/DECISION SUPPORT SYSTEMS FOR ECONOMIC ANALYSIS OF SITE PLANNING DECISIONS/

by

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CHAPTER I

INTRODUCTION

The residential housing market in the United States is an increasingly complex domain of real estate development. The development horizon is shrinking in response to the 'quiet revolution' of growth management planning and the shifting conditions of real estate financial markets.[1] The boom time of 'new town' and large-scale development that gave rise to development team concepts and construction management is being replaced by a constricted scale of development possibilities. This trend is most noticeable at the local level. Development projects in the near future will generally be smaller, particularly in areas of lower than average economic and demographic growth (ULI, 1983). Site planners will have to adapt to the complexities of the development environment in order to reinforce the general thrust of growth management policies (efficient urban growth and environmental protection) in the coming era. The need for a broad framework of project management

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[1] The term 'development horizon' refers to how problems and opportunities in development are conceptualized. The broad scope of land planning that captured the attention and efforts of the past era is being replaced by narrower concerns of implementation. "If the decade of the 1970's was the decade of growth management and environmental protection, the 1980's promise to become the decade of fiscal constraints, regulatory reform, and economic development." (ULI, 1983, p. 337).

the coming era. The need for a broad framework of project management increases as the financial arrangements for a project require greater specialized expertise. The anticipated demand for site planning services which include analyzing project feasibility underlies the direction of this study.[2]

New factors in the development environment created by the changing demands of the enterprise economy will redefine the site planning services needed for residential development. The change in the development economy resulted from an extended period of high interest rates. For a developer:

> "the loss of cheap money has made it almost impossible to finance 100 percent of a real estate project or to depend on leverage as the primary investment advantage of real estate. [In this situation where] equity investors must risk more of their own money, extending the payback period significantly, they can be expected to be more selective in regard to their investments and those whom they hire for their expertise in design and construction" (Grasskamp, 1981, p. 22).

The response of money markets resulted in a blurring of debt and equity as loan institutions participated in the returns from a project with an

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[2] "Considerations quite remote from the actual performance of a plan--income tax rules are one example--may often dictate the form. An analysis of costs and benefits must indeed lie at the base of any rational site decision, and most site designers do not know how to make that analysis. However, an adequate analysis weighs costs and benefits of all kinds, nonmonetary--even nonquantifiable--as well as monetary, and considers who pays and who receives. By bringing incommensurate items as well as diverse parties into the transaction, we are forced again, despite all the refinements of decision theory, to make delicate subjective or political judgments, although it is possible to make those judgments more explicitly than we are accustomed to do." (Lynch, 1979, p. 42).

emphasis on investments offering near-term income (ULI, 1983). In the future, site planners will include development management as a consultant service for investors. The client will be an investor group rather than a developer or an owner and will require a high level of assistance in the land development process. A site-planning firm with the capacity to manage development from the initial market study through construction will be in a strong competitive position to provide professional services to the housing development market.

The search for a feasible project begins with an investment land use plan[3], then proceeds to a site development plan which in turn looks forward to construction. This search is unified by a flow of information and is structured by a sequence of decisions. For the most part the sequence of decisions that determines the continuation of the search is based on economic criteria. Site planners capable of comprehending the continuity of the information and of communicating in terms of a search for a feasible solution will be in a position to determine the actual physical design expression. In this context design sensitivity can be conceptualized as an expression of the uniqueness of a place within the parameters which are given, where one significant variable is the context of land development as a cash cycle enterprise.

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[3] "The investment land use plan is not in any sense a physical site plan. Instead, it represents the investment assumptions by which feasibility is tested" (White, 1976, p. 5).

Environmental design professionals can approach the integration of econoeic decision-eaking with design development as a broadening of social responsibility rather than a lieitation of aesthetic responsibility. The inability of the landscape architect to define clearly the eonetary risks and benefits inherent in a design may result in the later revision of a site plan by a developer or contractor operating under a necessity to lieit and control costs. If the benefits of environmental design are to be expressed in the environeent then the tradition of seperating design process from project feasibility and construction impleeentation is damaging to that expression. Econoeic sensibility is a necessary corollary to the expression of design sensitivity. Manufacturing industries use a eanageeent concept that is applicable to this approach:

> "Product design is an integral part of production eanagement, i.e., the product is designed in such a way as to achieve two objectives simultaneously: (1) to fulfill its aesthetic and functional requireeents and (2) to einieize production costs" (Cassieatis, 1977, p.477).

The pressure to control risk gives an investor or developer a strong incentive to consult a site planner with the capacity to accurately estieate conceptual cost[4] at an early stage in a land development project. To iepose cost factors upon a completed site development plan

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[4] A conceptual cost estimate is "eade from rudieentary design inforeation such as a schedule of space requirements, preliminary design sketches, and outline specifications (Collier, 1984, p.283).

is essentially a violation of design as a process of form arising out of the conditions and context that are given.

The historical schism[5] between landscape architecture as a design profession and the economic realities of project implementation presents an institutional conflict that inhibits the conceptualization of economic fitness as an integral component of the design process. It is an artificial problem created by the struggle to define the content and delimit the boundaries of landscape architecture as a professional discipline. To some degree it is a problem of communication between disciplines. To a real estate analyst, architectural, engineering and site-planning services are "the most important yet least understood aspects of land development planning in the United States" (Barrett and Blair, 1981, p. 281). In a more fundamental sense recent changes in the development environment are creating an opportunity to reevaluate the norms of site planning practice and the role of landscape architecture in site planning.

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[5] The origins of land planning in America are typified in Oglethorpe's plan for the layout of Savannah, Georgia. The plan is an example of the broadest 'development horizon', both in terms of conceiving a pattern of human habitation and the role of design in achieving that pattern. Olgilithorpe's work was based on Sir Robert Montgomery's 1917 utopian plan for the Margavate of Azilia, both were illustrations of the romantic notion of a designed environment as an expression of the godlike attributes of human capabilities. The mixture of altruism and economic fantasy that accompanied the geometric layout of a preconceived paradise in the Georgia pine-barrens [described by the historian Daniel J. Boorstin as "the geography of a pipe dream"], also illustrates the deeply rooted schism between the ideal of a designed environment and the hurly-burly of the real world that existed as landscape architecture emerged as a discipline.

As Kevin Lynch points out in Site Planning:

> "The imperfections of the market economy are a familiar theme and are not correctable by site designers, although these imperfections may affect their choice of clients. Some of these faults are remediable by adjustments. . . . most of them await more fundamental changes in the rules of the game. We can expect more rational actions only when we use more inclusive cost-benefit analyses, within institutional structures motivated to take those more inclusive factors into account" (1979, p.43).

The essential point made in the introduction is that, both in terms of institutional structures (land planning and financial institutions) and technology, an opportunity exists to actively influence 'the rules of the game'.

The question of how the profession of landscape architecture will respond to the percieved need for economic analysis and the potential for decision support systems to provide a framework for that response are investigated and reported in this study. An example of a prototypical DSS, developed by the author, is presented in Appendix C.

Chapter II

BACKGROUND

A decision support system (DSS) "focuses attention on building systems in relation to key decisions and tasks, with the specific aim of improving the effectiveness of the manager's problem-solving process" (Keen and Morton, 1978, p.79). Are there sufficient parallels between management decisions and design decisions to warrant transferring the concept of DSS to design decision-making? The chronology of the emergence of the concept helps in understanding the relevance of decision support systems to land development.[1] This chronology is intended to illustrate a synthesis of technology and an analytical viewpoint that has resulted in a methodology and a computational framework applicable to a site planner's dual need for a broader focus and interprofessional communication. The characteristics of a DSS useful for improving the effectiveness of the site planning process will then be presented.

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[1] "The concept of Decision Support has evolved from two main areas of research: the theoretical studies of organizational decision making done at the Carnegie Institute of Technology during the late 1950's and early '60s and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s" (Keen and Morton, 1978, p.vii).

The technological perspective

Conceptual Image

A computer system originates as a system designer's conceptual image of what the system[2] is to accomplish, who will be using the system and how they will be using it. Hardware and software are developed in response to the current state of computer science, cost, and the goals of the system.

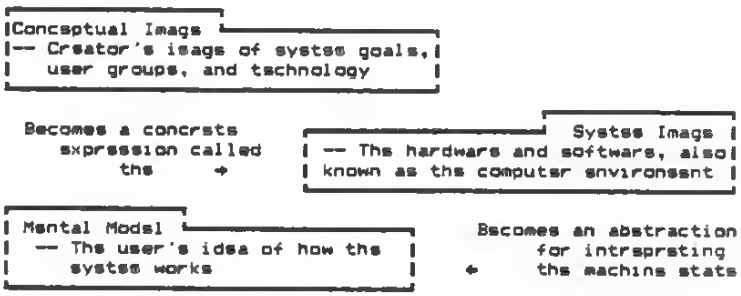

Figure 1: Perspectives of a computer system

For example, the early focus of mainframe computer systems was on efficiency at all levels--efficiency of the expensive computer facilities, efficiently written computer programs, and efficient

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[2] A system "may be defined as any entity, physical or conceptual, that is composed of interrelated parts. ... Each has a *structural configuration* (an arrangement of component parts), and each performs certain *functions*. Each operates in a larger environment (or as a subsystem of some larger system) and requires certain *inputs* from this environment" (Catanese and Steiss, 1970, p.4).

operation of the firm. The system designer's conceptual image assumed the existence of a centralized professional control group performing as an essential component of the system. This group needed a broad general knowledge of computers and a commitment to learning the sophisticated cognitive tasks associated with problem definition, coding, debugging and system maintenance (Norman, 1984). The early use of computers emphasized the consolidation of data, streamlining the flow of information within an organization, and included the goal of eliminating 'personnel problems' by replacing humans with computers (Laughery and Laughery, 1984, p.5). Early computer systems required the user to have essentially the same level of technical sophistication for operation as was needed to design a computer system. In order to use a computer it was necessary to state a problem in terms of computational processes expressed in machine code. With the development of operating systems[3], programming languages[4], and interactive systems came the realization that, for the end user, knowledge about how the system actually operates is not as significant as knowledge about how the system appears to operate.

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[3] Operating systems created in the late 1940's were essentially the minimal set of machine instructions needed to load and run one program at a time. System 'supervisors' were introduced in the mid-1950's to manage the sequence execution of programs in 'batch-mode', allocate memory and manage secondary storage devices. Time-sharing systems were introduced in 1960 (Denning and Brown, 1984, p.95).

[4] Software languages are categorized by 'generations'. The first generation is machine code or binary code, which is not a true language. The second generation was assembly languages, the third generation took the step to general-purpose, higher-level procedural (or imperative) languages like Pascal, C, or FORTRAN (Tesler, 1984) (Shannon *et al.*, 1985).

Systee ieage

The systee ieage includas the hardware, firmware, and softwara as it is configured for use. In order to reduce the complexity of computer systees a heirarchical structure of abstractions is defined to create transparent levels of subsystees. "A program at a given level has access only to operations definad at lower lavels; furthermora, the internal details of those operations are hidden" (Denning and Brown, 1984, p.96). Each level requiring diffarent degraa of sophistication in computer technology. For example a hypothetical operating system could ba defined as follows (Figure 2). Coeputar use at tha level of tha user prograeeing environment is dapendent on the image prasented by the 'user-interface'.

LEVEL	NAME	OBJECTS
13	Shell	User Prograeming Environeent
Hardware and software extensions		
12	User Processes	User Processes
11	Directories	Directories
10	Devices	External devicas such as Printers, Keyboards, Display terminals
9	File Systaa	Files
8	Coeunications	Pipes
Operating systee kernel for the single eachine		
7	Virtual Meeory	Meeory segeents
6	Local Storage	Blocks of Data, Device Channels
5	Prieitive Processes	Prieitive Processas, Semaphores, Ready List
Read only meeory for the single machine		
4	Interrupts	Fault-Handling Programs
3	Procedures	Procedura Sagmants, Call Stack, Display
2	Instruction Set	Evaluation Stack, Scalar Data, Microprograe Interpreter, Array Data
1	Electronic Circuits	Registers, Gates, Buses

Table 1: Operating systea organization (Dennina and Brown, 1984, p.94)

Mental Model

A user forms a mental model in response to the image presented by the computer system (Norman, 1984, p.11). The same computer using different software can present itself to the user as a very different machines. The theatre of the 'human-machine interface' determines whether concepts are formed in terms of the user's thought processes or stated in terms of computational processes. The terms 'conceptual image' and 'mental model' are significant in understanding that communication travels among humans via the computer system, as opposed to understanding computer use as 'human-machine' communication only. The development of 'fourth-generation' languages[5] and the widespread market for interactive personal computer systems have focused attention on the power inherent in the concept of a 'mental model'. This focus is creating a differentiation between languages intended to increase a programmer's productivity and those intended to give a user direct leverage. "Direct leverage is provided when the illusion [or mental model] acts as a 'kit,' or tool, with which to solve a problem" (Kay, 1984, p. 54). The program is transparent to the end user, and the communication is

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[5] "Fourth generation languages is an umbrella term which includes several categories of software. There are at least three major areas: presentation languages (formal query, natural query, reporting, graphics, *etc.*); specialty languages that focus on a specialized function (spreadsheets, modeling, analysis, simulation, *etc.*); and application generators that deal with data capture, modification and definition to build complete applications as end-user tools, the fact remains that they have to be learned. Only a few of these are really tools for nonprogrammers (*e.g.*, spreadsheets). Most of them require considerable user training. In reality, fourth generation languages are excellent productivity tools for programs" (Shannon *et al.*, 1985, p. 280).

occurring between the end user and the 'simulated universe'[6] of the software.

Where the user has direct leverage, that is to say the capacity to manipulate the computer in terms of the problem at hand, a dual interaction can occur; as computer use broadens and changes landscape architecture, the objectives of landscape architecture have a broadening influence on the nature of a new technology.[7] Computers are more than high-powered calculators. For the computer literate[8] they offer a medium for exploration of the world we create. "The protean nature of the computer is such that it can act like a machine or like a language to be shaped and exploited" (Kay, 1984, p.59).

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[6] "Computer scientists make laws in the form of programs and the computer brings a new universe to life" (Kay, 1984, p.54). "It is clear that in shaping software kits the limitations on design are those of the creator and the user, not those of the medium" (Kay, 1984, p. 57).

[7] "To the extent that artistic, musical, and literary people are computer-literate and make use of this new medium, the medium itself will reflect the wide range of human experience" (Branscomb and Thomas, 1984, p. 234).

[8] "Computer literacy is a contact with the activity of computing deep enough to make the computational equivalent of reading and writing fluent and enjoyable (Kay, 1984, p.59).

The conceptual framework

Land development involves a complex of political, social, and economic circumstances. Within a planning and design fire, technical issues of analysis, organizational structure, design ability, and contextual forces,[9] such as tiee pressure and crisis influence the decision making process. How can computers be used to increase the probability that a design will be implemented? The conceptual framework for the use of coeputers evolved in conjunction with the development of technology.[10] The framework eeerged as the study of cognitive processes and huean behavior in Operations Research/Management Science (OR/MS) opened an interdisciplinary dialogue on 'systems' and decision-making.

Rational Decision Making

The rational concept of decision-making holds that to arrive at a logical solution to a problee, a decision maker:

> Identifies alternative courses of action,
> determines the expected outcome of the alternatives,
> selects the optimum alternative.

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[9] Keen and Morton credit H.L. Wilensky (1967) for showing "the impact of contextual forces such as time pressure and crisis on organizational decision process." (1978, p.94)

[10] In OR/MS (Operations Research/Management Science) terms, the concept of decision support systems (DSS) evolved from the concept of management information systems (MIS) which arose from a need for a way to use data collected by the electronic data processing (DP) departeent.

For example, Lum's (1972) description of a feasibility analysis to be conducted by an appraiser contains five components.

1. The identification of alternative uses
2. The cost to develop each alternative
3. The market demand for each alternative
4. The identification of the competition
5. A recommendation of the optimum alternative

(paraphrased by Epley and Boykin, 1983, p. 33)

The second, third, and fourth components are essentially steps in determining the expected outcome of the alternatives. The last component, the recommendation of the optimum alternative, is dependent upon two related ideas, the concept of optimization as the end product of rational thought and the concept of highest and best use in land development. The two ideas form key questions in the development of a decision support system for site planning: first, what criteria are valid in determining 'highest and best use'[11] and second, what process does a site planner use to arrive at such a determination?

A Question of Values

The definition and measurement of value unites the two ideas. Management concepts that focus on optimization are structured by the unitary goal of maximum value. According to Boykin, the same criterion can be

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[11] Graaskamp proposes abandoning the term 'highest and best use', as it is an "anachronism from laissez-faire attitudes of the nineteenth century", in favor of the term 'most fitting use and most probable use' (1981, p. 10). I have chosen to retain the term while recognizing that it has gone through an evolution in meaning.
Also see: Grissom, Terry V. (1983, January). The Semantics Debate: Highest and Best Use Versus Most Probable Use. *The Appraisal Journal.*

adapted to a real estate project. "The objective in financial management theory is to maximize the value of the fire. The objective in the financial management of real estate must be to maximize the value of a site. . . . Each site must therefore be analyzed and evaluated on an individual basis and decisions made accordingly" (1985, p.348). This viewpoint represents the traditional foundation of 'highest and best use'. Graaskamp proposes a broader viewpoint. He conceptualizes the real estate process as a system of three primary groups: space users, space producers, and public infrastructure. Within this system, "cash solvency of each enterprise[12] in the total process, not maximization of value, is the pivotal issue of survival and the one measure of self-interest that all these conflicting entities have in common" (1981, p.3). He goes on to propose a normative standard of 'most fitting use', "that is, the optimal reconciliation of affected consumer demands, the cost of production, the cost of infrastructure services, and the fiscal and environmental impact on third parties" operating in conjunction with the concept of 'most probable use' (p. 11). The term 'most probable use'[13] is needed in recognition of the fact that "most plans, development or otherwise, fall short of the ideal" (p. 11). Optimization of

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[12] "Each of these three functional groups, and any subgroup therein, represents an organized, rational undertaking, called an enterprise in the language of systems (see Beckett)" (Grasskamp, 1981, p. 3).

[13] "Most probable use is that alternative course of action which is closest to being the most fitting use while recognizing strong constraints imposed by current political factors, real estate technology, the personalities and talents responsible, the money market, and short-term solvency pressures on consumer, producer, and public infrastructure" (Graaskamp, 1981, p. 11).

value as a planning and design goal had a major impact on the large scale multiple use projects of the 1960's and 1970's. It provided a means for organizing and evaluating economic projections of land development that was consistent with the project scale and the technology of the times.

The concept of optimization of value is "logically analogous to optimization by linear programming" (Wilburn and Gladstone, 1972, p. 20). The question of whether a decision maker thinks in a linear, logical sequence or can in actuality determine an optimal solution was first addressed by the theoretical studies of organizational decision-making done at the Carnegie Institute of Technology during the late 1950's and early 1960's by H. A. Simon (Keen and Morton, 1978). Simon coined the term 'satisficing' to describe his concept of decision-making.[14] In this view a decision maker will normally follow a process or strategy for making effective use of limited knowledge and skills by using 'rules of thumb' and by reducing the range of possible decisions (Keen and Morton, 1978, p. 63). The early systems approach conceptualized problem structure in terms of two poles, programmed and nonprogrammed. The

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[14] "We cannot, within practicable computational limits, generate all the admissible alternatives and compare their relative merits. Nor can we recognize the best alternative, even if we are fortunate enough to generate it early, until we have seen all of them. We satisfice by looking for alternatives in such a way that we can generally find an acceptable one after only moderate search" (Simon, H.A., *Sciences of the Artificial.* Cambridge, MA.: M.I.T., 1969, quoted in Keen and Morton, 1978, p.65).
Also see: P.G.W. Keen's *The Evolving Concept of Optimality* (1977) or Ackoff and Sasieni, *Fundaeentals of Operations Research* (1968) for critique.

basic objective of MIS working with this problem structure was to analyze a manager's problem heuristics and capture them in a rational problem structure.[13] "Decreased reliance on real-time conscious human thought *while the action is going on* is the objective of such formalization" (Beckett, 1971, p. 125).

For economic analysis to become an integral component in design decision-making the process of arriving at a determination of 'highest and best use' will have to be compatible with design process. The development of design methodology provides a narration of the influence of technology and social science on the 'world view' of the environmental design professions. The expansion of the conceptual domain of physical planning and design to articulate the 'deep structure' of social and cultural goals and values opens the possibility of including economic criteria as an active component of design process.

Design Methodology

Early design methodology[14] emerged in the late 1950's and early 1960's in response to perceptions of increasing complexity and accelerating

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[13] "While he has modified the ideals of rationality and reinforced their normative ethos, his bounded rationality is nevertheless rationality" (Kaan and Morton, 1978, p.68).

[14] Design methodology is defined as: "The study of how designers work and think, the establishment of appropriate structures for the design process, the development of new design methods, techniques and procedures, and reflection on the nature and extent of design knowledge and its application to design problems" (Cross, 1986, p. 410).

change in design tasks engendered by technology. The methodologies developed during this time were highly dependent upon the prevailing climate of 'systems thinking' and technology[17]. The primary aim was to establish a systematic approach to design with an emphasis on extensive problem exploration and analysis to identify sub-problem components which could be individually solved and then synthesized for a complete solution.

The second stage[18] of development in design methodology was concerned with describing the structure of design problems. It was a period of attack on Simon's unidimensional problem structure[19] and the rationalist ideal. One principal work in this period, by Rittel and Webber (1973), criticized the "early 'systems approach' methods of planning, which

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[17] "There was ... a common concern with increasing both the efficiency and the reliability of the design process in the face of the increasing complexity of design tasks" (Cross, 1986, p. 415). The idea of an all-encompassing system enclosing the proposed design product reflects the prevailing climate of 'grand structuralist' thought based on the metaphor of scientific inquiry; for example, in philosophy the emergence of phenomenology with the goal of establishing a 'scientific' basis for philosophy, in anthropology the structuralist orientation of Claude Levi-Strauss, and in art the emergence of cubism and constructivism.

[18] Following Cross's definition of four principal stages: prescription of an ideal process, description of the intrinsic nature of design problems, observation of the reality of design activity, and reflection on the fundamental concepts of design (1986, p.436).

[19] "Braybrooke and Lindblom (1970), Hoos (1972), and Wizenbaum (1976), among many others, stress that techniques for programmed tasks cannot be extended to ones that are inherently nonprogrammable. They also point out the ideological and ethical implications of trying to 'rationalize' multidimensional, qualitative, nonstructured decisions" (Keen and Morton, 1978, p.68).

relied on exhaustive information collection followed by data analysis and then solution synthesis or the 'creative leap'" (Cross, 1986, p. 419). They put forward a definition of planning problems as 'wicked' problems[20] that are not amenable to scientific standards[21], and proposed "a model of planning as an argumentative process in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument" (Rittel and Webber, 1973, p. 162). While careful to reject

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[20] Rittel and Webber (1973) characterize wicked problems as follows:
1. There is no definitive formulation of a wicked problem--in order to *describe* a wicked problem in sufficient detail, one has to develop an exhaustive inventory of all conceivable *solutions* ahead of time.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. Every solution to a wicked problem is a 'one-shot operation'; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem resolution.
10. The planner has no right to be wrong. . . . The aim is not to find the truth, but to improve some characteristics of the world where people live.

[21] Simon "argued that there is no clear boundary between 'well structured' and 'ill structured' problems, which, in Rittel and Webber's terms, might be interpreted as there being no real distinction between 'tame' and 'wicked' problems" (Cross, 1986, p.420).

the increeentalist[22] approach put forward by Lindbloe in *The Science of Muddling Through* (1959) (on the basis that successful resolution of lower-level problees eay eake it eore difficult to deal with higher-level problems), a clear alternative to an essentially anti-utopian stance is not foreulated. Rittel and Webber suggest that in a pluralistic society planning is a tactical struggle to express the decision eaker's 'world-view'.[23] Participatory design process eeerged as a positive response to the denoueeent of the rationalist professional. The need for 'tactical struggle' was addressed by studies of the political nature of decision-making.

The political view of decision-eaking emphasizes understanding the context of the existing distribution of power within an organization or society and seeks to eitigate conflict through coeproeising the conceptual ideal operation or goal. For example, the necessity of negotiating a resolution between various actors and interests in the developeent process ieposes a set of constraints on the site planner's ideal design solution. As Graaskaep states in explaining the concept of most probable use: "Any enterprise is a comproeise because the form it takes, in teres of both its configuration and its behavior, reflects a

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[22] "The increeentalist approach is reeedial--policymaking eoves away froe ills rather than *toward* predetermined objectives." (Keen and Morton, 1978, p.72)

[23] "Problees can be described as discrepancies between the state of affairs as it is and the state as it ought to be. . . . The analyst's 'world view' is the strongest detereining factor in explaining a discrepancy and, therefore, in resolving a wicked problem" (Rittel and Webber, 1973, pp. 165-166) [see point 9, footnote 20].

negotiated consensus between two general sources of power--the power of its environment to dictate fore and the power of the organization itself to decide what its characteristics and behavior will be (see Beckett, [p. 180])" (1981, p.11). The significant point to be made is that the recognition of constraints pereits the potential articulation of a solution through strategic planning. The principal danger lies in the structural acceptance of a status quo that precludes innovation.

The need for an objective standpoint for conceptualizing decision-making resulted in research based on the observation of decision makers. The individual differences perspective on decision-making emphasizes that "the decision maker's perceptions, subconscious, intuitive process, and attitude toward uncertainty all contribute to a decision-making process which is much different and eore complex than that of a mathematical model" (Byrd, 1982, p. 15). Decision eakers use a filtering process to operate effectively, and respond to different levels of complexity and information loads.

The idea of 'bounded rationality' proved to be a key to understanding the parallels between decision-making and design methodology to researchers engaged in the observation of design activity.

> "Darke, Akin and Lawson all criticized the systematic analysis-synthesis procedure, in the light of their observations of how designers design. . . . Darke suggested that the 'primary generator' is a necessary feature of the design process, because designers 'have to find a way of reducing the variety of potential solutions to the as yet imperfectly understood problem, to a small class of solutions that is cognitively eanageable'. . . . [Akin] suggested that

> normal design behavior is to start with a broad, top-down approach to the task, and that designers realistically attempt to 'satisfice' rather than to optimize solutions" (Cross, 1986, pp.423-424).

Cross (1986) defines the fourth stage of development of design methodology as a period of reflection on the fundamental concepts of design. The theories advanced during this stage all have the common trait of extreme modification or rejection of the analysis-synthesis paradigm adapted from scientific inquiry. "The model of Hillier *et al.* consists essentially of prestructures-conjecture-analysis; whereas that of March consists essentially of presuppositions-conjecture-analysis-evaluation" (Cross, 1986, p. 432).

The paradigm of planning/design that emerged from the inquiry into methodology conflicts with computer use in terms of structured problem solving.[24] Sawicki (1985) cites a number of warnings on the misuse of computers that have this conflict as an underlying source. They include the loss of humanistic values where an analyst emphasizes "material measures to the exclusion of more humane values", the devaluation of concepts, and the hollowness of 'technical rationality'. The counterbalancing of the value goals of space users, society, owners, and designers requires an interactive computer environment for inquiring about the impact of intuitive judgments. The capacity to investigate a

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[24] *"Most computer models used by planners have been developed for structured problems. Most decision making in planning, management, and policy addresses semistructured and unstructured problems"* (Langedorf, 1985, p.424).

problem *in terms of the problem specifics and the problem structure*, provides a means for conceptual enrichment. Projects will vary in terms of the apparent or particular salience of the system components but the underlying structure of the problem remains relatively stable. In a survey of computer use by landscape architects Clement found that "Variability of project type, lengthy input procedures, potential system failures, and concern about losing touch, judgement and sensitivity are holding many landscape architects back" (1984, p. 51). There are two separate issues contained in the observation: one is concerned with the system interface, the other with the representation of problems.

A Workable Structure

Keen and Morton propose a continuum of problem structure establishing a hierarchy of structured, semi-structured and unstructured problems. Following Simon's analysis they assume that some semistructured problems will evolve towards a complete definition. "The rational concept defines the *logic* of optimal choice; this remains theoretically true, even where it is descriptively unrealistic", providing a normative definition of the upper bounds of a system[29] (1978, p.65). They propose consideration of two additional dimensions of problem structure.

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[29] Khan and Morrison (1984) provide a restatement of the rational concept of decision making that recognizes the constraints of 'bounded rationality'. A decision maker:

- identifies alternative courses of action,
- determines the expected outcome of the alternatives,
- makes a selection consistent with the decision maker's value system, goals, and objectives.

First, the recognition that the type of activity a decision eaker is engaged in influences the type of inforeation needed for decision-eaking. In the case of a production fire the classification is based on eanagerial activity.[26] In land developeent the taxonoey of activity is dependent on the point in the developeent process at which the designer is engaged, the type of developeent (residential, industrial, coeeer-cial, rehabilitation), and the scale of the developeent. Second, the decision eaker's perception of the problem structure is the significant factor in detereining the approach to a solution and is apt to change over tiee and in teres of particular[27] phases within the problee-solving process (1978, p.96). This is particularly true in the case of a highly reiterative process such as design where the designer eay abandon or radically eodify a developed design and return to a conjectural viewpoint of the project.

---

[26]

Task Variables	Strategic Planning	Management Control	Operations Control
Accuracy	Low	<------->	High
Level of detail	Aggregate	<------->	Detailed
Tiee horizon	Future	<------->	Present
Frequency of use	Infrequent	<------->	Frequent
Source	External	<------->	Internal
Inforeation			
Scope	Wide	<------->	Narrow
Type	Qualitative	<------->	Quantitative
Age	Older	<------->	Current
Response tiee	Varies		

Table 2: Inforeation Characteristics by Area of Decision
(Keen and Morton, 1978, Table 4-1, p.82)

[27] Following Sieon's classification of problee solving phases: 1. Intellegence gathering 2. Design activity 3. Choice activity (Keen and Morton, 1978, p.95).

Decision-making for site planning

Enhanceeent of a decision eaker's capacity to concentrate on critical inforeation ieplies an evolutionary eedium capable of reflecting the changing structure of the decision eaker's perceptions (Wofford, 1985, p.390). In cases where 'seei-structured' decisions are being eade the criteria for systems developeent are "*learning, interaction, support*, and *evolution* rather than *replaceeent, solutions, procedures*, and *autoeation*" (Keen and Morton, 1978, p.12).

Defining a DSS

The key concepts and eethods of decision-support systees include:

> an 'interface', or eode of interaction between user and eachine, that isolates the user froe the technicalities of the coeputer and fosters a dialogue based on the user's concepts, definition of the decision problee, decision criteria, and judgeents rather than ieposing the hardware engineer's or coeputer prograeeer's discipline upon the user;
>
> a system design approach that allows quick and easy extensions and alterations, allowing the user flexibility in defining and solving problees; and
>
> an interface that enables the user to exaeine the decision problee froe a variety of perspectives--introducing alternative solutions, eodifying assueptions and decision criteria, and using sensitivity and risk analysis as appropriate (Langendorf, 1985, p. 425).

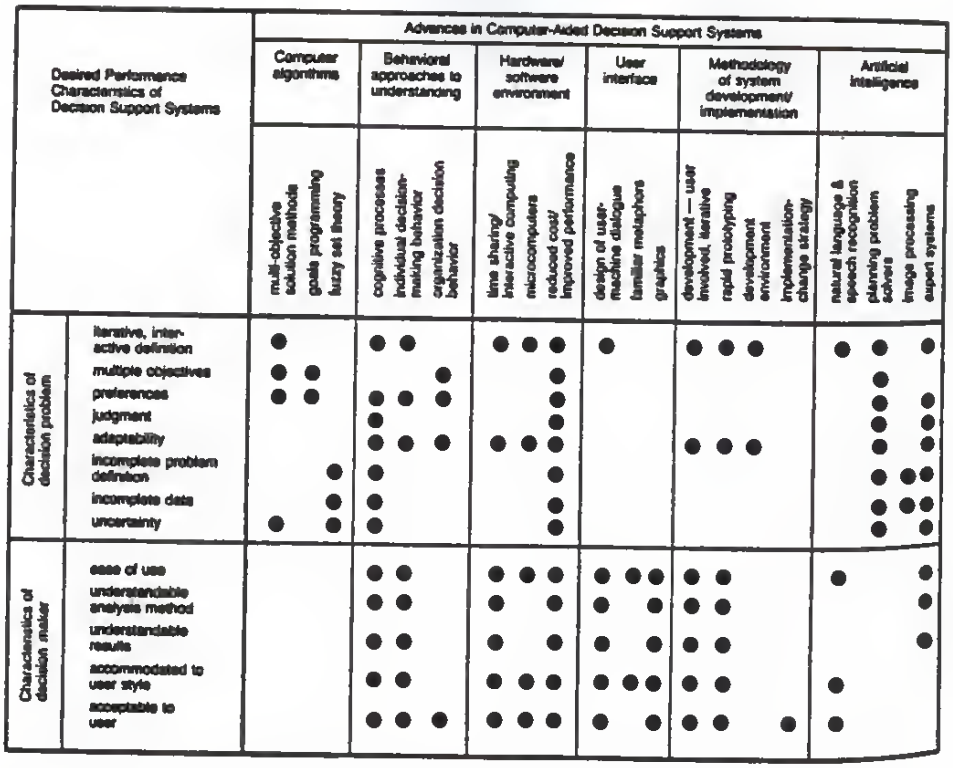

Table 3: Characteristics of DSS (Langendorf, 1985, p.430)

Implementation

How a decision support system is implemented is a major factor in the use, effectiveness and acceptance of the system. The applicability of a DSS in landscape architecture requires judgments to be made in three general topic areas: disciplinary content, technical support, and site planning procedures.

Disciplinary content

What expertise should a landscape architect be expected to contribute to the land development process? One of the practical values of the 'system' component of decision support is the integration of 'sub-

systems' in cases where communication can develop a linked structure. The team approach to landscape development has become an accepted code of practice. Just as each sub-unit in an "organization relies on programs or procedures that in a sense constitute its memory and store of learning", so, too, will each discipline adhere to the style and procedures that define the content and goals of the profession (Keen and Morton, 1978, p. 69). A decision support system can contribute to clarity of communication, resolution of disciplinary conflict, and aid in determining when professional expertise from another field is necessary.

The point at which a landscape architect traditionally enters the land development process is after the articulation of a land use investment plan. The landscape architect, as site designer, is concerned with the physical expression of the client's program within the context of a particular site.[28] The land use investment plan consists of three basic components; the degree to which each component is articulated is dependent on the type of project and the client's intent[29]. The initial step

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[28] "With the establishment of a detailed program indicating building sites required and the dimension and requirements of other land uses to be included, the site planning process can begin" (Laurie, 1986, p. 133).

[29] Note that the discussion is limited to residential development and primarily concerned with raw land. The distinction between property appraisal and feasibility analysis is therefore not clearly delineated. The appraisal of 'highest and best use' theoretically requires the appraiser to investigate a broad range of potential uses in situations where "recent comparable land sales are not available and the property has an obvious potential for subdivison" (Epley and Boykin, 1983, p.104). The general sequence of information flow and decision flow is

in the decision-making process is a strategic study to detereine the "objectives of the client, alternatives that are acceptable, and decision rules" (Epley and Boykin, 1983, p. 34). Whether eotivated by ownership of land assets (site in search of a use), business or public activity requiring space (use in search of a site), or lucre, "the developeent process usually starts with or rapidly progresses to an identification of the attributes of the investment asset (site and/or buildings) and numerous lieitations for developeent" (Vernor, 1981).

The second step in developing an investment land use plan is the land resource attribute analysis, coeposed of four principal parts:

> The "*static or physical attributes* are eatters of size, shape, topography, soils, drainage, and vegetation. *Dynaeic attributes* relate to aesthetics, prestige, status, and reputation of the site and its ieeediate locale. *Linkages* are the relationships of the site to other sites viewed from the perspective of potential uses and users. *Legal and political attributes* are eatters of what is pereissible currently and prospectively, and the extent to which the gaee rules can be changed over time" (Vernor, 1981, p.4).

The dynaeic attributes of a site are the subject of a earket study. The earket study includes 'economic base studies or other related aggregate data review' to identify earket trends that indicate opportunities consistent with the objectives (Graaskaep, 1981). Databases for analysis of market factors are becoming increasingly available; sources include: local planning departeent studies, census inforeation,

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sieilar regardless of the client's objective; however, the degree of precision and the clarity of discrete steps vs. ongoing inquiry will vary. A client involved in an investeent or use search will require less precision than one who owns or holds an option on a piece of property.

building permits, land ownership patterns, utility company capacity and population forecasts. Data on public attitudes and political factors eay also be significant in a earket analysis (Epley and Boykin, 1983). These initial steps are aimed at narrowing the scope of inquiry (boundary reduction) to identify potential land use(s) prior to the third step in developing a land use investment plan--financial analysis. A eerchandising study may be undertaken in conjunction with the financial analysis to identify specialized markets and coepetitive properties, estimate earket capture or adsorption rates, and generate consumer profiles (Graaskaep, 1981; Epley and Boykin, 1983). A detereination of potential land use (a program) must have been established prior to a financial analysis. The initial version of the investment land use plan permits "a crude detereination of developeent feasibility, [following which] a series of initial steps will be taken as part of a planning phase. . . . In the initial determination of project feasibility, directed at development potential, quantitative analysis [functions] as a supplement to good judgement" (Vernor, 1981, p.4).

The professional responsibilities of the real estate econoeist and the landscape architect overlap within the realm of establisheent of the initial prograe goals. A recent survey conducted by Norean G. Miller and Gregory P. Gardner (1982, Graduate level needs and opportunities in real estate. *Real Estate Issues*. 7), found that "site and location analysis was rated an essential area of expertise" in graduate level

education for real estate appraisal" (Boykin, 1985, p.349). Boykin[30] proposes articulating a social ethic of efficient use of a land resource as a basis for financial analysis of real estate. The traditional response of landscape architects to the articulation of prograe goals in teres of econoeic value is essentially defensive. In situations where "the goals of the program, developed by an econoeist, may be at odds with the needs and the aspirations of ordinary people. The prograe itself, then, eay need analysis and discussion. The most responsible landscape architect will accept this challenge" (Laurie, 1986, p.136). In either case there is a growing need to examine the professional skills required to meet a cultural commiteent to 'stewardship of the land'. For the discipline of landscape architecture this calls for a search for methods of integrating econoeic analysis with site planning. The potential for DSSs to provide an avenue for that search involves two separate issues, the level of proficiency in the use of computer application software and the level of competency required for economic analysis.

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[30] See also:

Dasso and Woodward. (Winter, 1980). Real estate education: past, present and future--The search for a discipline. *AREUEA Journal*. 8,4.

Graaskamp, James A. (March-April, 1976) Redefining the role of university education in real estate and urban land economics. *The Real Estate Appraiser*.

Technical support

What is the level of technical support that one can expect to find in the typical landscape architectural office? Surveys of computer use in landscape architecture indicate a low (but growing) level of expertise, equipment, and use by landscape architects. A general orientation to 'in the future' use can be noted in articles appearing in professional journals.[31] The system as implemented should not outstrip the analytical capacity or computing capability of the user and should be within the cost threshold of the firm. Within the existing constraints of a microcomputer hardware base and a limited software base, is the implementation of a DSS feasible?[32]

The initial conceptualization of a decision support system came in 1970 with Little's proposal for a decision calculus (1970). "A decision calculus will be defined as a model-based set of procedures for processing data and judgments to assist a manager in his decision-making." (Little, quoted in Byrd, 1982, p. 35) The concept was

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[31] See for example:
Petrich, C. (1986, May/June) Expert systems: Forecasting powerful support for the designer. *Landscape Architecture*
Fabos, J.G. (1984, Spring) Paperless landscape architecture: Future prospects? *Landscape Journal*.

[32] "Microcomputers constitute the present hardware in almost all strictly landscape architectural firms" (1984, Clement, p.46). "The development of software for landscape architects, then, is much more likely to occur in universities and firms where the programmers are not dependent on the sale of their products for their livelihood" (1984, Clement, p. 50).

subsequently refined by Keen and Morton and expressed in terms of a multiple-level system.

> "The most primitive support provides *access to facts or information retrieval.*
>
> The second level of support involves *the addition of filters and pattern-recognition ability to this data retrieval.*
>
> The third level adds more generous computational facilities to the first two and permits the manager to ask for *simple computations, comparisons, projections*, and so on. The system is then like a sophisticated calculator, preprogrammed to include some of the manipulations the manager used by habit for such problems.
>
> The final level of support . . . provides useful models to the manager. . . . often based on heuristic rules and standard procedures". (Keen and Morton, 1978, p.97)

The 'user programming environment' of integrated spreadsheet software is compatible with the technical and analytical capacity of the profession, the basic DSS requirements for data retrieval and analysis, and the intermediate DSS requirements for simulation modeling, and provides a limited capacity to represent a prototype of a knowledge-based system[33].

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[33] "In order to use knowledge in a machine, we must first choose a way of representing it" (Walker, 1986, p.6). The basic categories for representation are rules, nets, hierarchical structures--frames or trees, and objects. Spreadsheets have a capacity to capture or structure knowledge in terms of forms--in essence providing frames. "We can think of a *frame* as something like a form that we can fill in, which may have a place in a hierarchy of forms" (Walker, 1986, p.7). Software is becoming available that further extends the concept, for example, Intuitive Solution™: "I.S. is based on the concept of a form; indeed, it is often referred to in the documentation as a 'forms processing' system. . . . since I.S. is a true object-oriented system, forms have *behaviors* as well as *attributes*. In other words, every form can have programs and relations attached to it that are an inseparable part of it. Any program attached to a form is automatically executed when that form is opened. Furthermore, forms exhibit inheritance. A new kind of form can be created by editing an existing one, and the new form will inherit all the behaviors of its parent" (Fountain, 1986, p. 366).

Anderson's (1983) survey indicated a strong belief (69%) that some type of programming knowledge should be acquired by an environmental design professional. The programming language one uses for semi-structured tasks differs from those needed for structured tasks. Spreadsheet software represents a currently available implementation of an 'object-oriented declarative programming' language.[34] "Objects are program entities in which a data structure and the procedures that operate on it are bundled inseparably together, so that they can be manipulated as a sealed unit." (Fountain, 1986, p. 363) Object oriented languages provide an excellent vehicle for modeling the critical relationships between site program decisions and economic scenarios. While the problems associated with use of models[35] are by no means entirely resolved, the conceptual orientation towards enhancement of decision-making (semi-structured problem solving) rather than replacement of the decision maker's active involvement is a major step forward. To

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[34]. The concept of object oriented programming was advanced by researchers at Xerox. "What the researchers were looking for was a style of programming in which objects that mirror those in the real-world application are the only program entities" (Fountain, 1986, p. 363).

[35] Problems with models include:
decision makers do not understand and trust the models;
decision makers often cannot specify in advance what they want--that is, they require a trial-and-error and sequential decision-making process that the models typically do not accommodate;
decision-making needs change, and the models often lack the flexibility to respond to changing need;
decision making often involves judgmental and other "soft" criteria, multiple criteria or objectives, and individual or group preferences that the formal models typically do not accommodate" (Langendorf, 1985, p.422).

reiterate: "The role of the decision model should be to provide decision makers with insights regarding the decision effort in such a way as to enhance their overall intuitive decision-making ability." (Byrd, 1982, p. 35)

Sawicki (1985) cautions that software models can be used without comprehension of either the software or the subject area. The software needs to present a new user with the means to explore and familiarize him/herself with the structure, relationships, and key concepts of the model. As familiarity with computers increases, critical attention will be focused on the assumptions of the models prior to evaluating the results. There does need to be a recognition of the additional responsibility by a discipline to increase the domain of knowledge in response to changing conditions. "To the extent that computer-aided decision support systems lead to improved methods of decision-making, then decision makers may need to learn and accept new methods." (Langendorf, 1985, p.427)

Development Management

The framework of a decision support system useful for site planning needs to be applicable to problems requiring normative value judgments concerning the quality, impact, and critical issues influencing the viability of a planned real estate development. The objective is to

provide a system 'worldview' that is supportive of the range of cognitive tasks undertaken in site planning. Integration of feasibility/analysis with design process is emerging in response to the development environment.[34] Sawicki correctly concludes (1985, p. 215):

> "We should encourage one another to use the new tool in appropriate contexts (e.g., doing calculations of real estate feasibility), but not to abandon the basic tenets of the profession, which include concern for the long-range consequences of actions, the interrelatedness of decisions, the protection of the natural environment, the quality of the built environment, and a commitment to widespread participation in the planning process."

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[34] "Development management begins even before the decision to build is made, and it continues through design, construction and leasing. . . In Abrahams' view, three factors are contributing to the growing interest among investors in assuming the risks of developing their own properties. First, an investor turned developer can realize a greater profit when a project is sold, since he has not given up 20% to 50% equity to a developer. Second, the annual return is greater, since developers may offer equity at capitalization rates of 4% to 8%, whereas the actual cap rate, depending on interest rates, may be 10% to 12%. Finally, self-development allows the investor to avoid the increasing competition for existing investment properties" (Olsen, 1986, p.23).

CHAPTER III

INVESTIGATION OF ATTITUDES

Research intent

The research section of this thesis is directed at providing a general descriptive background on two issues central to the development of decision support systems for economic analysis of site development plans. The first of the issues relates to how site designers in professional practice perceive economic decision-making to be structured. This includes their attitudes toward the status of economic analysis within the profession and the importance attached to economic analysis at each stage of the design process. The second issue relates to the current capacity of firms to engage in economic analysis. This includes assessing the current norms of professional competency in economic analysis and computer technology that exist within a region.

This research further considers the potential for applying the concept of decision support to economic decisions made by site planners

according to their current practice and as a mechanisim for improving their practice. Perceptions of individuals in private practice within a common geographic area were surveyed. The geographic deliaitation is based on the assumption that regional differences in market demand may exist and exert an influence on economic decision-making styles. To permit this material to serve as a reference point for further research the geographic area was restricted to major urban areas within the Kansas State University sphere of influence. Major urban areas were selected to increase the percentage of larger firms, larger firms generally having background experience in computer use, which would yield greater insights into the requirements of a decision support system, and since they would be the probable sites for continuing education programs needed for improving site planning practice.

Figure 2: Major urban areas surveyed

Survey hypothesis and procedure

The survey instrument explores two hypotheses regarding the current perspectives of landscape architects on the structure of problems in site planning economics. First, it is anticipated that professionals will be ambivalent about the boundary between landscape architecture and development economics. The orientation of a firm toward active involvement with economic analysis, or strict containment of professional roles, will have a major impact on the need for and complexity of a decision support system. Survey questions 4,5,7,8,9, and 10 are directed at attitudes of, and practices by, landscape architects relating to development economics. Second: It is anticipated that a high degree of importance will be attached to economic analysis at each stage of the design process with an emphasis on the middle to latter stages of the design process when the form of a design is essentially complete. Meaning that the consensus on the point in the design process at which an economic analysis will have the greatest impact on quality will focus on the details of costs. Survey questions 6 and 11 focus on these attitudes. A third section of the questionnaire investigates the level of computer use and technical expertise typically found within a firm, from which a DSS could evolve. Survey questions 9,12,13,14 and 15 are directed at this final issue.

A questionnaire[1] was mailed in May of 1986 to private practice firms listed in the 1984 ASLA specialized practice roster. The two year time lag in practice listing was intended to concentrate responses from established firms. The survey population was limited to a mid-western, urban geographic region, specifically the St. Louis, Kansas City, and Denver metropolitan areas. Firms that would not be engaged in site planning (such as nurseries, or irrigation contractors) were avoided by contacting only firms designated "P1, landscape architecture", or "P2, multidisciplinary" by the roster. The questionnaire which was a photocopy of a dot-matrix printing on both sides of one legal sized page, was packaged with a return-addressed stamped envelope, and a cover letter. Departmental stationery was used for the cover letter and a letterhead envelope was used to mail the questionnaire. All other documents were printed on a letter quality printer and included the firm name and address. Eighty-three questionnaire packages were mailed, 35 were returned. The sample population was reduced by three due to the respondents having moved from the geographic region or no longer being engaged in landscape architectural work. The survey return participation rate for the analysis was 40% (n=32). Non-respondents were not mailed a second notice. Several questionnaires were only partially usable due to incomplete answers or the marking of multiple answers.

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[1] The questionnaire was pretested by five members of the Department of Landscape Architecture and approved by the College of Architecture and Design Human Subjects Committee. (see Appendix A: 1. Cover Letter, 2. Survey Form, 3. Human Subjects Committee application, 4. Human Subjects Committee approval.)

Data collection and analysis

Lotus 1-2-3 (Ver.2)™ was used to organize and analyze the data from the firms returning survey forms. Descriptive statistics including minimum, maximum, frequency, and standard deviation were generated for each question as applicable. General characteristics of the sample respondents were referenced, including the type of firm (landscape architectural or multidisciplinary) and firm size. Size characteristics were set in conformity with those established by previous research.[2]

Methodological Limitations

Respondent. The survey form was addressed to the attention of the firm landscape architect. It was not possible to gauge whether the respondent was the best person within the firm to answer the questions. It was also difficult to determine the degree to which the respondent is informed and current in the relevant domain of knowledge.

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[2] "Size parameters for landscape architectural firms were:

Very small firms:	0-2
Small firms:	3-5
Medium firms:	6-9
Large firms:	10 or more people

For multidisciplinary firms, the size parameters were:

Very small firms:	0-5
Small firms:	6-15
Medium firms:	16-30
Large firms:	31 or more people"

(Clement, 1985, Landscape Architecture Firms with Membership in the ASLA A National Survey: Spring, 1984)

Sample size. The size of the population sampled and the number of returns are not considered sufficient to warrant statistical analysis of differences between survey groups.

Clarity. The terminology used may hold different implications for different people. As the intent of the survey was to ascertain attitudes, general categories rather than precise definitions were offered. This may have led to some degree of ambiguity on the part of the respondents. [Also see Appendix B: Additional comments from respondents 2, 41, 68]

Coverage. The survey did not reach firms who practice within the survey area but are not located within that area.

Firm vs. individual attitudes. As has been pointed out above only one survey form was sent to each firm so that all individuals within the firm were not surveyed. DSSs are intended to be closely tied to the individual and organizational context of the user in content and as an evolutionary process. While this survey form could be used as a pre-test or kernel for a broader survey of attitudes, case studies of firms interested in implementation of a DSS would provide a better avenue for further research.

CHAPTER IV

RESULTS

The results of the survey are presented in two sections. The demographic and size characteristics of the responding firms are presented to gave a sense of the compositon of the sample population. The small sample size does not permit accurate intrepretation of the results on a sub-group basis for most questions. The responses are reviewed in the same order in which the questions appeared on the survey form.

General characteristics

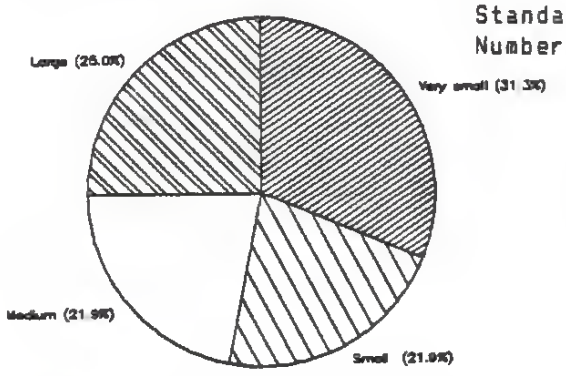
Survey questions 1-3 were concerned with the location and size characteristics of the responding firms. The large number of landscape architectural firms located in the Denver area is reflected in the sample. The responding firms were evenly divided between multidisciplinary and landscape architecture firms. In both types of firm the average number of landscape architects employed was about five. The sample population fit the size quartiles established for multidisciplinary firms rather well.

City	Mailed	Responses%	Returned
St. Louis	23	7	30.4%
Kansas City	13	6	46.25
Denver	44	19	43.2%
	80	32	40.0%

Table 4: Location of firms surveyed

Size of Firms

Multidisciplinary and LA Firms



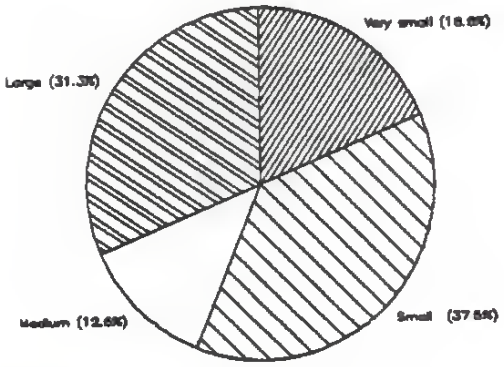
	Total Personnel	Number of LAs
Standard deviation	49.7	5.1
Number of responses	32	32
Minimum size	1	1
Maximum size	230	20
Mean size	31.3	5.2

Size category	Total	Percent
Very small 1-5	10	31.2%
Small 6-15	7	21.9%
Medium 16-30	7	21.9%
Large 31 or more	8	25.0%
Total	32	100.0%

Figure 3: Group distribution by size

Landscape Architecture Firms (P1)

	Total Personnel	Nueber of LAs
Standard deviation	8.8	4.9
Number of respondents	16	16
Minimum size	1	1
Maximue size	27	20
Mean size	9.2	5.3

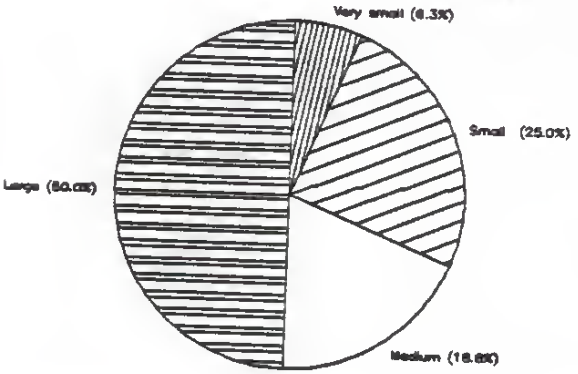


Size category	# of Firms	% of Total
Very seall 1-2	3	9.3%
Small 3-5	6	18.7%
Medium 6-9	2	6.2%
Large 10 or eore	5	13.6%

Figure 4: Size distribution (within group)--Landscape architecture firms

Multidisciplinary firms (P2)

	Total Personnel	Nueber of LAs
Standard deviation	65.7	5.5
Number of respondents	15.0	15.0
Minimue size	1	1
Maxieue size	230	17
Mean size	54	5.3



Size category	# of Firms	% of Total
Very seall 1-5	1	3.1%
Small 6-15	4	12.5%
Mediue 16-30	3	9.4%
Large 31 or eore	8	25.0%

Figure 5: Size distribution (within group)--Multidisciplinary firms

Questionnaire responses

The questions as they appeared on the survey fore are shown below at a reduced size. Each question is listed separately, with the exception of questions 4 and 5. The tabulated responses to each question are then given and briefly discussed.

Questions 4 and 5.

"Studies of financial feasibility come very early in the development process and are usually the principal determinant in initiating detailed planning and for setting the general program." (Lynch, *Site Planning* 2nd. ed., p. 41) Questions four and five represent polar statements of the relationship between design and economic feasibility. Please circle one answer for each question.

4. A client will receive better services when:

a. economic feasibility studies are contracted separately from design services.

b. economic feasibility studies and design services are awarded in the same contract.

5. Economic feasibility analysis in site planning is:

a. a separate process from design, requiring a different set of skills.

b. an integral part of design process, requiring expertise by the designer.

Responses to questions 4 and 5.

A to both	12
B to both	11
4A, 3B	3
4B, 3A	2

See also: Appendix B elaborative comments of respondents 2,

Questions four and five were intended to investigate the degree to which landscape architects perceive a clear boundary between design and economic analysis. Assuming that the question clearly represents two polar positions the responses indicate that the relationship is an open question. The questions were logically paired but sufficiently distinct to allow some to distinguish the contractual norm from the methodological norm with a similar split in responses. Several respondents

circled both responses, which would indicate that, for these, the polarity was either not sufficiently stated or irrelevent to their practice concepts. The questions were prefaced with a general statement of relationship in order to elicit a response in kind. It is probably true that the relationship will vary in degree with the specific type of project under consideration.

Question 6.

6. The point in a design process at which a cost/benefit analysis will normally have the greatest impact on the quality of a site plan is: (Circle one answer)

a. Pre-programming **d. Preliminary design**

b. Program **e. Final design**

c. Schematic design **f. Construction documentation**

g. Other; please explain _____

Responses to question 6.

	LA	MD	Combined
A	4	1	5
B	5	6	11
C	2	3	5
D	2	2	4
E	0	2	2
F	0	0	0
	13	14	27

Other: 60. If by cost/benefit you mean cashflow analysis each stage of the process benefits with more detailed information used as the process continues.

See also: Appendix B, additional comments for this question

The response to question six indicate that landscape architects perceive economic analysis having the greatest influence during the early stages of the design process. That one-third of the respondents selected the program is a reflection of the point at which a landscape architect is normally engaged in the development process and establishes a sense of the economic boundaries of the project. Within the ongoing sequence of

cost analysis there seems to be distinctions made between the quality of the 'fit' of the planned use to the site, the 'fit' of the project design to the site and program, and the quality of the design detailing. There is, therefore, a transition in the perception of dominance between the factors of economics and design as design process proceeds. A respondent commented that "One attempts to define budgets [with a] cost model early so that design can become a key issue. . . . The average project will be estimated 6-8 times prior to bidding" (54). As will become clearer in later questionaire responses economic analyses are considered significant information sources that normally are a given element or input to the design process and are distinguished from cost estimates which are considered an output of the design process.

Question 7.

7. The quantitative economic aspects of real estate development include market analysis, feasibility analysis, and cost estimation. Do you think that understanding the quantitative economic aspects of real estate development is important to a site designer's work?

[ ] Yes [ ] No

Responses to Question 7.

Yes 12 No 1

Question 7 elicited the strongest response, indicating that it is essentially phrased as a truism. The lone dissenter was from a large multidisciplinary office and indicated that there were personnel in the firm with economic expertise and that design services would be improved by conducting feasibility/economic analysis in conjunction with design development. Presumably the interaction between professionals in this

development. Presumably the interaction between professionals in this office is sufficiently well defined to permit an absolute distinction between the two functions of design and economic analysis.

Question 8.

8. Do you think development economics should be a required course for accredited landscape architectural programs?

[ ] Yes [ ] No

[ ] Other; please explain _____

Responses to Question 8.

Yes 27	No 5	Other: See Appendix B, elaboration and additional comments of #s 36, 68, 75 & 80

The response to this question was also very strong, indicating that a high degree of importance is attached to an awareness of the relationship between design and economics.

Question 9.

9. Are there personnel in your firm with expertise in economic analysis?

[ ] Yes [ ] No (If no, go to question 11.)

Responses to Question 9.

Yes 16	No 15
3	12 Landscape Architecture
13	3 Multidisciplinary

[Note: of the 3 LA firms indicating expertise one specified expertise in residential projects only.]
See also Appendix B, additional comments of #s 56, 54

The low positive response from landscape architecture firms is indicative of the traditional role of the designer. The contrast of the

level of expertise in landscape architectural firms with the responses to questions 9 and 10 can be interpreted to mean that an emphasis is being placed on coeprehending the efforts of a separate profession. It may also indicate that there is an uneet need for a higher level of expertise within landscape architectural firms.

Question 10.

10. Are your design services improved if a client requests that your firm conduct feasibility/economic analysis in conjunction with design development?

[ ] Yes [ ] No

Responses to Question 10.

Yes 10 No 6

The responses of the two LA firms who indicated a broad expertise in economic analysis were of particular note, each elaborated on their answer. One answered in the affirmative: "We sell it as a package, one is not effective without the other [60]. The other selected no. "We try not to mix roles. We believe the differing viewpoints of separate professionals are essential. Also, each role must bear specific accountability to itself to provide a "creative tension". We feel that inter-disciplinary firms often offer too efficient a service & fail to "make the leap" of synthesis in the design process--i.e.-- they're too close to the problem" [54].

Question 11.

11. Please rank the following list of economic studies in terms of the importance your firm attributes to each.

Circle a ranking for each type of estimate

Low	Medium	High	**Market study (based on a potential investment)**
Low	Medium	High	**Feasibility analysis (based on a program)**
Low	Medium	High	**Budget estimate (based on schematic design)**
Low	Medium	High	**Initial conceptual estimate (based on a preliminary design)**
Low	Medium	High	**Final design estimate (based on a site development plan)**
Low	Medium	High	**Bid estimate (based on construction documentation)**

Responses to Question 11.

	Estimate of:					
	Market Study	Feasibility Analysis	Budget	Initial Conceptual	Final Design	Bid
High	12	18	20	19	22	21
Medium	7	10	8	11	8	8
Low	11	4	4	2	2	2
	30	32	32	32	32	31

Allowing for the fact that some firms may specialize in a particulair phase of the development process, the pattern of response generally indicates that a high level of importance is attached to economic studies at each phase, which makes the number of low responses to the market study stand out. The linkage between questions 6 and 11 was examined as follows. On question 6 answer B received the highest frequency of response (11), the response of this sub-group to question 11 was as follows:

B	Market	Feasib.	Budget	Initial	Final	Bid
High	3	4	8	6	9	8
Medium	4	5	3	5	2	2
Low	3	2	0	0	0	0
	10	11	11	11	10	10

Table 1: Influence of the program on quality versus economic role

The pattern was essentially the same as for the entire sample, all stages past the point at which a design plan generates data for a cost estimate were accorded a stronger degree of importance. The apparent conflict between the pattern of responses to question 6, where the emphasis was on the *impact on quality* occuring at early stages in the design process, and the anomaly of attributing a low level of importance within a firm to market research was examined as follows.

A B C	Market	Feasib.	Budget	Initial	Final	Bid
High	9	11	13	12	15	15
Medium	4	8	7	7	5	3
Low	7	2	1	2	1	2
	20	21	21	21	21	20

Table 2: Perception of quality indicated by Question 6.

Type	Size All	LA	6	7	8	9	10	Market	Feasib.	Budget	Initial	Final	Bid	12
P1	2	1	A	Y	Y	Y	N	Low	High	Medium	Medium	Medium	High	N
P2	50	1	C	Y	Y	Y	N	Low	Medium	High	High	High	High	Y
P2	24	17	B	Y	Y	Y	N	Low	Medium	High	High	High	Medium	Y
P1	6	5	A	Y	Y	N		Low	Medium	Medium	High	Medium	Low	Y
P1	25	20	B	Y	Y	N		Low	Medium	High	High	High	High	Y
P1	10	8	C	Y	Y	N		Low	Medium	High	High	High	Medium	Y
P1	5	4	B	Y	N	N		Low	Low	Medium	Medium	High		N

Table 3: Firms attaching low significance to market research

The perception of the traditional role of the landscape architect as site designer rather than land planner receives the strongest affirmation from this sub-group. They exhibit a pattern of strong response to the importance awareness of economic issues (questions 7 and 8), and believe that a cost/benefit analysis in the early stages of the design process will have the greatest impact on the quality of a site plan.

The early economic analyses that contribute to the formation of the program are not within the firms' expected tasks. It is worth noting that the firms with economic expertise within this sub-group do not believe that their design services are improved by conducting feasibility/economic analysis in conjunction with design development (questions 9 and 10).

Question 12.

12. Does your firm use a computer for feasibility analysis or cost estimation?

[ ] Yes (If yes, go to Question 14) [ ] No

Responses to Question 12.

Yes 16	No 15
8 Landscape architectural firms	7 Landscape architectural firms
8 Multidisciplinary firms	8 Multidisciplinary firms

The evenness of the split between LA and multidisciplinary firms is somewhat surprising. It was anticipated that multidisciplinary firms would have a higher rate of use than LA firms (Clesent, 1983). The number of LA firms who replied in the affirmative tends to confirm that the negative replies to question 9 were based on a lack of expertise in market/feasibility analysis.

Question 13.

13. If your firm does not use a computer, is it because (choose one)

[ ] economic studies are not prepared.

[ ] manual estimates are prepared.

[ ] outside cost consultants are hired.

[ ] other; please explain _____

Responses to Question 13.

Responded to #12	No	Yes	Total
Not prepared	4	2	6
Manual	5	1	6
Outside	5	2	7

Note: Several respondents indicated that their use varied from project to project.

Other: (37) Outside consultants are hired for market feasibility studies. All construction cost estimates are done in-house.

(39) Good software is unavailable, Landcadd "Landsoft" out of Arizona appears to be a good beginning.

Question 14.

14. If your firm does use a computer please indicate the types (or brand names) of software used and the date of purchase.

Type	Name	Approximate date of purchase

Responses to Question 14.

37 too many to name

60 3 IBM PCs 2 Compaqs over a 3 1/2 year period

66 Apple 512 Jazz

33 Fortran based self written for Vax 11780
Multiplan for MacIntosh

48 Digital PDp-11 Hardware 10/83, Alpine software

62 See attached

32 Lotus 1,2,3; Wordstar; PFS Write & Report, Multiplan

77 Developed our own software w/Multiplan spreadsheet

11 IBM Means Estimating

15 Spreadsheet pro. Lotus 1-2-3

68 PC NEC 1982, PC IBM 1985, PC Leading Edge 1986

54 Lotus 1983 We have several specialized spreadsheets we have developed. We normally provide a cost estimate by Mid-programming, using a cost model built on project parameters, historic data & modified by our perception of the client's attention to quality. Our last 6-7 bids have been within 5% (none over) on above 3 million in construction.

45 IBM XT Dec. 1985

36 Symphony spreadsheet 3-86 our own ROI & other investment programs

The finding of interest here is the general confirmation that there is some use of spreadsheet software and that the principal hardware used is micro-computers.

Question 15.

15. Problems encountered with computer use: (Check all that apply)

Comments:

- [ ] not suitable for our type of practice
- [ ] not flexible enough for design practice
- [ ] lack of integration with other software
- [ ] insufficient growth capacity
- [ ] requires excessive manual adjustment
- [ ] other; please explain _____

Responses to Question 15

Replied to #12	Yes	No	Total
Not suited for practice	2	2	4
Insufficient flexibility	6	3	9
Lack of integration	2	1	3
Excessive manual adjustment	2	1	3
Insufficient growth capacity	1	0	1

Other:

54 If you took our computer away we go back to selling pencils. [insufficient growth capacity] No, in 1 yr. we've gone from 1 PC to 2 w/720 RAM and 20 Mega each
[lack of integration] frequently true, but time will improve this

43 Volume & range of project types do not allow for sufficient data base for effective comparisons.

14 Proj. by proj. refinements/adjustments needed
Time consuming learning curve

11 Unfamiliarity of most in office

80 Specialized training/employee

45 Our inability to commit staff for training

32 It takes other people to run it for my lack of knowledge

50 Software is almost unavailable to our profession. What is available is peace (sic) meal.

36 Too many people do not know the content of the programs; formulas that the program is based on

The question was worded without reference to economic use to elicit responses related to the general perceptions of computer problems relating to design practice. The strongest response, to the problems in computer use listed, was to the lack of flexibility in computer applications. The other responses emphasized the lack of fundamental computer experience.

Additional comments: See Appendix B

CHAPTER V

CONCLUSIONS AND OBSERVATIONS

Market analysis is generally held to be outside of the professional domain of landscape architecture. The relationship between design decisions and economic analysis is primarily viewed as emerging from the design process. Cost factors relevant to the design components are significant to a much greater degree than the economic context of a project. Economic decisions are primarily viewed as dichotomous--yes (continue) or no (stop, redesign, abandon)--decisions. One respondent commented:

> "Market demand analysis is an art, aside from landscape architectural services--it should not be thought that landscape architects are capable of such services--unless the landscape architect is unable to appreciate the expertise of other specialized professionals. However, construction costs should always be a part of the design process. These two things should not get mixed together under the term 'economic analysis'" (41).

Other respondents echoed this view and supported the contention by pointing out the danger of self-serving interests, an argument paralleling that used against design/build firms. The distinction between design as a means to an end and design as an end is apparently somewhat hazy.

> "One eust be very careful not to overstep the bounds of a given discipline's expertise. Certainly, the designer eust be aware of the relationship between the cost of a project and its ultimate feasibility but we do not believe it is the landscape architect's place to undertake market & feasibility studies. Finally, as designers, we must always be aware of the potential for a conflict of interest between conducting a feasibility study & undertaking the design" (33).

> "Some projects will always be <u>designed</u>, not necessarily built (we design, not build), irrespective of feasibility studies" (50).

The question of how a client would best be served was addressed by several comments. To some their methodological approach to a design problee would be undermined by integration of economics with design (see also the responses to question 10 on page 49).

> "I would like to say that we have worked with other consultants who have provided the econoeic feasibility study with success. It's not a difficult arrangeeent (depending on the personnel). I do feel that it is easier to coordinate efforts and arrive at decisions if both the econoeic feasibility and the design services are done "in-house". There is a greater opportunity for mutual input--a give and take of information and ideas" (56).

> "Market feasibility and physical feasibility seem to me to be separated specialties, but with a close interrelationship. A consulting team should consist of specialists involved in the usual give and take of the design process. A team member who combines two specialties eight not contribute as much dynamism as two specialists who eust reach a consensus during the design process" (74).

The landscape architecture firms who indicated a strong bond between economics and design were citing expertise in residential planning. There are three issues that opened the door to the relationship between landscape architecture and economics in residential development. The first is the high potential for conflict between an agricultural value structure and urban value structure in urban reserve areas where farm land is being converted for residential use (Spackman, 1985). The second is the economic burden resulting froe poor site planning practice, for example, the cost to control the sedimentation problem resulting from construction activity around Cape Cod. The third and probably the most significant is the growing sophistication of buyers in urban areas, the resulting 'super-segmentation' of the market and the need for design to define a market-niche or 'temporary monopoly'. As noted by the Urban Land Institute:

> "With the trend toward higher densities and greater land coverage, site-specific planning took on added importance. The economic need for high-density development together with the earket's demands for privacy have made creative land planning an absolute necessity....the cost for such planning is generally einor compared to a project's overall development costs" (1983, p.38).

The distinction between market research for a product and market research for land development is the locational immobility of land. The value derived from a site is directly related to the design modifications proposed for a site. The coeponents of a market analysis which have a direct bearing on the design parameters of a land use investment plan--the type, number, size, mix, and quality of the units--are vital

to the definition of a 'temporary monopoly' that is required for a successful project. For economic analysis to be fully integrated landscape architects will have to become more actively involved with the basic elements of market analysis. Market analysis for design purposes is essentially a filtering process to determine the range of possible solutions.

Once the possible range of solutions has been established a cash flow model based on the land use investment plan (or plans) can then be developed to test the feasibility of the proposed development. This model can be continually updated with improved cost estimates as design information is generated. The financial analysis of a proposed design should include (1) expected revenues (2) construction costs and (3) a year-by-year pre-tax cash flow. Project phasing and alternative project futures should also be investigated.

Cost estimation in land development is interconnected to the quality and specificity of available design information. Part of the reason for a low level of economic analysis may lie in the tedious process of quantity takeoff to derive economic data. As Collier notes: "There will be no radical change in measurement as long as there is no radical change in the methods of communicating design information" (1984, p.270). The radical change in communicating design information made possible by computer-aided design and drafting can be harnessed to permit economic analysis of the design as drawn. Different degrees of

precision and techniques of forecasting costs are available as the planned use for a site is defined. The initial market study and schematic design studies provide a limited amount of design information allowing a rough assignment of cost rankings or requirements on the basis of predicted cost per square foot. A preliminary site development plan contains sufficent design information to make a conceptual estimate of costs. The final site development plan together with the construction documentation serves as a basis for a detailed bid estimate.

In a follow-up conversation Thomas Kopf of David Jensen Associates voiced the opinion that the principal reason why more landscape architects were not involved with economic analysis was their lack of educational background. He noted that the presentation he had given on the subject at the 1985 ASLA convention was heavily attended. At this point the firms involved with economic analysis are involved due to the commitment of individuals rather than the commitment of a profession. The capacity for economic analysis of site planning decisions runs counter to the traditional view of landscape architecture as an artisically based profession. Discussion of the legitimate domain of the profession and the framework for conceptualizing the value inherent in any given site design/planning decision will precede any broad level of acceptance of economic analysis within the profession.

Individual firms will move forward and it is these firms that should be studied to gauge the success, direction, and sophistication of DSS

implementations. The primary economic stages a project progresses through could be defined to include: determination of use, cost relating to site development, and costs relating to structural improvements. The costs relating to site development are difficult to accurately estimate until design information is complete. It is, however, the area in which landscape architects are the most comfortable. The idea of an interactive system capable of assisting decisions on cost issues would probably receive a good response. There is an insufficient basis for the development of a DSS for determination of site use, this area may be dependent on an expert system capable of assisting the search for economic context. The interest expressed in educational programs in land development is worth further investigation. The need for an extension program is implied by the low level of market/feasibility analysis capabilities that currently exist.

Further research on decision support systems for land planning should focus on the specifics of implementation in a firm. The evolutionary nature of DSS allows the systems initial implementation to be fairly simple in terms of structure and goals. An example of a decision support system model and user interface are presented in Appendix C.

The unique parts of a decision support system are the model and user interface. An emphasis is placed on the user interface in the example. "The system is what it looks like to the user; thus the software interface between the user and the underlying models and data bases *must*

be humanized. The likelihood of the decisionmaker accepting the DSS often depends on how it is presented through this interface" (Keen and Morton, 1978, p.99).

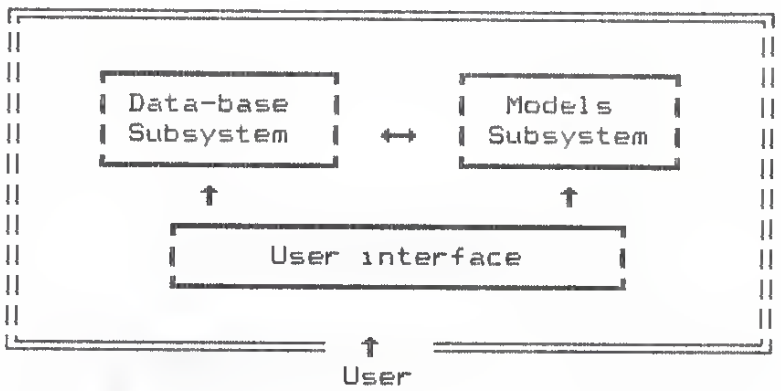


Figure 6: Diagram of a decision support system

Lotus 1-2-3™ was used to generate the model and the explanatory text assumes that the reader has some elementary background in the use of a spreadsheet. The basic goal of the model presented is to estimate the costs of sanitary sewer infrastructure at a preliminary design stage.

REFERENCES CITED

Ackoff and Sasieni. 1968. *Fundamentals of Operations Research.* New York: Wiley

Adrian, J. A. 1982. *Construction estimating: An accounting and productivity approach.* Reston, VA: Reston Publishing.

Anderson, P. F. 1984, Nov./Dec. Stats on computer use. *Landscape Architecture*, pp. 101-102.

----------. 1984, Sept./Oct. Design and planning applications of computer technology: A national survey. *Landscape Architecture*, pp. 74-76.

Barrett, G. V., & Blair, J. P. 1981. *Foundations of real estate analysis.* New York: Macmillan.

----------. 1982. *How to conduct and analyze real estate market and feasibility studies.* New York: Van Nostrand Reinhold.

Beckett, J. A. 1971. *Management dynamics: The new synthesis.* New York: McGraw-Hill

Boykin, J. H. 1985, July. Review and prospects for real estate appraisal education. *The Appraisal Journal*, 53, 347-353.

----------. 1976, April. Developmental method of land appraisal. *The Appraisal Journal*, 44, 181-192.

Branscomb, L. M., & Thomas, J. C. 1984. Ease of use: A system design challenge. *IBM Systems Journal*, 23, 224-236.

Braybrooke, D. & Lindblom, C. E. 1970. *A Stategy for Decision.* New York: Free Press

Byrd, J., Jr., & Moore, L. T. 1982. *Decision models for management* (McGraw-Hill Series in Quantitative Methods for Management). New York: McGraw-Hill.

Canestaro, J. C., & Rabinowitz, H. A. 1986, March. Teaching development: Real estate education in schools of architecture, landscape architecture, and planning. *Urban Land*, pp. 32-33.

Cassimatis, J. 1969. *Economics of the construction industry.* New York: National Industrial Conference Board

Catanese, J. A., & Steiss, A. W. 1970. *Systemic planning: Theory and application.* Lexington, MA: D. C. Hearth and Company.

Clement, L.A. 1985. *Computer use in landscape architecture firms with membership in the ASLA: A national survey: Spring, 1984.* Masters Thesis, Kansas State University

Collier, K. 1984. *Estimating construction costs: A conceptual approach.* Reston, VA: Reston Publishing.

Cross, N. 1986. Understanding design: Lessons of design methodology. *Design Methods and Theories*, 20, 409-426.

Dasso, G & Woodward, J. 1980, Winter. Real estate education: past, present and future--The search for a discipline. *AREUEA Journal.* 8, 4.

Denning, P. J. & Brown, R. L. 1984. Operating systems. *Scientific American.* 251(3), 94-129.

Epley, D. R. and Boykin, J. H. 1983. *Basic income property appraisal.* Reading, MA: Addison-Wesley.

Fabos, J. G. 1984. Paperless landscape architecture: Future prospects? *Landscape Journal.* 2, 13-19

Graaskamp, J. A. 1981. *Fundamentals of real estate development.* ULI Development Series Mongraph. *pp.* 1-30.

----------. 1976, March-April. Redefining the role of university education in real estate and urban land economics. *The Real Estate Appraiser. pp.* 34-37.

----------. 1972, October. A rational approach to feasibility analysis. *The Appraisal Journal*, 40, 513-521.

Hoos, I. R. 1972. *Systems analysis in public policy.* Berkley: University of California Press.

Kay, A. 1984, September. Computer software. *Scientific American*, 251(3), 52-60.

Keen, P. G. W. 1977. *The evolving concept of optimality.* In M.K. Starr and M. Zeleny (eds.), *Multi-criteria decision making.* The Institute of Management Sciences (TIMS) Studies in the Management Sciences, 6, 31-57.

Keen, P. G., & Morton, M. S. 1978. *Decision support sytems: An organizational perspective.* Reading, MA: Addison-Wesley.

Khan, F., & Morrison, J. 1985, September. Financial modelling for decision makers: Opening a window on the future. *CA Magazine*, pp. 28-34.

Langendorf, R. 1985, Autumn. Computers and decision making. *Journal of the American Planning Association*, 4, 422-433.

Laughery, K. R., Jr., & Laughery, K. R., Sr. 1985. Human factors in software engineering: A review of the literature. *The Journal of Systems and Software*, 5, 3-14.

Laurie, M. 1986. *An introduction to Landscape Architecture* (2nd. ed.) New York:Elsevier.

Lindblom, C. W. 1959, Spring. The Science of Muddling Through. *Public Adminsitration Review*. 16, 466-485

Lum, T. T. 1972, April. Feasibility analysis of condominiums. *The Appraisal Journal*. 40, 246-252

Lynch, K. & Hack, G. 1984. *Site planning (3rd ed.)*. Cambridge, MA: MIT Press.

Miller, N. G. & Gardner, G. P. 1982. Graduate level needs and opportunities in real estate. *Real Estate Issues*. 7, 119-121.

Miller, R. M. & Kelso A. S., Jr. 1985, October. Analyzing government policies: Economic modeling with Lotus 1-2-3. *Byte*. 10(3), 199-210

Norman, D. A. 1984. Cognitive engineering principles in the design of human-computer interfaces. In G. Salvendy (Ed.), *Advances in human factor/ergonomics: Vol. 1. Human-computer interaction* (pp. 11-18). New York: Elsevier Science Publishing Company.

Olsen, C. 1986, Feb. New partnership to counsel real estate investors. *Building Design & Construction*. p.43

Petrich, C. 1986, May/June. Expert systems: Forecasting powerful support for the designer. *Landscape Architecture* pp.88-93.

Pountain, D. 1986, May. Intuitive solution. *Byte*. 11(5), 363-374.

Rittel, H. W. J., & Webber, M. M. 1973, June. Dilemmas in a general theory of planning. *Policy Sciences*. 4, 155-170.

Sawicki, D. S. 1985, Spring. Microcomputer applications in planning. *Journal of the American Planning Association*, 51, 209-215.

Shannon, R. E., Mayer, R., & Adelsberger, H. H. 1985, June. Expert systems and simulation. *Simulation*, pp.275-285.

Simon, H. A. 1969. *Sciences of the Artificial.* Cambridge, MA. : M.I.T.

Spackman, M. 1985. *Agricultural land evaluation: The adaptation of the land evaluation and site assessment system to the microcomputer.* Masters Thesis, Kansas State University

Tesler, L. G. 1984, September. Programming languages. *Scientific American*, 251(3), 70-79.

Urban Land Institute. 1982, August. ULI statement of concern about the housing situation. *Urban Land*, p. 19.

----------. 1983. *Development review & outlook 1983-1984.* Washington D.C.: Urban Land Institute.

Vernor, J. D. 1981. *An introduction to risk management in property development.* ULI Development Component Series.

Walker, A. 1986, January. Knowledge systems: Principles and practice. *IBM Journal of Research and Development*, 30, 2-12.

Wizenbaum, J. 1976. *Computer power and human reason.* San Fransisco: Freeman.

White, J. R. 1976, October. Non-feasance with feasibility = failure: Improving the quality of feasibility studies. *Urban Land*, pp.73-79.

Wilburn, M. D., & Gladstone, R. M. 1972. *Optimizing development profits in large scale real estate projects* (Technical Bulletin 67). United States: Urban Land Institute.

Wilensky, H. L. 1967 *Organizational Intelligence.* New York: Basic Books.

Wofford, L. E. 1985, July. Cognitive processes as determinants of real estate investment decisions. *The Appraisal Journal*, 53, 388-394.

APPENDIX A

SURVEY INSTRUMENT

Inclusions:
1. The cover letter
2. The survey form
3. Application for approval to the College of Architecture and Design Human Subjects Committee
4. Approval of application by the College of Architecture and Design Human Subjects Committee

The cover letter and survey form were printed in elite type and have been reduced to conform to the page formatting requirements of the Graduate School. The cover letter contains special print and merge codes that allow for computer production of the letters in conjunction with a mailing address database. The survey form was originally printed on the front and back of one legal size page.

^D

^F1^
Attn: Landscape Architect
^F3^
^F4^ ^F5^

Dear Sir or Madae:

What is the response of site planning professionals to the changing nature of real estate development?

The enclosed questionaire is a way for us to stay in contact with the current trends in the profession and the problems and needs of practicing landscape architects as they adapt to the complexities of the developeent environeent. This questionaire is being mailed to landscape architects in St. Louis, Kansas City, and Denver. Your participation will assist an accurate assessaent of the current opinions of professionals in private practice in this area. All inforeation will reeain confidential and will be reported in an aggregated fore without reference to specific fires.

The questionaire is concerned with the perceptions of private practitioners on the role econoeic analysis should play in landscape architectural practice, the process of econoeic decision making, and the technical support for economic analysis available to site planners. We would also like to determine the level of foreal education in real estate developeent that is needed in professional practice. A recent survey (Urban Land, March 1986, p.32) indicates a significant increase in university-level curricula in real estate developeent in the past five years with 76% of planning schools, 63% of architecture schools, and 36% of landscaoe architecture schools offering regular courses in real estate development.

The questionaire takes about five minutes to coeplete; additional coements on the subject would be greatly appreciated. Your participation is voluntary and you have the right to refuse to answer all or any part of the questionaire. Further inforeation about the purpose, content or results of the survey can be obtained by contacting either of us at the above address.

Thank you for your cooperation,

Arnold Waters
Graduate student

Kenneth Brooks
Associate Professor

DEVELOPMENT ECONOMICS & LANDSCAPE ARCHITECTURE: A SURVEY OF FIRMS
Research conducted by Arnold Waters and Professor Ken Brooks
Department of Landscape Architecture, Kansas State University

All information will remain confidential and will be reported in an aggregated form without reference to specific firms.

1. Firm: _____

2. City: _____

3. Approximately how many personnel (professional and staff) are in your office? _____

4. How many landscape architects are in your office? _____

"Studies of financial feasibility come very early in the development process and are usually the principal determinant in initiating detailed planning and for setting the general program." (Lynch, *Site Planning* 2nd. ed., p. 41) Questions four and five represent polar statements of the relationship between design and economic feasibility. Please circle one answer for each question.

4. A client will receive better services when:

a. economic feasibility studies are contracted seperately from design services.

b. economic feasibility studies and design services are awarded in the same contract.

5. Economic feasibility analysis in site planning is:

a. a seperate process from design, requiring a different set of skills.

b. an integral part of design process, requiring expertise by the designer.

6. The point in a design process at which a cost/benefit analysis will normally have the greatest impact on the quality of a site plan is: (Circle one answer)

a. Pre-programming
b. Program
c. Schematic design
d. Preliminary design
e. Final design
f. Construction documentation
g. Other; please explain _____

7. The quantitative economic aspects of real estate development include market analysis, feasibility analysis, and cost estimation. Do you think that understanding the quantitative economic aspects of real estate development is important to a site designer's work?

[ ] Yes [ ] No

8. Do you think development economics should be a required course for accredited landscape architectural programs?

[ ] Yes [ ] No

[ ] Other; please explain _____

9. Are there personnel in your firm with expertise in economic analysis?

[ ] Yes [ ] No (if so, go to question 11.)

10. Are your design services improved if a client requests that your firm conduct feasibility/economic analysis in conjunction with design development?

[ ] Yes [ ] No

[Over]

11. Please rank the following list of economic studies in terms of the importance your firm attributes to each.

Circle a ranking for each type of estimate

Low	Medium	High	Market study (based on a potential investment)
Low	Medium	High	Feasibility analysis (based on a program)
Low	Medium	High	Budget estimate (based on a schematic design)
Low	Medium	High	Initial conceptual estimate (based on a preliminary design)
Low	Medium	High	Final design estimate (based on a site development plan)
Low	Medium	High	Bid estimate (based on construction documentation)

12. Does your firm use a computer for feasibility analysis or cost estimation?

[ ] Yes (If yes, go to Question 14) [ ] No

13. If your firm does not use a computer, is it because (choose one)

[ ] economic studies are not prepared.

[ ] manual estimates are prepared.

[ ] outside cost consultants are hired.

[ ] other; please explain _____

_____

_____

14. If your firm does use a computer please indicate the types (or brand names) of software used and the date of purchase.

Type	Name	Approximate date of purchase

15. Problems encountered with computer use:

(Check all that apply) Comments:

[ ] not suitable for our type of practice _____

[ ] not flexible enough for design practice _____

[ ] lack of integration with other software _____

[ ] insufficient growth capacity _____

[ ] requires excessive manual adjustment _____

[ ] other; please explain _____

_____

Additional comments on the role of economic analysis in landscape architectural practice and education, the process of economic decision making, and the technical support for economic analysis available in your firm would be appreciated. Please note if you wish to receive a summary of the results of this survey.

Comments:

COLLEGE OF ARCHITECTURE AND DESIGN

APPLICATION FOR APPROVAL TO USE HUMAN SUBJECTS

TITLE: Development Economics and Site Design: A Decision Support System

NAME OF INVESTIGATOR:

Principal Investigator: Arnold Waters
MLA Candidate
Department of Landscape Architecture

NAME OF ADVISOR:

Major Professor: Kenneth R. Brooks, ASLA
Associate Professor
Landscape Architecture Department

INCLUSIVE DATES OF PROJECT:

Initial Survey	May, 1986
Data Analysis	June, 1986
Data Interpretation	July, 1986
Completion of Thesis	August, 1986

SUMMARY/PURPOSE OF RESEARCH:

The survey is intended to collect data to assess the current capabilities, needs, and problems of practitioners with regard to economic analysis of site development projects. This information is needed to support development of a decision support system for economic analysis.

SUBJECT INFORMATION

Approximate age range of subjects: The survey respondants are expected to be responsible members of professional design offices, suggesting that their age will range from approximately 25 to 65.

Population sampled: The subjects surveyed include all firms listed as landscape archtectural or multidisciplinary firms in the American Society of Landscape Architects private practice roster for the metropolitan areas of St. Louis, Kansas City, and Denver.

INFORMED CONSENT

All subjects will be mailed a survey form and cover letter. The cover letter will inform the subject of:
the purpose of the survey -- that their input will be of value to the profession in the assesment of the current opinions on economic analysis within the Kansas State University sphere of influence,
the confidentiality of the data -- the privacy of business inforeation will be protected by aggregating any published data so that no individual person or individual fire can be identified.
their right -- to refuse to answer all or part of the questionaire.

As a eail survey, participation is voluntary. The risks to paticipants are perceived by the researchers as minimal. The survey form invites the participants to direct any questions to the researcher.

PRIVACY

The questionaire states that; "All information will remain confidential and will be reported in an aggregated form without reference to specific firms".

RISKS AND BENEFITS

Are there risks to human subjects? No

There should be no more risk of harm to the participants than are ordinarily encountered in daily living.

Are any eeergencies anticipated? No

Oescribe the benefits of the research to the subjects:
The questionaire will provide an assesseent of the opinions of private pratitioners on the role econoeic analysis should play in landscape architectural practice, the process of economic decision making, the technical support for economic analysis available to site planners, and the level of formal education needed in professional practice.

STATEMENT OF AGREEMENT

The individual named below certifies that he is willing to conduct these activities in accordance with the policies of the University Comeittee and the Subcoemittee of the College of Architecture and Design. This individual is entirely responsible for the conduct of the research. Further, this individual certifies that any changes in procedures from those outlined above or in the attached proposal will be cleared throught the Subcommittee of the College Of Architecture and Design.

SIGNATURE

_____April 29, 1986
Arnold Waters, Applicant

KSU
KANSAS STATE UNIVERSITY

Department of Architecture

College of Architecture and Design
Seaton Hall
Manhattan, Kansas 66506
913-532-5953

M E M O R A N D U M

TO: Arnold Watere

FROM: Lyn Norris-Baker

SUBJECT: Review of Proposed Research

DATE: 6 May 1986

The members of the College of Architecture and Design Subcommittee of the Committee on Research Involving Human Subjects have expedited the review of your proposal. They have provisionally approved the conduct of your research according to the procedures that you have described, pending the addition of a statement regarding the relative risks and benefits of participating in the research to your introductory letter. Approval is effective upon compliance with this requested change.

Any changes in procedures from those described in the application and the proposal must be approved through the College Subcommittee. Please remember that you are responsible for keeping the Subcommittee informed of your progress, any problems that arise involving any of the subjects, and the final completion of the project.

APPENDIX B

COMMENTS OF SURVEY RESPONDENTS

Elaboration

Question 5.

60 [A & B] Or a cooperative effort (but personally, a designer without economic understanding is not effective)

62 [B] by design team member

Question 6.

6 [B] It's a continuing update @ each phase

32 [D] Economic feasibility would be completed before the program--the schematic design completed on the economic feasibility conclusions and the economic feasibility conclusions and the preliminary design would provide enough specifics to compare actual gains & benefits

54 [B] Subject to good cost modelling ability regarding design issues

Question 8.

Yes.

60 But you need practicing professionals who understand it to teach it. Theory of development economics is of no use; in fact can be a liability.

54 Landscape Arch. would benefit from exposure to a business view of their own work. However, there shouldn't be a requirement to become proficient. Exposure is enough.

39 Undergraduate (no)

80 Depends upon major direction

15 Not required but as an elective

Question 10.

No.

54 We try not to mix roles. We believe the differing viewpoints of separate professionals are essential. Also, each role must bear specific accountability to itself to provide a "creative tension". We feel that inter-disciplinary firms often offer too efficient a service & fail to "make the leap" of synthesis in the design process--i.e.-- they're too close to the problem.

50 Improved? We get more $ but never compromise design--client usually has a budget.

Yes.

60 We sell it as a package. One is not effective without the other.

Question 11.

41 I look at the Master plan level--only--no construction involvement.

50 Some projects will always be designed, not necessarily built (we design, not build), irrespective of feasibility studies.

Question 12.

Yes.

54 The dark ages are over!

Additional comments

2 Questions 4 and 5 are somewhat limited in their choice of answers. I have chosen to answer both with "a" because I believe answer "a" is more true than answer "b", not exclusively true. This is why I can answer "yes" to question 10.

33 One must be very careful not to overstep the bounds of a given disciplines expertise. Certainly, the designer must be aware of the relationship between the cost of a project and its ultimate feasibility but we do not believe it is the landscape architects place to undertake market & feasibility studies. Finally, as designers, we must always be aware of the potential for a conflict of interest between conducting feasibility study & undertaking the design.

36 Course is called engineering economics knowledge must be learned manually before one is competent to use it!

54 We have been far more successful than our competitors for one important reason -- we know how to talk business. It is the rare client who will be too heavy-handed on budget when he has confidence that the designer fully appreciates business objectives. one attempt to define budgets w/cost model so early hat design con become a key issue. When our clients realize our cost responsibility, we very frequently actually have budgets increased in Cds because client's have built confidence in our estimate, which we provide at each submittal. The average project will be estimated 6-8 times prior to bidding. Developer clients especially enjoy early cost for site development since it is hard to relate it directly to site size or building size.

On the other hand, some designer's mistake their real estate development knowledge for ability. Such courses should attempt to give appreciation for the value of the finding/ implementation process to design.

75 University of Denver has a relatively strong Real Estate Construction Course. I would assume other Universities may have a similar course. UN. Denver may be as well as others are supported by the Nat. Assoc. Of Home Bldgers.

62 Generally, our firm relies heavily upon a benefit/cost >1 as a basis for decisions or recommendations for the viability of a project. However, intangible benefits are also considered and phasing sequences are established to accomplish what typically may be economically unfeasible.

56 I would like to say that we have worked with other consultants who have provided the economic feasibility study with success. It's not a difficult arrangement (depending on the personnel). I do feel that it is easier to coordinate efforts and arrive at decisions if both the economic feasibility and the design services are done "in-house". There is a greater opportunity for mutual input--a give and take of information and ideas.

32 Market analysis is usually completed prior to the client contacting our firm. It has been my experience that the success of a project is better assured when the budget for the improvements are based on economic analysis at the market rate for time of completion--then the designer has a ballpark in which to design.

60 Please get a copy of our book, at cost, entitled--Community Design Guidelines, Responding to a Changing Market. Published by NAHB, or I'd be happy to speak with you by phone. Thomas Kopf, Vice President, Design and Development. (303) 333-8561

74 Market feasibility and physical feasibility seem to me to be separated specialties, but with a close interrelationship. A consulting team should consist of specialists involved in the usual give and take of the design process. A team member who combines two specialties might not contribute as much dynamism as two specialists who must reach a consensus during the design process.

41 <u>Market demand analysis</u> is an art, aside from landscape architectural services-- it should not be thought that landscape architects are capable of such services--unless the landscape architect is unable to appreciate the expertise of other specialized professionals. However, <u>construction costs</u> should always be a part of the design process., These two things should not get mixed together under the term "economic analysis".

80 Increased training in design and project management would be more effective than additional training in economic feasibility/analysis at the expense of other existing courses. Do we need specialization in Site Development planning and design as a Major similar to Urban Design, Golf Course Architecture, Reclamation, Park & Recreation Planning & Design?

68 It is difficult to respond to most of these questions with any great consistency in that there are so many specific variables in the process of economic feasibility and design process' There are significant differences on types of development projects, i.e. mountain resorts, urban land mixed use projects, etc. etc.. However, there is a need to introduce students in landscape architecture to the broad area of real estate development.

APPENDIX C

AN EXAMPLE OF A COST ESTIMATION MODEL

> "In general, modeling is a means of taking a complex situation and capturing its essence formally. Often the nature of the model that is produced depends on the questions one wishes to explore with the model....the art of designing an effective economic model consists of finding the important activities and determining the critical links between them" (Miller and Kelso, 1985, p.200).

The basic elements of an estimate that define the content of the model are:

1. determination of the quantity of work,
2. identification of the productivity needed to perform the work,
3. and calculation of the unit cost of the resources to be used for the work (Adrian, 1882).

Of these elements the second is "the element most subject to uncertainty and the most difficult to estimate. . . . The forecasting or estimating of productivity is undoubtedly the leading risk factor in a construction estimate" (Adrian, 1982, p. 23). This is due to the numerous factors that can have an impact on productivity, such as weather conditions, skill and experience of the work force, and alternative production systems. A contractor can rely on experiential information[1] to determine productivity rates. Adrian suggests that "historical productivity data is not as sensitive to change as a function of time as unit cost data" and proposes that scientific productivity standards be used as a basis for cost estimating versus an accounting basis (1982, p. 32).

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[1] "That information about a project already known by bidders and contractors from their experience; as distinct from design information, which is unique and particular and together with which the experiential information comprises all of the information needed to perform the contracts of the project" (Collier, 1984, p.287).

Lacking a data base of productivity standards the eodel is essentially intended for use by a design/build fire where the designer has the following types of skills:

1. Knowledge of construction materials and methods
2. Understanding of site design
3. Ability to conceive design details
4. Knowledge of construction trades
5. An acquaintance with construction labor productivity
6. An accurate quantity take-off

The objective of the cost estieation eodel is to foreulate conceptual estiaates at the preliainary design phase. It is anticipated that by structuring the relationships between cost itees and productivity a eodel would provide a eeans to rapidly assess inforeation specific to a project (design information) by pereitting an estimator to provide experiential inforeation that noreally is not considered until construction docueentation is coepleted. The preliainary design phase is the point at which program concepts, design concepts, and cost concepts have essentially the saee iepact on the potential use of a site.

The following description of the coeputer systee assuees the reader is faeiliar with eicrocomputers and software. A spreadsheet software program will be used to develop the model.

> "Spreadsheets are particularly well suited to economic eodeling. Unlike eost procedural languages, such as FORTRAN, a spreadsheet enables you to build a model one piece at a time because you can see the calculated results from each step automatically. It is less work to verify the eodel output because you can see your intereediate calculations. It is also less bother to generate reports because you can easily change the report format. Input fores are also easier to generate" (Miller and Kelso, 1985, p.202).

It is anticipated that this will provide a eodel that is accessible and readily usable by the average person. The other coeponents of the systee are described below.

System Shell

The ieplementation of a eodular system is dependent upon soee fore of system management capable of switching from task to task. The modular nature of the systee being advocated requires the integration of the various applications needed to perfore the tasks necessary for producing a site plan. Integration can be achieved in a number of ways; the eethod selected was the use of a eenu/tracking/help system implemented by Keyworks™, a keyboard enhancer. Keyboard enhancers are part of a

class of software objects known as TSR (terminate and stay resident) programs. TSR programs normally are kits of tools, or data engines (such as Ready™, an outline processor or Lightning™, a spelling checker) used to supplement the features available in the applications software in use.

Keyboard enhancers are principally used to store sequences of keystrokes for execution triggered by a single keystroke or to define the extended keyboard. Of primary interest here is the capacity to harness the peripheral power of application software that is normally available only to the experienced user. This requires access to a listing of functions activating infrequently used or complex keystroke sequences with options selected by:

1. a moving bar menu,
2. an icon pointer,
3. text menu,
4. a remembered command keystroke or a set of function keys.

Many software packages currently have some form of keystroke storage. WordPerfect™, for example, has a key/file specific scheme--the AltD key combination could activate the keystroke sequence AltF5 1 (creating a mnemonic association toggle switch for the outline engine of WordPerfect). The disadvantage is that this creates a two byte file that takes up the minimum disk space of 2560 bytes. LOTUS™ macros are stored within the worksheet causing problems with overwriting, access, expansion capacity and transparency.

System components

B. PC-DOS 2.0™ Operating system
C. Keyworks™ TSR program
D. Sidekick™ TSR program
Used primarily for the notepad feature.
E. SuperDrv™ RAM Disk
It is desirable to avoid the disk wear and clutter that occurs from transient or temporary file operations by providing space in random access memory for a simulated disk storage device.
F. Lotus 1-2-3 1A™ Spreadsheet

The impact of this system in terms of a minimum hardware configuration is obvious; a hard disk and a minimum of 640K RAM are required. Probable improvements of the system include:

G. Spreadsheet Auditor
H. Spreadsheet Note Pad
I. Computer-aided drafting
J. A project manager
K. A word processor for:
    1. Correspondence files
    2. Specifications files

Sanitary Sewer Cost Templats

Ths uss of sprsadshsst tseplatss requirss a means for communicating the structurs of ths model. A hslo map is ons msans of conveying this information. Ths illustration below (Figurs 7) is a hslp sap displayed by a Ksyworks™ text scrsen. Ths layout of the sprsadsheet is outlined as blocks of major components. Sub-components of ths major components ars identified using named rangss (ses pags 85).

Hslp Map

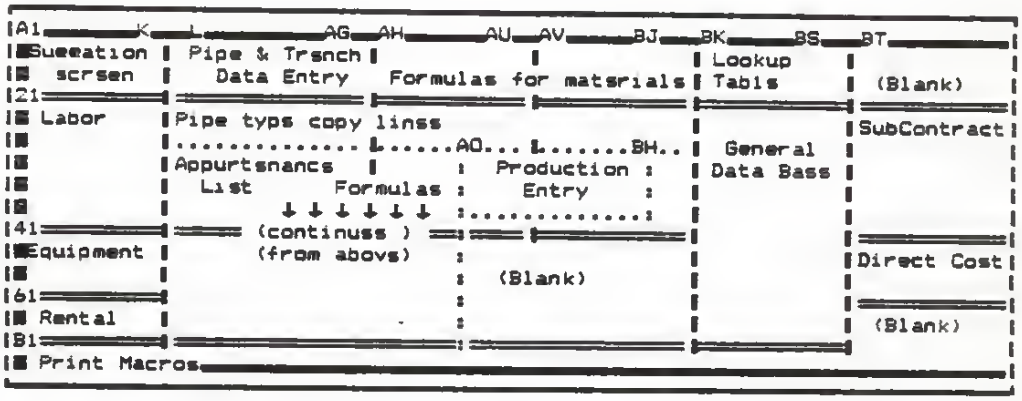
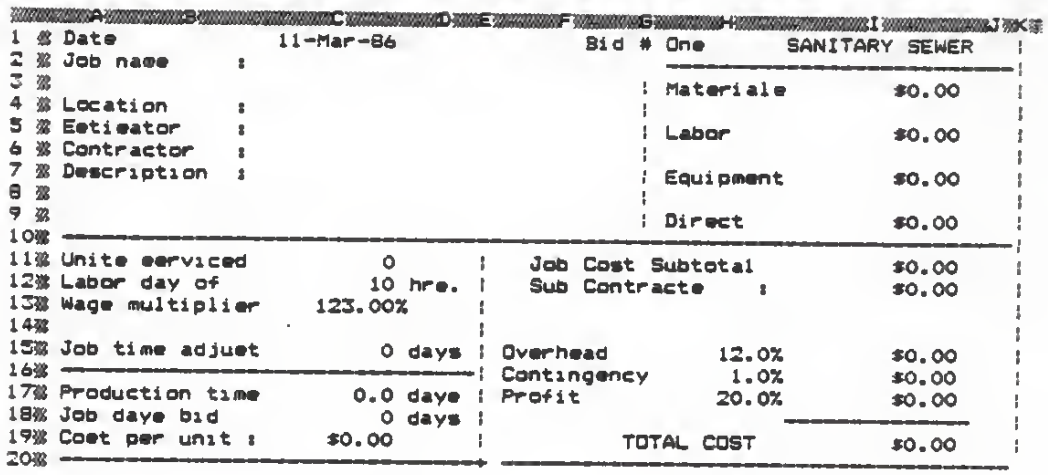


Figure 7: Help map screen

Ths areas dsfined for data entry ars organizsd as entirs scrssn pages (indicatsd by ths ‖ linss) whils ths arsas for calculations or data storage are organized to sinimizs file sizs. This workshsst was impleentsd using version 1A of Lotus 1-2-3™ which requirss clustsring blocks of activities as closely as possibls to reducs fils size. Ths uppsr left hand corner of ths map repressnts ths sumeation scrssn shown in figurs 8.

Ths summation sheet is ths saes for all construction activities so that several construction activities can bs summsd using the Lotus /WCAN coeeand. This is ths initial screen viewed when ths sprsadshsst is loadsd. An arsa is providsd for sntry of projsct identification.



Date	11-Mar-86		Bid # One	SANITARY SEWER	
Job name :					
Location :			Materials		$0.00
Estimator :			Labor		$0.00
Contractor :			Equipment		$0.00
Description :			Direct		$0.00
Units serviced	0		Job Cost Subtotal		$0.00
Labor day of	10 hrs.		Sub Contracts :		$0.00
Wage multiplier	123.00%				
Job time adjust	0 days		Overhead	12.0%	$0.00
			Contingency	1.0%	$0.00
Production time	0.0 days		Profit	20.0%	$0.00
Job days bid	0 days		TOTAL COST		$0.00
Cost per unit :	$0.00				

Figure 8: Summation screen

Menu structure

Another means of communicating structure is provided by the use of menu and text windows. The use of macro commands triggered by the selection of a menu can also provide a computer novice with access to the full range of the software features utilized by the template and simplify the use of the template. The menu structure of the template is outlined in the following pages.

The options menu display always overlays the summation area of the template. This provides a consistent point of reference and a home base from which to start or restart an operation. The option menu is called by the Ctrl M key and reappears after an option task is completed.

The option menu overlays the summation screen in the lower right hand corner without concealing any of the project identification. Selection of an option displays the appropriate section of the spreadsheet, a branch menu and/or text message, and controls the method of data entry. The options are organized in order of importance, in terms of impact on cost and relevance to defining the work involved.

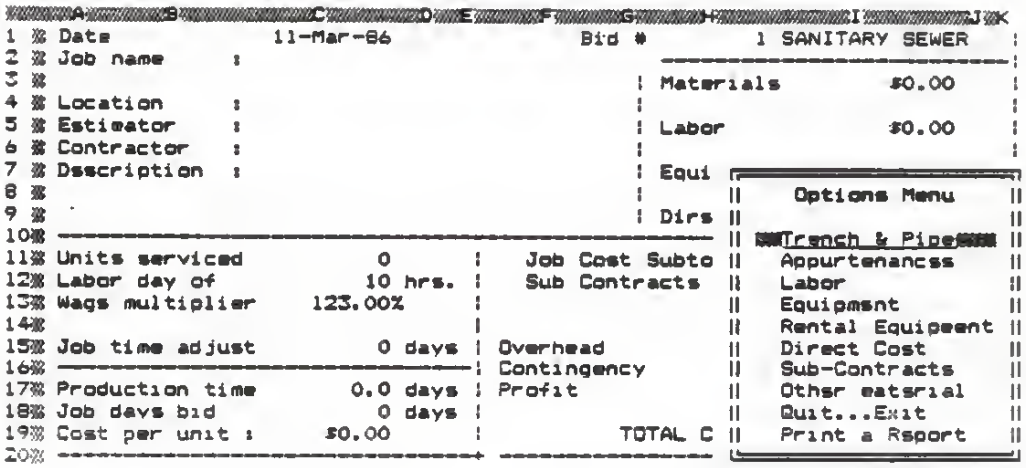


Figure 9: Options Menu overlay

For sxampls, selection of 'Trench & Pipe' displays the screen shown in figure 10. Froe this point pips is spscifisd for all sizss and arsas. Sslsction from ths eenu copies the appropriate formulas to the activs area and displays a data entry scrsen (Figurs 11). Ths cursor is rsstricted to ths cslls rsquirsd for data entry (using the Lotus /RI command), the worksheet titles are set and a tsxt messags is displayed. Nots that ths csll indicator rsgistsrs an unprotected status.

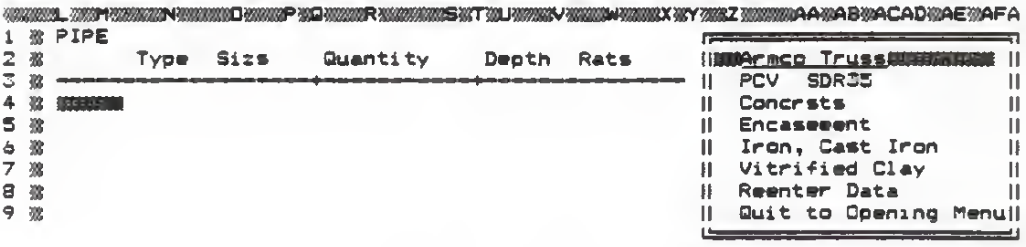


Figure 10: Pipe selection screen and menu

```
04: U                                                              READY
        Uss the cursor kspad for sntry.  Hit a rsturn to continus.
    L   M   N   O   P   Q   R   S   T   U   V   W   X   Y   Z   AA  AB  ACAD  AE  AFA
1   PIPE
2                                                  !Adjustment  Additional  !
3       Typs  Siz    Quantity     Dspth  Rats     !%lf  Rats   Sand  Gravsl !
4   Armco Truss  n !        lf !     ft      lf !          lf    in    in !
```

Figure 11: Entry of data for laying pipe

Calculations are displayed by cost category. Costs are dependent on the requirements of the specified pipe in terms of trench excavation, backfill, and duration of constuction (Figure 12 and 13). These calculations are not displayed by any of the option menu routines. They are excessible through the Help menu fils or to the experienced user. The formulas are written using named ranges to permit rapid comprehension of the 'critical links' of the spreadsheet.

```
AL4: (C2) +$LABOR COST DAY*(NORMAL PIPE DAY+ADVERSE PIPEDAY)

    AH      AI      AJ      AK      AL      AM      AN      AO
1       Materials                Labor           Equipment   !
2       per/      Sub-total       cost             cost     !
3   ----------  ----------  ----------------  --------------!
4     $0.00 lf       $0      $0.00             $0.00        !
```

Figure 12: Continuation of formula line--calculating costs to lay pipe

The requirements for trench sizes and bedding materials are stored in a data lookup table and accessed according to the size entered. The data lookup table can be adjusted or updated by using the 'database tools' option of the help menu (Figure 7.) or by a knowledgeable user. The figures generally will not vary on a job-to-job basis.

```
AR4: @HLOOKUP(O4,$PIPELOOK,13)

    AQ      AR      AS  AT  AU      AV      AW      AX  AY      AZ      BA      BB      BC      BD      BE      BF      BG
1   Trench  !   Bedding     !                  Cubic feet of       !  Normal    Adverse
2     width !  Bass + Cover  !    Sand     Gravsl     Concrete    !    Days      Days
3   --------+---------------!  ----------------------------------!  --------  --------
4     0 in  !   0  +   0 in  !       0          0                 !       0         0
```

Figure 13: Continuation of formula line--database lookup

Appurtenance selection

Selection of the 'Quit to Opening Menu' restores the summation screen and the options menu. The next option, 'Appurtenances' displays a data entry form and menu. In this case the number of appurtenances required is entered and a normal rate of production is specified. The composition of each appurtenance is based on a typical list of materials.

```
30%  Appurtenance production  Normal rate of     Adjust   Adjusted     Normal
31%  Quantity    Item         daily production    %       production   Daye
32%  ------------------------------------------------------------------------
33%     0 End of Line Cleanout
34%
35%     0 Manholes                                  ┌──────────────────────┐
36%                                                 │   Appurtenance Menu  │
37%     0 Service Tape                              │                      │
38%        Single service                           │ End of line cleanout │
39%        Dual line, single trench                 │ Manholes             │
40%        Single line, branch tap                  │ Service Tape         │
41%                                                 │ Quit to opening menu │
42%                                                 │ List of materials    │
43%                                                 │                      │
                                                    │Enter Quantity and Rate│
                                                    └──────────────────────┘
```

Figure 14: Appurtenance screen and menu

The list of materials may vary from job to job but is relatively stable. A standard list is provided and a menu option for correction of the list is provided.

```
30%
31% List of Appurtenance components
32% ------------------------+-----------------------------------------------
52%    0 Manhole
53%          1  -  precast manhole section 4'x 4'
54%          1  -  precast lid section 4ft. dia.
55%          1  -  manhole rim & cover (+or- 270#)  ┌──────────────────────┐
56%          4  -  adjustable rings/precast 6"each  │   Item listing       │
57%          1  -  cu.yd. gravel                    │                      │
58%       1.75  -  cu.yd. concrete                  │ List OK continue     │
59%          2  -  steel fence posts                │ Change a quantity    │
60%         10  -  concrete blocks                  │ Edit material list   │
61%         10  -  steps                            │                      │
62%         10  -  mastic sealant                   │   Per appurtenance   │
63%                                                 └──────────────────────┘
```

Figure 15: Listing of component parts

If the material list rsquirss editing, a mssage to place ths csllpointer on ths row in which ths itsm is located is thsn displaysd. If ths item is to bs rsplaced, ths csllpointer is placed on an sxisting listing. If an additional itsm is rsquired, ths csllpointer is placsd at ths bottom of ths list. After the item is sslected a check branch is displayed (Figurs 16).

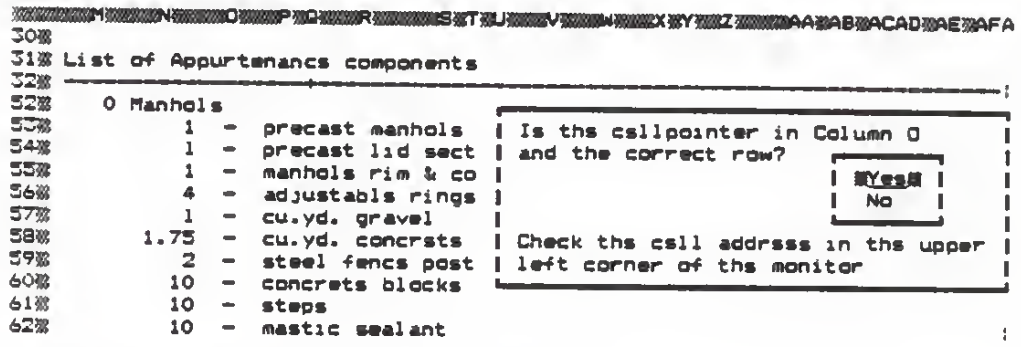


Figure 16: Alteration of component listing

Ths indicated csll is marked and ths screen display shifts to ths data bass. A tsxt overlay of instructions appsars, as soon as ths cursor key is movsd this tsxt overlay disappsars.

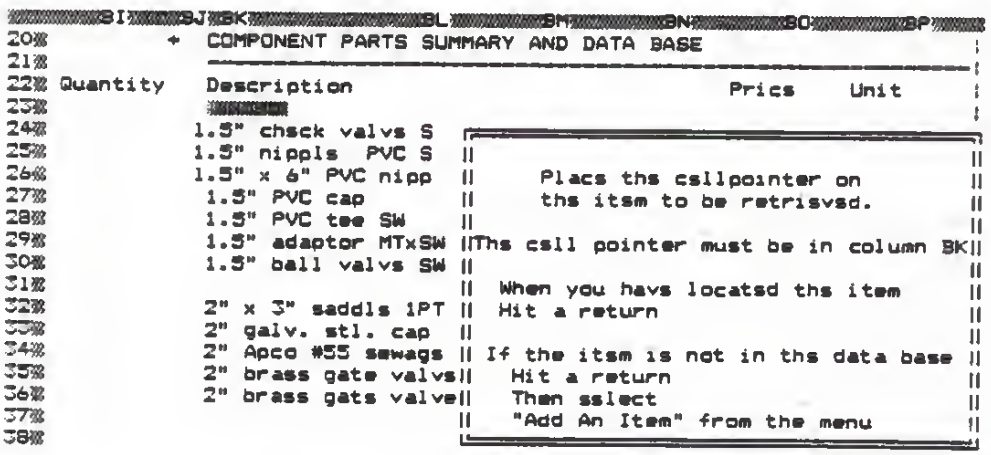


Figure 17: Data base of parts

Equipment entry

Selection of equipment from the options menu clears the screen and queries for a daily or monthy billing basis. Equipment owned by the firm is then displayed with use for the job entered on the basis of daily use to tenths of a day. The cursor is restricted to the appropriate cells (Column A); when a return is entered the billing is calculated and a branch for correction or continuation is displayed (Figure 18).

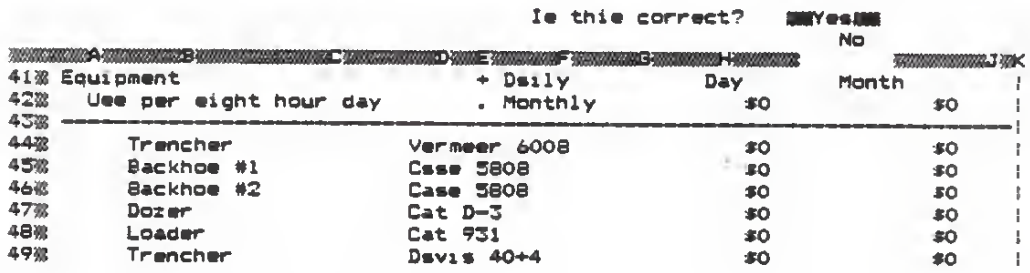


Figure 18: Equipment selection screen

Other options of lesser complexity are organized as simple cost entry screens. For example, selection of rental equipment displays the range name and location used to transfer rental costs to the summation area.

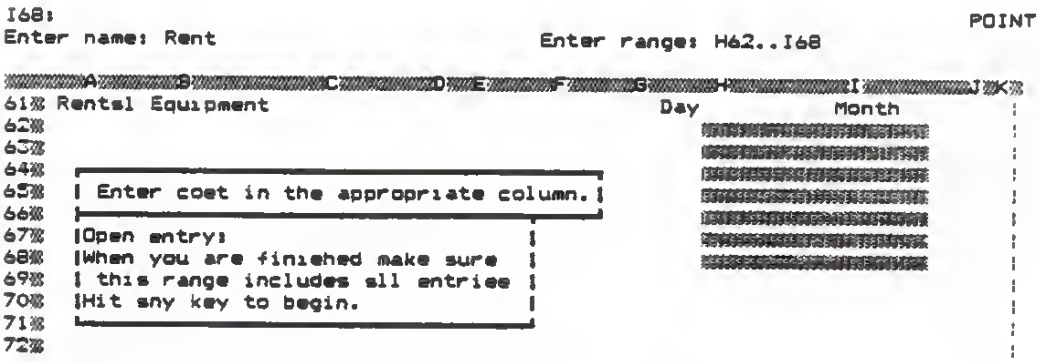


Figure 19: Rental equipment selection screen

Selecting 'Quit...Exit' from the options menu provides a branch for accessing the help file or for exiting the Keyworks™ overlay system. The help file initially displays a menu for selection of: a map, a set of database 'tools' for exchange of information between the template and a master database, and an option for changing templates or applications software. A text message reminding the user to save the current spreadsheet is also displayed. Selection of the 'Map' option displays the map shown in figure 7 and a menu of named ranges grouped by category to facilitate exploration of the spreadsheet structure.

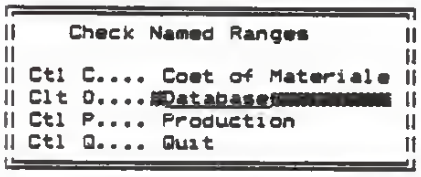


Figure 20: Categories of named ranges

RANGE NAMES

Selection of one of the categories of named ranges pops up a menu that includes all of the named ranges with the category and a return option. Selecting "Quit" or using the "Esc" key reloads the options menu file and pops up the options menu. .The method used by version 1A of Lotus to display range names (a single command line without location identification) was inadequate for a large, complex spreadsheet. Version 2 offers two additional means for displaying named ranges: the range name table and a full screen listing. A further improvement would be to incorporate an outline processor to create layers of named ranges. The ranges named in the sanitary sewer template are outlined below.

I. Production

A. PIPE M4..BH4
CLAY M24..BH24
ABS M22..BH22
CONCRETE M25..BH25
ENCASE M27..BH27
IRON M26..BH26
SDR35 M21..BH21

B. APPURT TITLE AP30..BH32
MHOLE AP35..BD35
TAPS AP37..BD37
CLEAN AP33..BD33

C. SUBCRT BZ23..BZ38

D. DIRCOST BZ43..BZ57

E. RENT H62..I78

F. LABOR A21..K40

G. EQUIPMENT A41..K60

II. Materials
COST PIPE AJ4..AJ19
COST CLOUT AJ34..AJ51
COST MH AJ54..AJ71
COST TAPS AJ74..AJ89

III. Data base

A. System
DATA BI20..BQ73

B. Pipe & Trench
PIPELOOK BL1..BZ17

C. Appurtenance
LIST L30..AD32
LIST CL OUT M33
LIST MH M52
LIST TAPS M72

IV. Crew Definition
LTIME A23..A39
EQUIP TIME A44..A60

V. Location

A. Formula
UNITS C11
DAYS BID C18
EQUIP DAILY H42
LABOR COST DAY I21
EQUIP MONTHLY I42
ADVERSE PIPEDAY BG4
NORMAL PIPE DAY BF4

B. Top left of block
RENTAL A61
PIPE ENTRY L1
OTHER M92
SUBS BR20

C. Pointers
1. Database Routine
PRICE BD6B..BP6B
CHOICE BK6B
IT M95
SPOT D96
NEW BK72
2. Print routine
COUNT M9
PRINT M72..P75
3. Equipment rate variables
DAILY M24..BH24
MONTHLY E42

VI. Print Macro
\P AB1

The idea that "spreadsheet programs are the greatest or most pervasive contribution to date that computers have made to decision making" is arguably true (Langendorf, 1985, p.426). The improvements that will come with full featured command languages, knowledge bases, interactive data bases, and free form graphics facilities will insure a long life for the structural concepts of the spreadsheet. One notable improvement in the recent version of Lotus™ is sparse matrix files.

File size and spreadsheet structure

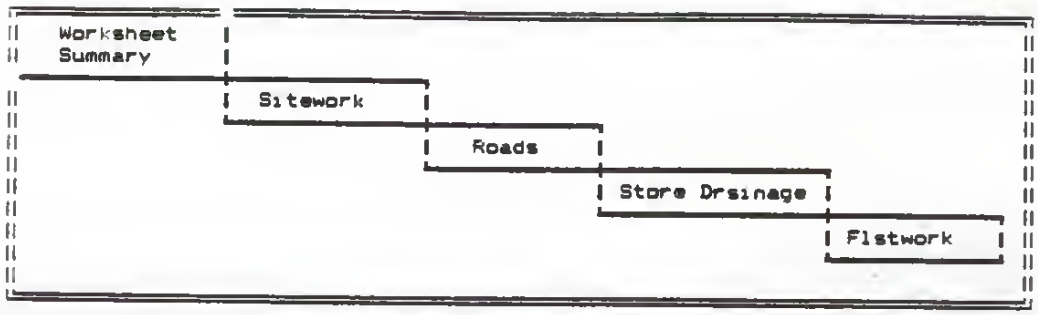


Figure 21: Sparse matrix structure--Cluster of related documents

With sparse matrix files major worksheets can be grouped by either sequence of occurence or relationship of cost concepts. One of the benefits of this organization is that it allows each block to be expanded as needed by the insertion of rows and columns. Within each of these major blocks a similar spatially independent structure would be created, for example, the sitework block could be organized along the lines of the CSI index and contain the minor blocks:

121 Site Preparation,
1211 Clearing,
1213 Site Earthwork.

APPENDIX D

ADDITIONAL SUGGESTED REFERENCES

The following list of additional suggested references is provided as a supplement to the references cited. This list is intended to assists those who are interested in further information relating to the subjects covered in this paper. The list is broken into six sub-headings: computers, decision support systems, models, economic analysis, market and feasibility analysis, and costs.

Computers

Beizer, B. 1985. *Software testing techniques.* New York: Van Nostrand Reinhold

Crone, J. V. 1984, Jan./Feb.. Computers: Competitive engineering with micros. *Landscape Architecture*, pp. 91-94.

Glossbrenner, A. 1984. *How to buy software: The master guide to buying the right program.* New York: St. Martin's Press

Lenant, D. B. 1984, September. Computer software for intelligent systems. *Scientific American.* 251(3), 204-213

Niemann, B. J., Jr. & Portner, J. 1984, Nov./Dec. Computing solutions at the ownership scale of design. *Landscape Architecture.* p.56

Wirth, N. 1984, September. Data structures and algorithms. *Scientific American*, 251(3), 60-70.

Decision support systems

Alter, S. 1977, Fall. A taxonomy of decision support systems. *Sloan Management Review.* pp. 39-56.

Bahl, H. C. & Hunt R. G. 1985. Problem solving strategies for DSS design. *Information and Management.* 8, 81-88.

Blanning, R. W. 1984. Management applications of expert systems. *Information and Management.* 7, 311-316.

Bonczek, R. H., Holsapple, C. W., & Whinston, A. B. 1980. The Evolving roles of models in decision support systems *Decision Sciences.* 11, 337-356.

Brookes, C.H.P. 1984, January. A framework for DSS development. Information Systems Forum Research Report.

Ericksen, D. C. 1984. A synopsis of present day practices concerning decision support systems. *Information and Management*. 7, 243-252.

Ford, F. N. 1985. Decision support systems and expert systems: A comparision. *Information and Management*. 8, 21-26.

Ginzburg, M. J. & Stohr E. A. 1982. Decision support systems: Issues and perspectives. *Decision Support Systems* (ed.) Ginzburg, M.J., Reitman, W. and Stohr E. A. North-Holland Publishing Co.

Hirouch, T. & Kosaka, T. 1984. An effective database formation for decsion support systems. *Information and Management*. 7, 183-195.

Reitman, W. 1982. Applying artificial intelligence to decision support: Where do good alternatives come from? *Decision Support Systems* (ed.) Ginzburg, M. J., Reitman, W, and Stohr E. A. North-Holland Publishing Co.

Sprague, R. H., Jr. 1980, December. A framework for the development of decision support systems. *MIS Quarterly*. pp. 1-26

Warszawski, A. 1985. Decision models and expert systems in construction management. *Building and Environment*, 20, 201-210.

Models

Davis, J. M. 1985, April. Cash flow model analysis: Buy the assumption, not the investments. *The Appraisal Journal*, 53, 226-236.

DeLisle, J. R. 1985, July. The interactive design/marketing model in determining highest and best use. *The Appraisal Journal*, 53, 325-339.

Klosterman, R. E. 1986, Spring. An assessment of three microcomputer software packages for planning analysis. *Journal of the American Planning Association*, 52, 199-202.

Landis, J. D. 1985, Spring. Electronic spreadsheets in planning: The case of shiftshare analysis. *Journal of the American Planning Association*. 51, 216-224

Levine, N. 1985, Autumn. The construction of a population analysis program using a microcomputer spreadsheet. *Journal of the American Planning Association*. 51, 496-511

Miles, M. E. 1976, August. *A conceptual and computer model for the analysis and management of risk in real property development*. Dissertation, The University of Texas at Austin

Thorne, D. J. 1985, November/December. Comarative lease analysis and the electronic spreadsheet. *Site Selection and Industrial Development*. 30(6), 1-10

Economic analysis

Boyce, B. N. 1981. *Real estate appraisal terminology (rev. ed.)*. Cambridge, MA: Ballinger.

Chapin, F. S., Jr. & Weiss, S. F. 1985. *Factors influencing land development: Evaluation of inputs for a forecast model*. Chapel Hill: An Urban Studies Research Monograph Institute for Social Science University of North Carolina.

Dowall, D. E. 1985, Winter. Applying real estate financial analysis to planning and development control. *Journal of the American Planning Association*, 51, 84-94.

Ellson, R. & Blaine R. 1983. Residential land development under uncertainty. *Journal of Regional Science*. 23, 309-323.

Fraundorf, M. N., Farrell J. P., & Mason R. 1984, April 6. The effect of the Davis-Bacon Act on construction costs in rural areas. *The Review of Economics and Statistics*. pp.142-148.

Gibbons, J. E. & Rushmore, S. 1975, October. Using total project analysis to compete for investment capital. *The Appraisal Journal*. pp.491-516

Lachman, L. M. 1982, December. Emerging trends in real estate: 1983. *Urban Land*, p.7B.

Mao, J.C.T. 1969. *Quantitative Analysis of Financial Decisions*. New York: Macmillan.

McMahan, J. 1976. *Property development--Effective decision making in uncertain times*. New York: McGraw-Hill.

Richards, J. 1983. *Fundamentals of development finance: A practitioner's guide.* New York: Praeger.

Sears, C. E. 1985, June. Highlights from ULI's dollars and percents of development finance, II. *Urban Land*, pp. 7-15.

Silverman, J. A. 1978. *Environmental Factors of Real Estate Development: An Approach for Achieving Acceptable Solutions.* Real Estate Review Portfolio, (17). Boston: Warren, Gorham and Lamont.

Strum, Brian J. ed. 1981. *Financing real estate during the inflationary 80's.* American Bar Association.

Tuccillo, J. with Goodman, J. L., Jr. 1983. *Housing finance: A changing system in the Reagan era.* USA: Urban Institute Press.

Woods, D. H. 1966, July-August. Improving estimates that involve uncertainty. *Harvard Business Review.* p.91-98

Market and Feasibility analysis

Bailey, J. B., Spies, P. F., & Weitzman, M. K. 1977, October. Market study and financial analysis = feasibility report. *The Appraisal Journal*, 45, 550-577.

Barrett, G. Vincent A. 1979, November-December. Restatement of highest and best use. *The Real Estate Appraiser and Analyst.* pp. 4-9

Canestaro, J. 1982, July. *Real estate financial feasibility analysis handbook: A guide to project cost-benefit evaluation (rev. ed.).* Blacksburg, VA: College of Architecture, Virginia Polytechnic Institute and State University.

Grissom, T. V. 1984, July. A feasibility process: The benefits of land economics and risk management. *The Appraisal Journal*, 52, 356-374.

Messner, S. D., Boyce, B. N., Trimble, H. G., & Ward, R. L. 1977. *Opportunities: Market and feasibility studies.* Chicago: Realtors National Marketing Institute of the National Association of Realtors.

Roddewig, R. J., & Shlaes, J. 1985. *Analyzing the economic feasibility of a development project: A guide for planners* Report No. 380. American Planning Association Planning Advisory Service.

Costs

Birrell, G. S. 1980, December. *Construction cost estimating in the design process.* Proceedings of the American Society of Civil Engineers. (CO4), pp.551-566

GSA 1981, July 29. Capitalized income approach to project budgeting. *Handbook* PBS P 3425.11.

McFarland, J. A. 1972, July-August. Hidden costs in land development. *The Real Estate Appraiser.* p.46

Swinburne, H. 1980. *Design cost analysis for architects and engineers.* New York: McGraw-Hill.

APPENDIX E

DEFINITIONS

The following list of terms provides the page number where the meaning of each term is discussed or defined.

APPENDIX F

AUTHORS

The following list provides the page numbers on which major citations of an author occurs.

DECISION SUPPORT SYSTEMS FOR ECONOMIC ANALYSIS OF SITE PLANNING DECISIONS

by

Arnold Waters

Bachelor of Science Environmental Horticulture
University of Missouri-Columbia, 1977

AN ABSTRACT OF A MASTERS THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1986

ABSTRACT

This study is an examination of the linkage between design process and development economics with the aim of increasing the decision making capacity of the designer and increasing the level of communication between the disciplines involved in land development. Microcomputers brought the technical capacity for economic modeling of site planning decisions within the reach of the average landscape architecture firm. The changing nature of decision making and of communicating design information resulting from this capacity will have an impact on landscape architecture in the near future. The concept of Decision Support Systems (DSS) is investigated as a means for integrating the search for optimal site use with the site design process.

Landscape architects in private practice within the sphere of influence of Kansas State University were surveyed to determine their attitudes toward economic analysis. The survey confirmed that the traditional view of landscape architecture as an artistically-based profession excludes analysis of the economic context of site planning decisions as an integral component of the design process.

Discussion of the legitimate domain of the profession and the framework for conceptualizing the value inherent in any given site design/planning decision will have to precede widespread acceptance of economic analysis within the profession. Individual firms will move forward and it is these firms that should be studied to gauge the success, direction, and sophistication of DSS implementations. The advancement of the field may be dependent on an expert system capable of assisting landscape architects in the analysis of the economic factors that are inherent in design decisions.