the addendum) have shown how multi-disciplined experts used GIS to quantify the attributes of real estate that were previously not thought to be quantifiable. The use of similar research using 3-D GIS models for survey research via web-based applications would provide empirical support for the value that literature tells us is created within the minds of the market participants.

The 'four-square' model presented by Myers and Beck underscore the entirely different skill set that is needed to properly move from historic market-wide data to submarket forecasts. Weber used the 'four-corner' example to help illustrate the same issue in the context of the valuation of contaminated land. A reliable methodology for forecasting the cash flow results of remediation and redevelopment of contaminated land is essential for reducing the risk of both construction and permanent financing of brownfield sites. Both the LA Basin and many European cities need to redevelop existing land uses for new construction to occur, so reliable methods are needed.

Peterson discussed problems inherent in defining market areas and making inferences for demand based on certain sampling techniques-all critical elements for proper market analysis. Stanley has improved on the use of gravity models in an attempt to deal with spatial interaction problems that result when new development impacts and changes the existing urban structure. Fryear et al have found that those in the retail industry are heavy users of GIS, suggesting that education in some of the more complex GIS applications would be very beneficial if it were offered in many more of the university programs described as real estate related by Roulac.

Continuing the focus on retail real estate, the authors of Megatrends in Real Estate detail some of the important issues that have to be dealt with in order to understand markets and deal with risk. Eppli demonstrated empirically that spatial economics alone only explain 60% of actual sales volumes of retail sales/SF of non-anchor tenants, the key determinant of the level of feasible rent (threshold that a tenant in a proposed shopping center can pay, as well as what the center will be worth upon the completion of its construction. This shows why the simplistic Ling and Smersh Voroni polygons and desire line maps are inadequate as a GIS tool for forecasting rents. The analysis showed that the addition of retail clustering and anchor tenant image to household incomes, high, and low population density variables explained 77% of the sales/SF for the major shopping centers in Eppli's study.

Lachman added to the complexity of valuation by discussing some of the demographic changes within market areas that are responsible for changing trends in retail sales at shopping centers and the likelihood of accelerated changes in trade area demographics. The graph of the results of the PolicySimulator (**Figure 12**) can provides an example of an aging population and fewer of the high-spending young adults. The overall population is also declining, which is said to be the case in many parts of Italy, France, and other countries. If one could reliably forecast future trade-area demographics reversionary values would be more accurate. Another major point that she made was that changing economic conditions are responsible for changing population and sales by the time new construction is completed.

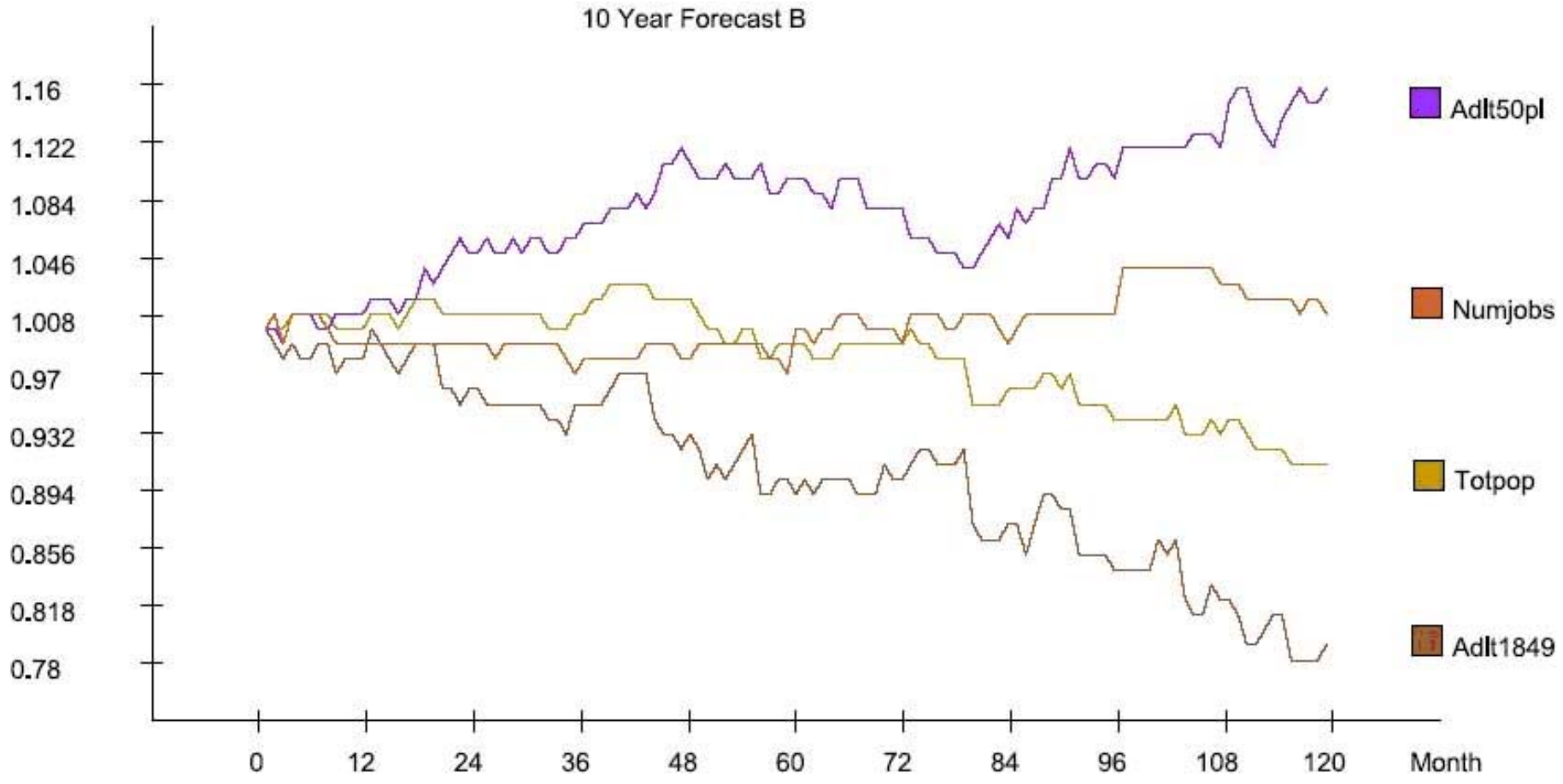


Figure 12. Graph of some of the results of a PolicySimulator Run Source: Weber

Okoruwa added to retail modelling knowledge developing a refinement to the gravity model via the use of a Poisson distribution and demonstrated how the center size and socio-economic characteristics explain sales. They noted a very important consideration for valuation experts here an especially in other parts of the world – the inability to obtain data such as sales volumes that are necessary to calibrate statistical models.

Kately confirmed the importance of all of the variables researched by the above authors as part of the analysis of retail demand. He also notes that the more simplistic models used in the past have been proven to be inaccurate as demonstrated by retail bankruptcies. He also thinks that changing demographics, as stated by Lachman, have significantly complicated trade area analysis that is required to translate consumer demographics into not only the amount of retail spending, but the most likely locations where this spending is going to occur. He states that retail markets will be much more segmented in the future, resulting in additional risks that need to be measured.

Sweet states that demand if a function of the potential use of a site. Both he and Coughlin note that it is necessary to analyze the cash flows from the development of a site in order to determine its value. In other words, both agree with the appraisal literature from the 1930's as well as those who implemented Federal Regulation R41c and the California Debt Advisory Commission. This approach has been held to be inadmissible in court because its reliable use is predicated on proper application of the "four squares" of Myers and Beck, the authors that have also noted that the use of "Appraiser's Comparable Model" results in the major unreliability of value when they use it.

Dewberry and Davis provide a list of disciplines requisite for proper analysis of land development that is necessary to reliably estimate the resultant cash flow from land development that is critical to the value of developable or re-developable property. All of these experts make use of land as illustrated by the graphic containing Roulac's list of experts. The conclusion is that valuation experts should be educated in the manner of Roulac's "New Property Professional."

ESRI has a suite of extensions that would be very useful for providing the information required by the "New Property Professional." The Spatial Analyst is a powerful tool for suitability studies, and the emission of ozone is readily analyzed by the Geostatistical Analyst. Extending ArcView 3 by linking it to S-Plus provides a very powerful tool for exploratory data analysis as part of an inductive method of applying GIScience to real estate problems. ESRI's 3D Analyst is a very powerful tool for use in survey research. Models of proposed development can be created and displayed to respondents via the internet via the use of Sawtooth Software.

The Center for Advanced Spatial Analysis (CASA) at University College London has a multitude of examples of their 3-D GIS in Advanced Spatial Analysis: The CASA book of GIS, edited by Longley and Batty (2003). Such GIS models have been displayed as part of a choice-based conjoint research by Weber (2004B) that is designed to quantify the accuracy of estimates of the highest and best use of land, as well as to generate demand curves for absorption studies.

As note above, Graaskamp described highest and best land use problems as being of two types, A-The search for a site for a specific use or B-The search for a use for a specific site. ArcGIS9 Getting Started with ArcGIS provides examples of how well-suited this tool is for answering Graaskamp's first question. GIS-proficient valuers can find the best sites for a given use, with input from the many other GIS-proficient specialists listed by Roulac. The additional benefit from using geogprocessing to solve this problem is that the script provides the documentation that provided the much needed transparency. Anyone else in the world could review the valuers steps and pass judgement on their appropriateness.

Conclusions

1.11 Daubert: An Attempt to Replace Subjective Judgments

An International Lender could require an appraisal as a result of litigation from financing U.S. real estate. If so, their appraiser's testimony (in all but 5 U.S. states) is likely to have to comply with a court case know as Daubert. Rule of Evidence 702 contains the following list of factors which courts have applied in determining the reliability of expert witnesses, such as appraisers.

1. Whether experts are proposing to testify about matters growing naturally and directly out of research they have conducted independent of the litigation, or whether they have developed their opinions expressly for purposes of testifying. (this item justifies the formulation of prescriptive best practices that should be known globally)
2. Whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion ('junk science' or jumping from Myers square 1 to square 4);
3. Whether the expert has adequately accounted for obvious alternative explanations;
4. Whether that expert "is being as careful as he would be in his regular professional work outside his paid litigation consulting"; and
5. Whether the field of expertise claimed by the expert is known to reach reliable results for the type of opinion the expert would give. (the lack of reliability of the appraiser's comparable model)

Daubert's general acceptance factor does not "help show that an expert's testimony is reliable where the discipline itself lacks reliability, as, for example, do theories grounded in any so-called generally accepted principles of astrology or necromancy". Smith and many others note that appraisal is often unreliable. Court decisions on the application of Daubert indicate that appraisal is not considered to be a 'junk science' if it uses scientific methodologies instead of subjective judgments. As noted above, the courts in California (one of the 5 non-Daubert states) have decided that the developmental approach to value, used by most developers in pricing developable land, is not admissible due to the wide variance in value when used by appraisers. It might result from violation of item 2 above, due to the omission of substantive market analysis by appraisers. Why should courts have to be the ones to decide appropriate appraisal practices?

The appraisal of many commercial / industrial properties and apartment developments that are not subject to long term leases is a lot like what ones gets from a fortune cookie. The fortune is typically for something pleasant to happen, as is the case with projections of income at 3% to 4% into the future, based on some sort of national survey of buyers or inflation. Income is said to increase at 'pleasant' rate into the future, without any substantive econometric support.

Most of the five criteria listed here depend on some organization to find such methodologies and test them for their reliability. Item 5 is key, in that valuation methods would have to be shown to provide the most reliable results. Treating future value as a complex adaptive system would result in somewhat differing value estimates from each simulation, but testing such a model over time could determine whether or not this type of model would be reliable. It would not result in a falsifiable model with statistical levels of confidence, but reliability could be as good as other models used in Dauberrt compliant fate & transport modelling of soil contamination.

The Collateral Assessment and Technologies Committee (CATC) of the Real Estate Information Professionals Association (REIPA) consists of the nation's largest AVM developers. In a recent letter that was electronically published on the internet, the Committee stated in their letter that:

A recent research report published by the October Research Corporation strongly suggests that appraisers are under substantial "transactional pressures" to over state the value of a given property. "The survey reports percentages by which the pressured appraisers inflated the values and the results are alarming. Fifty-one percent (51%) of the time appraisers were asked to inflate value by up to 10%. Another 41% of the time appraisers were asked to inflate by 11% to 20% of the value. Eight percent (8%) of the time they were pushed for valuations exceeding 20% of true value.

The report shows that one-third of appraisers say they fear losing business if they do not comply with these requests." The big issue is how much of the time do appraisers succumb to these transactional pressures to artificially inflate property values? The study concludes, "Everybody does it some of the time." These transactional pressures are likely to increase as real estate markets soften and mortgage transaction volumes decline creating less overall demand for collateral valuation products.

A change in the valuation paradigm could finally result in appraisal advancing from the simple appraiser model that has been in use since the 1930s. Research done by Weber (2004)has shown that the U.S. "market" is wrong about half the time in its estimate of the future income and implied reversionary values of major office and retail properties, so it is a poor measure of risk if used without an indication of non-bubble *actual* or *true* value of income property..

Replacement of the appraiser's comparable paradigm with an econometric and survey research based paradigm using GIS, OLAP, and other geospatial technologies would replace the subjective judgments of appraiser with GIS-based models. These tools would identify the sustainable competitiveness of the local market that creates demand and provide the necessary transparency for inspection by others. Educating multi-disciplined experts in GIS-based global valuation methods would preclude the ability of clients to control the appraisal process.

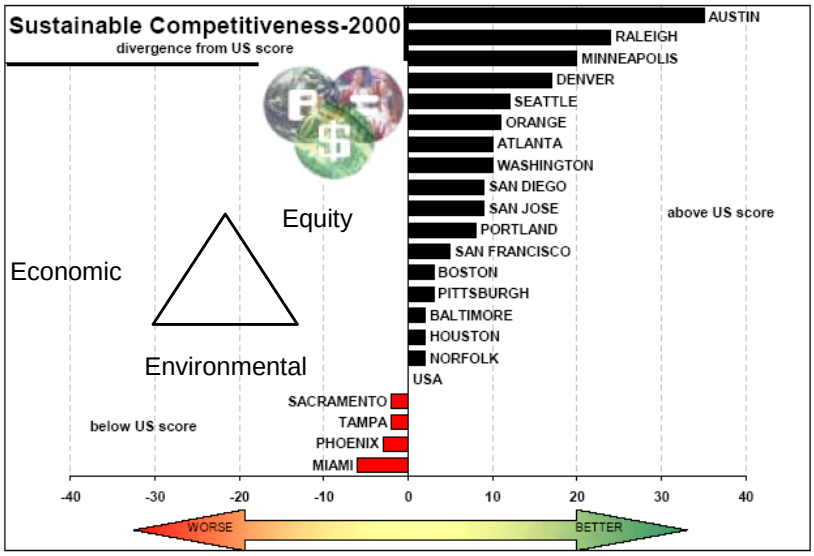
How can one tell when the market is likely to be wrong? DeVol and many other submarket analyses have shown that the first step is a detailed understanding of the concentrations of employment within a few miles of an income property, ideally by four-digit SIC code or greater level of precision. The most reliable estimate of changes in these employment categories over the next 3-5 years is a critical second step. Employment forecasts for this duration have also been shown to be reasonably reliable, as shown by Weber (2001). The third step is an understanding of the sustainable competitiveness of the metropolitan area where the income property is located. Equity, economic, and environmental conditions can act as a prism, channelling certain types of employment to the local areas, setting the direction of income and cash flow from years 3-5 to year 10 of a 10-year cash flow analysis.

If submarket populations can be simulated reasonably accurately at part of a 7-10 year forecast, such a model could provide greater accuracy in estimates of longer-term cash flows and reversions. The method that is presently used, i.e., the assumption that <u>all</u> U.S. markets will find rents growing at 3%/year and capitalizing reversionary incomes all at the same rate is absurd.

The San Diego Association of Governments is convinced that their economic future is dependant on what they refer to as their sustainable competitiveness. They describe this competitiveness as resulting from factors (**Figure 13)** that they group as Economic, Environmental, and Equity issues. SANDAG has been somewhat of a pioneer in the use of GIS for their analysis of economic linkages that foster the growth of their employment clusters Environmental issues have also been analyzed in San Diego via GIS to insure sustainable growth. An example is the use of GIS to analyze the level of value of habitat.

Figure 13 - Relative Sustainable Competitiveness

Quantifying Economic, Environmental and Equity Risks for Securitization Purposes



Source: Weber, Adapted from San Diego Association of Governments

These factors are very similar to the economic, environmental, regulatory, and sociological forces that are said to shape the demand for real estate. Greater reliability in forecasting the future income and reversionary value of real estate is likely to result from greater reliability in forecasting all four of these variables as they relation to a given property.

Lachman, at Lend Lease Realty Investments, also made a presentation at PREA and in a paper for the ULI, referring to the Forrester Research study. The Forrester study suggests that 3.3 million U.S. jobs will be offshored, and that "all of those jobs are performed in office buildings, so the effect on the office inventory is significant".

Her paper predicts "a reduction of about 500 million SF of net office absorption" over the next 10 years because of the exportation of office jobs". If her forecast is accurate, where will the jobs most likely be lost? Which office sub-markets are most likely to lose them? Detailed analysis of the types of employment within a few miles of a site is more likely to identify this risk.

One won't find the answer from appraisal methods still in use from the 1960s. Spatial econometrics, as noted by DeVol (1999) combined with GIS-assisted survey research, is more likely to provide the answer and planning models can deal with the spatial aspects of place and the social, regulatory, and environmental factors that are said to be the basis for real estate demand. Microsimulation can merge the required analytical tools into a relatively user-friendly package which warrants testing for reliability in an attempt to resolve the historical problems of of real estate appraisal.

Acknowledgements

Gratitude is expressed to Mr Mark Campbell at the California Debt Advisory Commission for taking the time to discuss the interpretation of the requirements of the Appraisal Standards for Land-Secured Financing that has been a focal point of this paper. They are to be commended for providing what is often referred to as a Statement of Work that provides definitive explanation of their expectations regarding what can be a highly complex type of analysis.

Gratitude is also expressed to my supervisors at the University of Ulster for their input relative to the preparation of this paper.

Addendum

1.12 Step 1 – Productivity Analysis

Productivity Analysis is defined as the process of identifying the productive capacity of a property to determine the real estate services it can provide. This is done by considering the attributes of the site and its improvements, concentrating on how these physical, legal, design, and locational attributes are combined to meet the needs of competitive users. Productivity analysis is required for the determination of highest and best use since it identifies the range of possible uses and relates the uses to those uses which are in demand in the specific market area of the property in question.

Robbins et al (1994) demonstrated how GIS can be used to develop spatial attributes that can be used to estimate the value of acreage that has a highest and best use as wilderness or scenic land. It was noted in the process that appraisal is first and foremost a systematic application of behavioral research, in which the appraiser strives to fit the attributes of land into a market context, driven by the decisions of market participants. Graaskamp stressed the need for an appraiser to understand the behavior and motivations of the participants in real estate transactions. The example also makes use of this belief in a multidisciplinary approach to adequately address the context and participants involved in the purchase and sale of real estate assets.

Graaskamp assembled an interdisciplinary team of scientists from the University of Wisconsin-Madison that was engaged to appraise the market value of acreage in the Alpine Lakes Wilderness Area. This was done by the use of a spatial database that relied on remotely assessed data as a data source

Direct comparison of the sales of similar acreage was the method used to value the subject land, so it was necessary to identify the physical attributes of this type of property that motivated its purchase. Some of the attributes thought to affect the economic value of such property follows:

- *Physical attributes such as size, shape, soils, geology, slope, water, flora and fauna*
- *Legal and political attributes affecting use and degree of decision making within the private sector, inducing federal, state, country, and private land use control relevant o the parcel.*
- *Linking attributes that ie the site to infrastructure systems, such as roads and trails, or to peripheral activities and establishments that may generate demand for the parcel*
- *Dynamic attribute related to how people perceive a site – prestigious, dangerous, attractive, enjoyable, beautiful, etc.*
- *Environmental attributes related to off-site effects of the subject property, for example, storm water runoff, or destruction of a view shed.*

The valuation process had yet to recognize the attributes associated with wilderness lands as economic commodities. Wilderness and scenic beauty attributes had been considered intangibles that could not be priced in the marketplace. The sales comparison approach infers that buyers attach personal values to combinations of specific attributes These attributes have to be identified for both the subject and comparables so that value adjustments ban be made for the differences that are inherent in what are unique parcels of real estate. This process is not unlike adjusting the price of a four-bedroom home downward to reflect the value of a three bedroom home...

Reference was made to two systems used to categorize land based on wilderness and scenic beauty : The Wilderness Attribute Rating System (WARS) and the Variety Class Assessment

System (VCAS). These systems were used by the U.S. Forest Service to rank land for wilderness and scenic beauty.

Visual quality was one of four supplementary attributes comprising the fourth component of the WARS system. The determination of visual quality for WARS was done using what was known as the Variety Class Assessment System (VCAS). The VCAS uses a diversity index to rate the variety and diversity of wilderness areas based on five landscape elements: landform, rockform, vegetation, waterform (lakes) and waterfront (streams).

WARS and VCAS provided a starting point for the creation of a GIS-based valuation system for this project. A survey of hikers knowledgeable about the attributes of wilderness areas was made in order to quantify the relative desirability of various combinations of site attributes. Hikers were asked to take photographs of various scenes encountered during their travels through the property and to supply corresponding survey data. The primary feature in a photograph was rated on the survey as to whether it adds to or detracts from the scenic beauty of the scene. Each scene was also given an overall rating for its scenic beauty

The survey technique was termed visitor employed photography VEP. VEP is an extremely powerful tool because it yields both a visual (photographic) and a ranked description of what features are deemed to be scenically beautiful or those deemed to be detractors of scenic beauty by users of wilderness. The process of combining GIS-based wilderness evaluation with automated sales comparison price estimating, a spatial approach to wilderness valuation, was termed the Wilderness Evaluation System (WES). It enabled a detailed, quantitative comparison of the attributes of site in relation to other sites that had sold, using them as comparable sales.

The GIS raster maps included in the book are shown below. The property was modelled as 10 acre cells, each of which ended up being assigned a Wilderness Attribute Score (WAS).

Physical Attributes Used in Valuation

Ownership Elevation Water Feature

Mapping of Attirbutes as Part of the Valuation Process Source: Adapted from Robbins

The ratings for the attributes of wilderness land are in the table below. The WAS also made use of viewsheds, linkages, and amenities of adjacent parcels in the overall rating.

Attribute Mapping of Each 10-Acre Cell via Visitor Employed Photography Source: Abbreviated from Robbins by Weber

		Scenic Beauty Ratings										
	Dynamic attribute	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
P	1. Sharply dissected slopes	0	0	0	4	10	9	25	58	56	78	240
P	2. Moderately dissected slopes	0	0	2	3	8	6	14	31	30	31	125
P	3. Irregular slopes	1	0	1	4	4	20	33	48	42	48	201
P	4. Ridgedlands	0	0	1	0	1	0	2	2	4	8	18
P	5. Peaks	0	0	0	1	6	7	22	37	48	74	195
R	6. Avalanche chute-rock	0	0	0	1	2	2	4	16	9	25	59
R	7. Avalanche chute-snow	0	0	0	0	0	1	6	7	10	8	32
R	8. Talus or Boulder lands	0	2	3	5	16	28	46	82	95	107	384
R	9. Rock outcrop-foreground	0	1	3	8	22	26	54	77	74	84	349
R	10. Rock outcrop-midground	1	0	4	8	21	30	57	100	110	130	461
R	11. Cliff	0	0	0	3	6	8	19	38	43	68	185
R	12. Pinnacle	0	0	0	3	7	6	22	38	46	63	185
R	14. Snow field	0	0	0	3	9	8	11	41	61	74	207
R	15. Glacier	0	0	0	1	3	2	1	2	5	7	21
V	16. Stocking 0-10% FG	0	1	1	5	7	9	11	12	30	13	79
V	17. Stocking 0-10% MG	0	0	2	0	5	4	7	21	16	32	87
V	19. Stocking 10-39% MG	0	1	1	2	10	13	29	43	47	39	185
V	20. Stocking 40-70% FG	0	0	5	6	16	10	32	29	41	20	159
V	22. Stocking 70%+-FG	0	1	3	3	4	10	31	41	38	30	161
V	24. Large old growth	0	0	1	0	1	0	7	3	9	4	25
V	25. Dries	0	2	5	8	15	30	0	88	`77	70	358
V	26. Dry meadow	0	1	1	3	4	11	20	30	23	44	137
V	27. Valley-wet meadow	0	0	0	1	2	8	12	13	25	24	85
V	28. Slope-wet meadow	0	0	0	0	0	4	7	14	5	22	52
W	29. Unusual shoreline	0	0	0	0	1	3	6	8	10	9	37
W	30. Water falls	0	0	0	2	3	5	6	12	12	17	47
W	31. Rapids	0	1	2	2	6	6	16	25	17	16	91
W	32. Stream meander	0	0	0	0	0	0	1	1	7	6	15
W	33. Lake or pond	1	1	2	1	6	17	25	45	49	59	206
W	34. Stream	0	0	2	2	0	4	14	11	10	7	50

P=Physiography, **R**=Rockform, **V**=Vegetation, **W**=Waterform

1.12.1 Step 2 – Market Delineation

The course handbook used to educate appraisers in market and marketability analysis (1993) notes that the attributes of a property define the service that it can provide. For example, a one-acre vacant site is not physically capable of accommodating a regional shopping center, so the market analysis need not consider supply and demand on a regional basis.

Peterson (1994) notes that a critical first step in any market analysis is the delineation of the geographic area in which properties of a subject type compete and the characterization of this area. Examples that she provides are gravity models, regression, and the calculation of time-distance boundaries. It is noted that empirical methods are often used to map the subject property and its competitors within this delineated market area. Examples provided are customer-spotting procedures such as in-store or automobile license-plate surveys, raffles, or the collection of guest registration cards, going on to say that there are serious problems with these procedures.

There is an extensive amount of GIS literature that also state this problem, referring to it as the 'Ecological Fallacy'. In a discussion on geodemographics, Birkin et al (1996) note:

The strength of these approaches is that they almost invariably plausible patterns of demand variation between different geodemographic groups. The key problem lies in the linkage process whereby individual respondents are ascribed a geodemographic characteristic on the basis of the area in which they live rather than the type of person that they are. For example, a BMRB respondent living in an area of 'young married suburbia' might easily be a 65 –year old spinster! This problem,, known as the 'ecological fallacy', (see Openshaw 1989b, Flowerdew 1991b, Birkin 1993, is endemic to geodemographics.

It is also noted as one of the many problems in spatial analysis, such as its opposite, the atomistic fallacy, (focus on the individual, ignoring his or her environment) by Longley and Batty (1996).

Peterson compared two market studies that were prepared for the proposed marina, one that used customer spotting and another that used consumer surveys, finding three fundamental problems with the consumer spotting approach: conflicting information, incomplete specification of capture rates, and lack of representativeness, The consumer survey approach to market area delineation gathers from a representative sample of consumers an identifies the facilities they use. The research findings can be generalized to that larger population base because the sample drawn is representative of a larger population of interest.

She concludes consumer surveys offer three added benefits vs. problems with consumer spotting:

1. The analyst can identify the extent of dissatisfied demand - those current patrons of the subject and /or its competitors who may be attracted to a new or improved facility.
2. The ability to define the level of potential move-up demand. In this study, it included boaters who presently trailer and launch their smaller craft, but were planning to buy larger boats that would need slop space, and
3. To ability estimate induced demand-boaters who are not renting because of dissatisfaction with available facilities.

Fryrear et al (2001) conducted a survey of corporate executives and found that retail was the predominant industry that used GIS. Their work noted that the real value of the technology was the ability to integrate otherwise disparate databases. The predominant uses for the technology were noted to be for site selection and the analysis of demographic data. Real estate development

companies were the second most common users. The most common type of data said to be used for analysis was socioeconomic data. In the survey it was found that 57% had difficulty in finding qualified personnel to make use of GIS. Ninety percent of the respondents said that GIS was "Very Imporfant" to "Important" to the organization's mission

The American Real Estate Society also sponsored Megatrends in Retail Real Estate: Research Issues in Real Estate Volume 3 with the International Council of Shopping Centers. In Chapter 4 Eppli (1996) provides on overview of the theory of retail real estate starting with the Central Place Theory of the 1930s. This theory examines two broad premises-Range, or the maximum distance a consumer willl travel to purchase a good and Theshold, the minimum demand that is necessary for a store to become economically viable. The spatial economics of his theory assumes that all customers have homogeneous tastes, live on a featureless plain, so retail market areas have hexagonal shapes. An example is the Voroni polygons that are readily created in the ESRI Spatial Analyst extension. :

The simple assumption here is that residents will only shop at the market that is closest o their place of residence, ignoring travel time, store size and many other variables. Early research found that the model was too simplistic, in that people would bypass closer locations to shop at a more distant, but desirable location. This concept was illustrated by the use of desire-line maps, as illustrated by Figure XX. These desire line maps can al so be created by ArcView and are now referred to as spider diagrams.:

Eppli provided a study that shows how spatial economics, retail clustering, and anchor tenant image affect nonanchor teanant sales. These factors help to explain why desire-line maps show that households travel past more nearby shopping centers in order to patronize more nearby ones.

Their database included over 4,500 nonanchor lease observations from 54 regional shopping centers that were obtained from three different data sources. These centers are located throughout the U.S., so the results can be generalized on a national basis. Anchor tenant fashion image was obtained using a survey of department stores.Steps 3 to 6 – Demand Factors, Spatial Interaction, and Subject Capture

Benjamin et al provide a method of telling when new retail supply is likely to be developed. The problem with some urban areas such as the Los Angeles Basin is that there will always be a new supply of shopping centers, because appraisers are told to assume that proposed centers exist prior to their development. In depth feasibility studies simply are not commissioned. The difficult thing to estimate is how much business each of the centers in the market area will lose in the event a new shopping center is built in a given market. GIS can be useful in processing the data for gravity and discrete choice modelling to find the competitiveness of supply.

Okoruwa et al (1996) note that estimating the retail sales is critically important in real estate decision-making. Part of the feasibility study process is an estimation of the cost of developing a property in order to find out what level of rents will have to be charged to cover the cost of the land and building construction. The threshold for retail tenants is based on their sales volumes, and if sales at a proposed center are inadequate, tenants will be going out of business and leaving.

Successive refinements of the Central Place Model resulted in the retail gravity models that have been commonly used to estimate the retail sales potential of propose shopping centers. The PGM or Poisson Gravity Model improves on the gravity model by including center-specific variables in addition to center size and socio-economic characteristics of the shoppers in addition to their distance from the shopping centers.

AGIS Model for Quantifying the Effect of Competitive Supply by Center Size
Klosterman, Brail, and Bossard. Klosterman, in particular, have been very active in providing models for use by planners, particularly those that make use of GIS. One of his recent analytical GIS products is known as What If..

As Bossard (1993) notes, "The gravity spatial interaction model is one of the most popular urban models and has been used for more than fifty years to estimate and predict the interaction over space of various social and economic activities, including trip distributions within metropolitan areas and the distribution of retail sales to residential neighborhoods. The RETAIL model can be used to estimate the proportion of the purchases made by the residents of each neighborhood in a metropolitan region at each shopping center in the region. The market area share estimates produced by the model can also be displayed on maps, showing the dominant market area of competing shopping centers using techniques illustrated in Laserna, Landis, and Strategic Mapping (1989)."

Conceptual Basis

The spatial interaction gravity model assumes that the attraction between two entities is directly proportional to their sizes. The impedance to interaction is the cost of overcoming the distance between them, raised to an exponential power. In other words, the gravitational attraction of a shopping center to a resident within a retail trade area varies directly with the spatial concentration of retailers at a location, but varies inversely with the square of the distance between the retailer and the customer. This basic model was developed by Huff in 1963 and explained since then in many textbooks.

The Huff model shown in Equation 1 estimates the market share of purchases by residents from each residential zone (such as the zip codes shown in the map above by Bruckner) termed i. to each competing center, referred to as j (e.g., in the above map, where Amon, Kinnicks and Longs are located) by the use of an inverse power function. The attractiveness of each center is termed Sj. Sj (a proxy for the "S"ize of the center) is raised to the power of parameter β (to be solved for to provide the best fit of the model), and the impedance to interaction raised by distance (D), which grows based on the power of a second parameter, λ which also needs to be solved for.

(1) $A(j/i) = Sj^{\beta}\ Dij^{-\lambda}$

The market share (e.g. the 5% of the total) of the purchases by residents of zone i (zip code XXXXX) that center j (such as the subject) captures is termed P(j/i), and it is found by dividing the attractiveness of shopping center j to residential zone i, as shown in **Equation 1** by the sum of the attractiveness measures for all competing shopping centers (100%) in the market area. The relationships are described by **Equation 2.**

(2) $P(i/j) = Sj^{\beta}\ Dij^{-\lambda} / \Sigma j\ Sj^{\beta}\ Dij^{-\lambda}$

This is the probability that residents of zone i will shop at center j.

The decline of a center's attractiveness over distance is based on entropy maximization as developed by Wilson in 1970. The attraction of a center on a spatial interaction basis, under the model developed by Wilson, is defined as a negative exponential product of the distance and a distance impedance parameter referred to as α. This relationship is shown in Equation 3.

(3) $A(j/i) = Sj^{\beta} \varepsilon^{(-\alpha Dij)}$

The choice between the use of the inverse power and the negative exponential models is based on whichever one provides the best empirical fit between the predicted and observed values. Bossard notes that the exponential model typically produces the best fit, as defined by R^2. He noted with the graph from the literature that the power functions typically over-predict for short distances, as illustrated by Foot (1981).

Bossard notes that a 'happy medium' can result from Reif's finding that a combination of the power and negative exponential functions that behaves as traditional inverse power function if α is zero and as an exponential function if λ is zero. This model is shown in Equation (4) and it is the one that is used in Brossard's model.

(4) $P(i/j) = Sj^{\beta} Dij^{-\lambda} \varepsilon^{(-\alpha Dij)}$

Model Applications

Brossard then notes that the Huff retail gravity model is applied by dividing the study area into what he refers to as BSUs, or Basic Spatial Units, or geographic boundaries for which total sales estimates are available. The choice of BSU in the United States has typically been Census Block groups, when modeling convenience shopping and Census Tracts or Zip Codes for larger market areas. This choice can also vary based on the types of expenditures being modeled and the local transportation network. Studies of consumer expenditures are typically used to estimate potential retail sales from each of these geographic boundaries.

The centroid of each boundary needs to be calculated along with the distance between each centroid and each store. This distance is measured as the 'crow flies', or straight lines, by road distances, or travel times. The maps that I used for Bella Terra used travel times as the methods of not only delimiting the market areas, but also for use in estimating distances to centroids by the travel times to your shopping center.

The attractiveness of shopping centers is typically expressed as the choices that they provide to the shopper. The variables used to quantify the attractiveness can be the size of the center or the number of its tenants, department stores, or the actual sales of the centers.

Calibration is the process of estimating the values of the model parameters for a particular region by using the model inputs in conjunction with the exogenous estimates of the output values that the model is used to estimate. This calibration process attempts to find the values of the parameters the reproduce the known results (sales) for the time period under analysis. Brossard states that the values of α, β, and λ depend on local conditions in the market area, with transportation costs being the most significant variable. These calibration parameters are said to be the prized trade secret possessions of retail consulting firms.

Survey of local residents, or diary data, as used by U.S. Consumer Expenditure Surveys, have been common methods of deriving the sales data that is necessary in order to fit the empirical data to the model expressed in **Expression (2).**

Calibration is often done with total sales data for retail centers, not information on sales by each center to each neighborhood. The result can be a misestimation of sales to each of the different neighborhoods. This can create problems when the model is applied to different areas.

Brossard's model uses aggregate sales, so it might suffer from the same problem. It also used Mean Trip Lengths (MTLs) rather than sales data for model calibration. His model produces a number of tables with statistics and attractiveness scores. It requires the number of households in each neighborhood, their mean incomes, and estimates of the proportion of household income that is spend in the types of centers being analyzed. The GLA of each shopping center is needed along with the distance between each neighborhood and each center. Center sales and/or mean trip; length estimates are required for model calibration.

The model has been run below for a fictitious are called Ecotown, which is made up of three planning areas, each of which contain a major shopping center. The analysis has been designed to consider the effect on retail sales patterns of the development of a large shopping center at the periphery of the planning areas. There are three procedures that are used:

1) An estimate of the base case conditions
2) A consideration of alternative scenarios with defined parameters, and
3) The calibration of the model with local data

Estimated Base Sales to Neighborhoods

The first step is to measure the base case conditions. This requires an estimate the sales patterns, assuming that no data are available for the sales of the existing shopping centers, but that acceptable calibrations parameters are available. The output (copyrighted material – see Exhibit 21.4, page 434) shows the initial estimate of the sales of each of the existing shopping centers (Excluding the proposed New Town Center) shown as Number 4) to each of the neighborhoods that comprise the overall market area.

The initial analysis is summarized by the table (copyrighted material, see Exhibit 21.5, pg. 435. It aggregates the total sales to each of the shopping centers prior to the development of New Town, showing the $Sales/SqFt of each shopping center along with the resultant % of the market that results from these sales patterns. <u>It should be noted that these Sales/SqFt are critical indictors of retail feasibility since they define the level of rent that can be afforded by retailers as noted by England (2000).</u> This has become a major issue in the U.K. because new "big box" retail centers are said to be dominating area sales and putting retailers in the smaller centers out of business, resulting in blighted neighborhoods.

The next table (copyrighted material, see Exhibit 21.6, Pg. 436) summarizes the neighborhood household and expenditure data that is necessary for each neighborhood in order to calibrate the model.

A consideration of alternative scenarios with defined parameters

This step (copyrighted material, see Exhibit 21.7, Pg. 438) provides the data for the analysis of the proposed shopping center that is to be located in Neighborhood 4. The scenarios assume that 1,000 households will reside in the new submarket area and that they have a mean income of $40,000. The distances of the centroid of this boundary to the other centers are also shown in the row for Neighborhood 4.

The Base Case (A) shown at the top of the second table is the current situation, i.e., prior to the development of a new shopping center. The list of assumptions B-F are summaries that relate to five other land development scenarios for New Town Center, ranging from Community to Regional shopping centers.

Scenario B examines the impact of building New Town as a proposed regional shopping center with 250,000 square feet, by developers that hope to acquire a large share of a rapidly growing regional market. The owners of the existing centers are very worried about the effects that a center of this size will have on their businesses. An analysis is required, therefore, that will be able to estimate the total sales in each of the existing and proposed centers in total dollars and in dollars per square foot.

Scenario C results in Ecotown's public officials being dismayed to find out that sales in Center 2, their downtown center are likely to drop below the $150 per Square Foot needed for it to remain economically viable.

Scenario D is used by public officials who want to know how large the proposed shopping center can be without causing the sales in center 2 to fall below $150 per Square Foot. This question can be answered by using an iterative procedure of adjusting the size of Center 4 and observing the effect on the sales of Center 2. If the sales of center 2 decline to less than $150, center 2 is too large since it is drawing too many customers away from Center 2.

Scenario E assumes that center 2, which has been assumed to have 100,000 square feet of floor space, is actually two neighboring centers of 50,000 square feet each. This alternative examines the effect of converting one of the centers to office use, so that there are only 50,000 square feet of retail use, in relation to the development of a Regional center.

Scenario F assumes that the new center has 1 million square feet of retail space. It is designed to show the likely impact on the other existing centers.

The calibration of the model with local data

The calibration procedure attempts to identify the parameters that provide the best fit between the predicted and observed data for mean trip lengths and total sales in each center. The calibration is done using only the data for the existing centers and neighborhoods. The model is then run using the golden section method to optimize the β, λ, and α parameters. The goodness-of-fit is then measured by comparing the actual and predicted mean trip lengths on the basis of percentage error, the total squared error, or the R^2 values.

The parameters are optimized separately, starting with λ. The result is used in the equation to then estimate the best value for β. After these two parameters are placed in the model the simulation is then run in order to estimate the best value for α. The model is then used to run the five scenarios by using the calibrated parameters.

Evaluation of the Model

The author concludes that the model can be very useful for three applications:

1) Determining the feasibility of new retail developments
2) Predicting the shopping patterns of the residents of large new residential developments, and
3) Estimating the likely impact that a new development will have on the sales of existing shopping centers.

It is also said to be useful for modeling other activities, such as the usage patterns of recreational facilities or office developments.

The three parameters in the model are used as global parameters that affect all centers and neighborhoods in the model. Center-specific parameters would be preferred, especially for different types of centers or for centers with different accessibility characteristics. Different parameters could also be used for different types of purchases. The methods discussed in the next section can be used to resolve some of these problems.

1.13 Discrete Choice Modeling

DiPasquale and Wheaton (1996) published a textbook on Urban Economics and Real Estate Markets that has been used to teach undergraduates at many universities throughout the country. In their section in retail demand, the authors start out referring to the classical retail model, but noted that a more diverse set of factors determines the customer draw of a center, in contrast to the simple classical theory.

These authors note that researchers have started using computer simulation models that make use of data on actual shopping patterns to estimate, statistically, the factors that influence consumer patronage decisions. Their textbook states that, if done, these models "provide a forecasting tool for evaluating the potential impact and likely patronage of new or redesignated retail facilities."

Their forecasting model uses an approach known as discrete choice analysis. Discrete choice analysis is used to understand how economic actors select one option out of a number of mutually exclusive choices that are available to them. This methodology has been extensively used in market research, travel behavior studies, and in location choice made by households in deciding where to live, or by firms in deciding where to locate. It won a Nobel Prize for its use.

DiPasquale and Wheaton use the theory by assuming that consumers choose one and only shopping center to patronize from among the region's competitive supply. Their analysis also starts by dividing the market area into zones, typically based on census tracts. There are n of these zones in their model, which they denote by a subscript i varying from 1 to n. The census data provides information on the number of households and their incomes, which have been found to be the primary determinants of retail buying potential. They use h to designate income categories, designating them as varying from j=1 to h. The median income of all households in category j is the census variable Yj. The census provides the number of households in each income category, in each zone, i.e. Nij. These variables represent demand.

The supply of centers are those that are considered to range from 1 to m. They use the subscript k to denote the census tract that in which each competitive center is located, so k= 1 to m. Each of the centers has a set of attributes that households find desirable when shopping, such as the size and mix of stores, the types of tenants and availability of parking. They use the variable g as the total number of attributes. and the variable I=1,g at center k=1, m: Zlk.

Thirdly, a matrix is needed that contains the travel time information, which contains the time it takes to travel from each census tract to each of the competitive centers. These travel costs have been designated as Tik, with the first subscript referring to one of the n residential zones. And the second subscript referring to the m zones with centers in them.

The residents in the market area evaluate the desirability of each of the shopping centers as a shopping destination based both on the center's attributes as well as the cost of traveling there. It is assumed, for simplicity, that the desirability of a center to households in a particular income category can be expressed as a simple linear utility measure, which differs based on each income category. The utility that a household of type j, living in zone I would derive from shopping at center k is Uijk is written as a linear function of center attributes, travel costs, and coefficients, or utility parameters that depend on the category of the household, as shown in Equation 1.

(1) $$Uijk = \alpha jTik + \Sigma \text{ for } l\text{-}1 \text{ to } g\ \mu ljZlk$$

The term to the left of the addition is the marginal disutility of travel, varying by income. The second part quantifies the desirability of the center based on the value of all of its attributes.

The discrete choice model is used to convert household shopper utilities into probabilities of actually patronizing a particular center. Some attributes of the centers are not known with certainty, so demand should be measured probabilistically. If there is a probability that a particular center yields higher utility than all the others, then there is a patronage probability that each household from income category j, living in zone I, will shop in center k. This probability, Pijk is often written:

(2) $$Pijk = \varepsilon^{Uijk} / \Sigma \text{ from } k=1 \text{ to } m \ \varepsilon^{Uijk}$$

The denominator sums the probabilities over all centers, so the result is always 1. Equation 2 determines how the utility of each center to a household determines their shopping probabilities. A center's total patronage depends on three considerations. The first is its attributes compared to the other centers. The second is its location compared to the other alternatives. The third is the spatial distribution of households throughout the market area. A center will be successful when those consumers for whom the center has a high shopping probability are both nearby and plentiful in number. Summing across the zones in which households live, i, the total patronage of center k by income group (Sik) is given by a third equation**.** Overall patronage is the sum of that patronage from each income group j.

Thus, the authors note that the spatial pattern of households within a metropolitan area and an identifiable market of competitive centers, a discrete choice model can be developed to predict shopping center patronage. To questions arise:

1) How to use information about current shopping patterns to estimate the parameters in the utility Function (1). Numerical estimates are needed for αj and μlj.
2) The second is how to forecast with the model and evaluate the likely impacts of new centers or changes to existing centers.

<u>The Application of the Model</u>

The authors provided a specific application of the model in the Boston metropolitan area. This area was limited to the central city of Boston and 104 towns in nearby suburban communities. The region's planners developed estimates of the number of households in each of the zones by five income categories. Supply consisted of ten super-regional malls and the three largest regional malls. The 1987 Census of Retail Trade was used to identify nine center attributes, such as the size of the center in square feet, number of parking spaces, total number of stores, number of stores in each of five categories, and parking costs. The attributes are shown in their Table 6.3 on Pg. 144..

Survey research (part of a D-Level market study) was undertaken during the mid-1980s about retail behavior. About 4,000 households were asked which income category they were in and whether they had visited any of the 13 centers during the previous week. The total number of shoppers from zone I with income j who went to shopping center k (Sijk) was estimated.

The utility parameters in **Equation (1)** can be estimated by ordinary regression analysis by the use of the survey results. A separate regression was estimated for each income category of households (j=1,5) and each of regression had 480 observations. The independent variables for each observation are the differences in attributes and travel costs. Their Table 6.4 gives the estimated values for the utility parameters from the Boston sample.

The first row provides the marginal disutility of travel distance α for i households in each of the five income categories. It is clear that as income increases, households have less aversion to traveling and are therefore willing to shop at ever greater distances.

The remaining rows show the marginal utilities for each of the center attributes by income category of households (μlj). The number of both discount and variety stores in a center, for example, create strong marginal utility for the lowest income categories and strongly negative for the highest income categories. Restaurants are positive for all groups, but more so for those with higher incomes.

The number of shoppers by income for the 13 centers has been predicted in their Table 6.5**.** The center with the largest predicted total volume of trips was the South Shore center. It has one of the broadest attribute mixes that appeal to a broad base of shoppers, but the authors attribute its popularity to its location, saying that it has only two small competitors in the southern half of the Boston metropolitan area. The Back Bay and Chestnut Hill Mall draw the largest predicted volume of wealthy patronage.

Both attributes and location are important, as may be noted by Harvard Square. This center attracts mostly low-income shoppers, which is largely due to its location in the midst of a very large student population. This type of analysis also provides a valuable tool for consulting, as may noted by the next example provided by the authors.

The question was posed of where a new 300,000 square foot department store would generate the most additional traffic. The question was answered by repetitively solving the model with a new department store and 300,000 square feet of additional space, in order to note the increase in the number of shoppers. The coefficients from the previous table suggested that the new department store would be most valuable to a center with a predominantly higher-income patronage. This is a good guess because the simulations reveal that 70,000 to 80,000 more shoppers are attracted to Back Bay, Chestnut Hill, and South Shore when the department store is added to those centers.

End Notes

While helping out with strategic planning for the Appraisal Institute, I read the Winter 1999 issue of ArcNews. It contained an article titled A Case study in GIS Modeling that showed how a new technology, ModelBuilder, could allow a university team to provide a suitability study, a component of a highest and best use study, in four days that would previously have taken weeks for them to build. This was about the time I was reviewing the new requirements of Daubert, the U.S. Supreme Court decision that required expert witnesses, such as appraisers, to use the scientific method if practical. This made me wonder if GIS could be instrumental in such a task.

When considering applying to study for a doctorate, I read Advanced Spatial Analysis: the CASA book of GIS (2003). It was written to describe cutting-edge developments in GIS applications at University College London's Centre for Advanced Spatial Analysis (CASA). Drawn from archeology, architecture, cartography, computer science, environmental science, geography, planning, remote sensing, geomatic engineering and transport studies, these applications are emerging as the basis for spatial decision support systems across a wide range of industries and jurisdictions. The author's use of the term Advanced Spatial Analysis is said to reflect their perception of the expansion of the use of GIS for spatial representation, analysis, modeling, and design into many other fields.

Their version of the evolution of GIS has been as follows: GIS has wide roots in many spatial sciences including geography, the earth sciences, architecture, urban planning and ecology. It was noted that its use began in the 1960's with the development of computerized cartography and remote sensing for military satellites. Its use grew more with the development of database technologies in the 1970's, and micro computers in the 1980's. Spatial analysis grew parallel to GIS in development due to the increasing use of quantitative methods in geography, geology, regional science, macro-economics and the earth sciences during the same time frame.

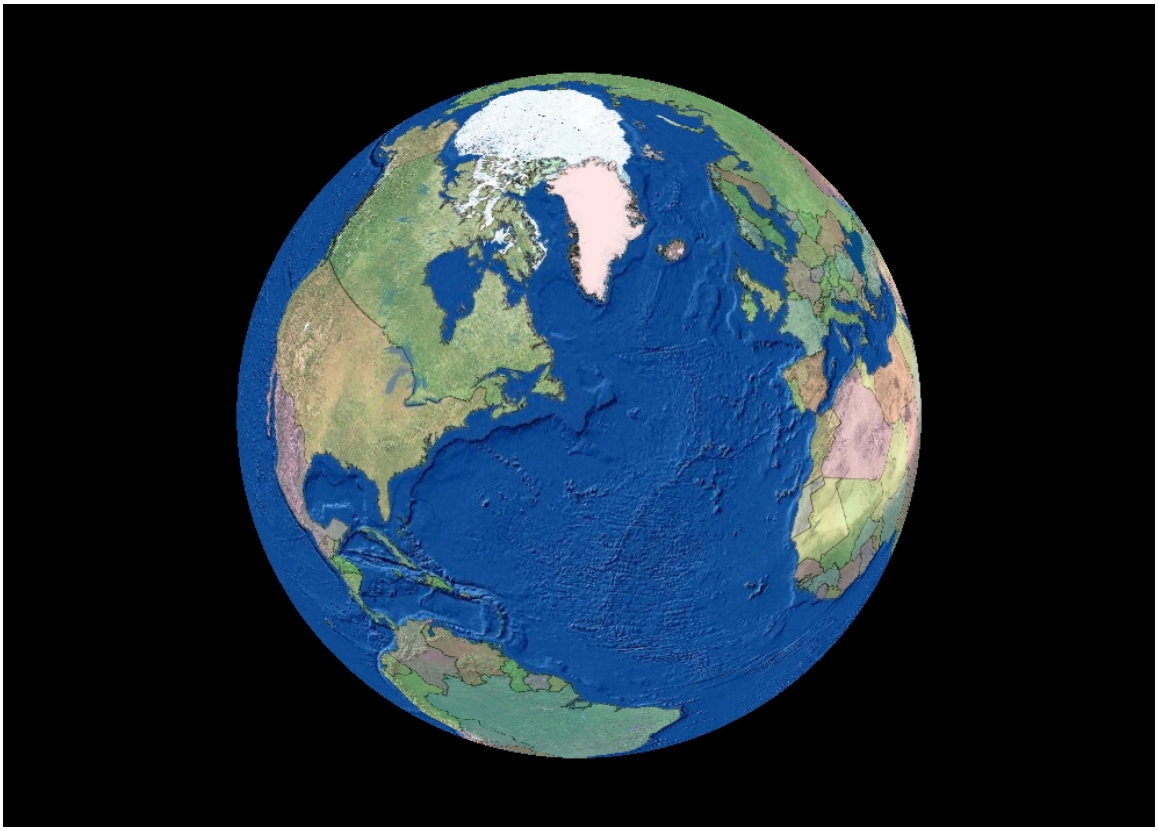
The editors note that there is a desire, even by novice users, to perform advanced spatial analysis and that improved methods are needed to provide clearer perception, interpretation and interrogation of spatial data. A trend they noted is the 3-D visualization that is increasingly available via GIS. The editors forecast that multimedia web sites linking photogrammetric and 3-D graphics with other forms of multimedia, delivered across the Internet, will be central to future developments in GIS. This need for visual communication of complex issues would be very helpful in the courtroom, in addition to providing the statistical significance called for by Daubert.

Modeling our World: The ESRI Guide to Geodatabase Design (Zeiler, 1999) was referenced in the article by Weber titled Environmental Uses of GIS, the Scientific Method and Daubert. This book notes that geographic data models are digital frameworks that describe the location and characteristics of things in the world around us. With a Geographic Information System, we can use these models as lenses to see, interpret, and analyze the infinite complexity of our natural and man-made environments. A new geographic data model termed the geodatabase has been recently introduced that can significantly extend the level of detail and range of accuracy with which one can model geographic reality in a database environment. This book is a comprehensive guide and reference to GIS data modeling in general and to the geodatabase model in particular. It shows how to make right decisions about modeling data that affect each stage of GIS project, from database design and data capture to spatial analysis and visual presentation.

In the introduction to Geography and GIS – Sustaining our World, Jack Dangermond noted that

The sustainable movement is a strategy of using economic and human activities to support the environment and improve the quality of life. It involves discussing solutions to the many complex problems shared by communities across the globe-pollution, congestion, depletion of open space, inefficient energy consumption and loss of a sense of place.

As a result of his pioneering vision, a portal to the global community can be on anyone's desktop by simply clicking the icon for ESRI's ArcGlobe that is shown below.



As the manual notes, with 3D Analyst and ArcGlobe, one can:

- Use several forms of geographic data including vector data (buildings,
- parcels, roads, power lines, water hydrants, and soils) and raster data
- (digital elevation models [DEM], satellite imagery, digital orthophoto
- quadrangles [DOQ], and aerial photography
- Manage and navigate through extremely large databases (terabytes).
- Extrude two-dimensional representations to three dimensions.
- Create three-dimensional fly-through animations.
- Perform analyses such as overlay, viewshed, and buffer.
- Use GIS tools and functions in a 3D environment.
- Apply various data layer effects such as transparency, lighting, shading,
- and depth priority.
- View multiple perspectives simultaneously.

These features provide an excellent way for the multitude of specialists the Roulac mentioned in his list in Figure 3 of this paper to collaborate with the New Property Professional. It might be that a United Nations-type of approach might provide the best consultative advice on problems of particularly complex real estate assets that are affected by significant environmental issues. (See page 2 of Using ArcGIS Geostatistical Analyst for an example)

But what about the effect of such problems on the value of real estate, or the uncertainty (risk of the value being wrong) resulting from these physical, economic, or environmental issues? Isn't it still the appraiser that is supposed to be the expert witness regarding value? If so, this witness has an obligation to use or understand the scientific approaches that are used by those in the other disciplines that have a necessary involvement. As Thrall has pointed out, it is impractical to have one person be a master of all of these professional specialties. Still, it has been argued that one in the position of an appraiser has to be knowledgeable enough about these specialties in order to be able to effectively communicate with them.

As Roulac suggests, it would be good for the central "risk manager" to have a foundation in the analytical methods of the MBAs , but also have an understanding of the other disciplines that were stressed by Kinnard and Ratcliff back in the 1960s. The need for scientific model building in order to simulate and solve complex problems with scientific tools and credibility suggests that a research doctorate would also be very beneficial. What type of credential should the New Property Appraisal Professional have in order to be able to coordinate a team of professionals in a valuation? A Doctorate in GIS-Based Global Valuation Methods?

In any event, we have to thank the visionaries, led by Jack Dangermond at ESRI for creating the wonderful tools that enable such analysis as well as the visionaries like Stephen Roulac at Ulster that recognize the need for a multitude of disciplines to be involved in effective global property participation in the future..

In the mean time, I will be happy trying to forge ahead on the next GIS frontier, trying to extrude a 4th dimension of analysis out of the first three dimensional tools that have been made available from ESRI. Many have noted that GIS has typically provided only static spatial snapshots. Dynamic processes are hard to represent via GIS. "Shifting spatial analysis from statistics to dynamics or, in other words, from product and structure to process and behavior, is another challenge for the future. It seems like CommunityVis with its Build-out, PolicySimulator and other modules have made a significant start in this direction.

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Bio

- Mr. Weber has been a real estate appraiser for over twenty years, both as the principal of is own firm and in the capacity of senior manager at a hotel consulting firm. He also created an Appraisal Review department at the FDIC in order to help resolve the banking crisis of the early 1990s, where he developed a special interest in improving the appraisal process . This resulted from the wide variance in appraised value they received for the same property, at the same point in time.

- He has been a member of the American Real Estate Society since that time. This is a group of academic and high-level real estate executives involved with real estate research. After years of his research and affiliation with the group, he decided to pursue his doctorate at a highly regarded university in the U.K.

- His main interest is in large scale, complex real estate properties requiring market studies and feasibility analysis.

Recent Publications on Real Estate Analysis

- 2004 – "Valuation via Microsimulation" – A research paper that summarizes research that shows that the "market" has a poor track record of estimating "market value", based on the analysis of quarterly income vs. cap rates in major U.S. metro areas since 1985. Research shows how the reliability of appraisal can be improved.
- 2003 – "The Use of GIS for Situs Analysis" – A research paper showing how GIS can be used to define trade areas for major retail centers and forecast their sales and resultant values. The paper was accepted for presentation at the June, 2003 meeting of the European Real Estate Society, in Helsinki, Finland..
- 2002 – "The Use of GIS & OLAP – Accurate Valuation of (Re)Developable Land", a study of how new GIS and database technology can be of use in econometric modeling as part of the market analysis required prior to using a land residual technique. Shows the development of valuation techniques that are both NCREIF and Daubert-Compliant. Won an ARES Best Paper award for land development. Published in the latest issue of the Journal of Real Estate Portfolio Management.
- 2002 – "A Beginning Best Practice Brownfield Valuation Model", the forth in a series of studies dealing with advanced methods of quantifying the financial risk and resultant value of brownfields and other (re)developable properties. The Appraisal Journal, January 2002.
- 2001 – "Market Value Without a Market – A Sequel", a paper that that was requested for presentation to the International Association of Assessment Officers at the GIS and CAMA conference that was held in Baltimore, Maryland. It was an update to an article named "Market Value Without a Market", published in the October 1990 issue of the Appraisal Journal.
- 2000 - "Show What You Know", a paper on the use of GIS to detect loan fraud, based on a presentation on "Fraud and the Real Estate Appraiser". The paper was published in the proceedings for Valuation 2000, a multinational meeting of appraisers. The paper was also published in the October, 2001 issue of the Appraisal Journal.
- 1999 - Jointly authored a chapter in "Cities in the Pacific Rim-Planning Systems and Property Markets" with Paul Syms, an associate in England. Our chapter in this book discussed the redevelopment of brownfields in the Los Angeles area.
- 1999 - "The Valuation of Contaminated Land", published in The Journal of Real Estate Research, Volume 14, No. 3. Describes the use of Monte Carlo methods for financial risk analysis for the valuation of brownfields. Won an ARES Best Paper award on land development.
- 1998 - Wrote a chapter in a book titled "GIS in Real Estate: Integrating, Analyzing and Presenting Locational Data", published by the Appraisal Institute and distributed internationally by Adams Business Media/GIS World. The chapter written is titled "Application of GIS to Real Estate Appraisal Problems". It describes methods in which GIS can be used to quantify the demand for real estate.

Other Recent Speaking Engatgements

- Summary of Research Projects – Member of a panel arranged by the Appraisal Institute to discuss advanced methods of real estate appraisal at the April, 2003 meeting of the American Real Estate Society. Also asked to make a presentation on the use of GIS for the Los Angeles Chapter of the Appraisal Institute. The presentation discussed four research papers completed and presented in 2001. The research was on the use of GIS for the estimation of market rent for a proposed apartment complex by the use of a geo-database using statistical inference.

- A Beginning Best Practice Brownfield Valuation Model – A paper presented at the July, 2001 meeting of the International Real Estate Society. The paper summarized our research commissioned by the Royal Institute of Chartered Surveyors on methodology used in the US and the UK, found an absence of empirical support for valuation methods in use, and concluded with a recommended methodology for valuing property that has contaminated soil.

- The Use of GIS and OLAP for Market Analysis: Differentiating Between Real and Market Value – A paper presented at the April, 2001 meeting of the American Real Estate Society. The paper illustrated the benefits of using a geodatabase for a decision support system. This study won the competition sponsored by the Urban Land Institute for the best paper on development.