DECISION SUPPORT SYSTEMS
FOR
ECONOMIC ANALYSIS OF SITE PLANNING DECISIONS/

by
Arnold Waters

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University of Missouri-Columbia, 1977

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Approved by:

[Signature]
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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. 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 realm 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 eras 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 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.  

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 plan3, 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.

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 economic decision-making with design development as a broadening of social responsibility rather than a limitation of aesthetic responsibility. The inability of the landscape architect to define clearly the monetary 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 limit and control costs. If the benefits of environmental design are to be expressed in the environment then the tradition of separating design process from project feasibility and construction implementation is damaging to that expression. Economic sensibility is a necessary corollary to the expression of design sensitivity. Manufacturing industries use a management concept that is applicable to this approach:

"Product design is an integral part of production management, i.e., the product is designed in such a way as to achieve two objectives simultaneously: (1) to fulfill its aesthetic and functional requirements and (2) to minimize 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 estimate conceptual cost at an early stage in a land development project. To impose cost factors upon a completed site development plan

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* A conceptual cost estimate is "made from rudimentary design information 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 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 delineit 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.

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 schise 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 perceived 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" (Kean 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.

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 1960's" (Kean 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.

\[\text{Conceptual Image} \rightarrow \text{System Image} \rightarrow \text{Mental Model} \rightarrow \text{Hardware and software, also known as the computer environment}\]

\[\text{Becomes a concrete expression called the system image} \rightarrow \text{The user's idea of how the system works} \rightarrow \text{Becomes an abstraction for interpreting the machine state}\]

**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

\(^2\) 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 systems³, programming languages⁴, 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.

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).
**System Image**

The system image includes the hardware, firmware, and software as it is configured for use. In order to reduce the complexity of computer systems a hierarchical structure of abstractions is defined to create transparent levels of subsystems. "A program at a given level has access only to operations defined at lower levels; furthermore, the internal details of those operations are hidden" (Denning and Brown, 1984, p.96). Each level requiring different degrees of sophistication in computer technology. For example a hypothetical operating system could be defined as follows (Figure 2). Computer use at the level of the user programming environment is dependent on the image presented by the 'user-interface'.

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>NAME</th>
<th>OBJECTS</th>
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<tr>
<td>13</td>
<td>Shell</td>
<td>User Programming Environment</td>
</tr>
<tr>
<td></td>
<td>Hardware and software extensions</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>User Processes</td>
<td>User Processes</td>
</tr>
<tr>
<td>11</td>
<td>Directories</td>
<td>Directories</td>
</tr>
<tr>
<td>10</td>
<td>Devices</td>
<td>External devices such as Printers, Keyboards, Display terminals</td>
</tr>
<tr>
<td>9</td>
<td>File System</td>
<td>Files</td>
</tr>
<tr>
<td>8</td>
<td>Communications</td>
<td>Pipes</td>
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<tr>
<td>7</td>
<td>Virtual Memory</td>
<td>Memory segments</td>
</tr>
<tr>
<td>6</td>
<td>Local Storage</td>
<td>Blocks of Data, Device Channels</td>
</tr>
<tr>
<td>5</td>
<td>Primitive Processes</td>
<td>Primitive Processes, Semaphores, Ready List</td>
</tr>
<tr>
<td>4</td>
<td>Interrupts</td>
<td>Fault-Handling Programs</td>
</tr>
<tr>
<td>3</td>
<td>Procedures</td>
<td>Procedure Segments, Call Stack, Display</td>
</tr>
<tr>
<td>2</td>
<td>Instruction Set</td>
<td>Evaluation Stack, Scalar Data, Microprogram Interpreter, Array Data</td>
</tr>
<tr>
<td>1</td>
<td>Electronic Circuits</td>
<td>Registers, Gates, Buses</td>
</tr>
</tbody>
</table>

Table 1: Operating system organization (Denning 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 machine. 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 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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*"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' 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. Computers are more than high-powered calculators. For the computer literate 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).

* "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).

"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).

* "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 firm, technical issues of analysis, organizational structure, design ability, and contextual forces, such as time 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 computers evolved in conjunction with the development of technology. The framework emerged as the study of cognitive processes and human 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 problem, a decision maker:

- Identifies alternative courses of action,
- Determines the expected outcome of the alternatives,
- Selects the optimum alternative.

*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) department.
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'\(^\text{11}\) 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

\(^{11}\) 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 firm. 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 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' 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)" (Graaskamp, 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 opti-
mization 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. 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
structure in terms of two poles, programmed and nonprogrammed. The

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
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. "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 emerged in the late 1950's and early 1960's in response to perceptions of increasing complexity and accelerating

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15 "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).

16 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. 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 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 and the rationalist
ideal. One principal work in this period, by Rittel and Webber (1973),
criticized the "early 'systems approach' methods of planning, which

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 Wizenbae
(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\(^\text{20}\) that are not amenable to scientific standards\(^\text{21}\), 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

\(^{20}\) 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 incrementalist approach put forward by Lindblom in *The Science of Muddling Through* (1959) (on the basis that successful resolution of lower-level problems may make it more difficult to deal with higher-level problems), a clear alternative to an essentially anti-utopian stance is not formulated. Rittel and Webber suggest that in a pluralistic society planning is a tactical struggle to express the decision maker's 'world-view'. Participatory design process emerged as a positive response to the denouement 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-making emphasizes understanding the context of the existing distribution of power within an organization or society and seeks to mitigate conflict through compromising the conceptual ideal operation or goal. For example, the necessity of negotiating a resolution between various actors and interests in the development process imposes a set of constraints on the site planner's ideal design solution. As Graaskepaep states in explaining the concept of most probable use: "Any enterprise is a compromise because the form it takes, in terms of both its configuration and its behavior, reflects a

22 "The incrementalist approach is remedial--policymaking moves away from ills rather than toward predetermined objectives." (Keen and Morton, 1978, p. 72)

23 "Problems 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 determining 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 form 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 permits 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 more complex than that of a mathematical
model" (Byrd, 1982, p. 15). Decision makers 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 manageable'. . . . [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 semi-structured 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. They propose consideration of two additional dimensions of problem structure.

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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 maker is engaged in influences the type of information needed for decision-making. In the case of a production firm the classification is based on managerial activity. In land development the taxonomy of activity is dependent on the point in the development process at which the designer is engaged, the type of development (residential, industrial, commercial, rehabilitation), and the scale of the development. Second, the decision maker's perception of the problem structure is the significant factor in determining the approach to a solution and is apt to change over time and in terms of particular phases within the problem-solving process (1978, p. 96). This is particularly true in the case of a highly iterative process such as design where the designer may abandon or radically modify a developed design and return to a conjectural viewpoint of the project.

26

<table>
<thead>
<tr>
<th>Task Variables</th>
<th>Strategic Planning</th>
<th>Management Control</th>
<th>Operations Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>Low</td>
<td>&lt;--------&gt;</td>
<td>High</td>
</tr>
<tr>
<td>Level of detail</td>
<td>Aggregate</td>
<td>&lt;--------&gt;</td>
<td>Detailed</td>
</tr>
<tr>
<td>Time horizon</td>
<td>Future</td>
<td>&lt;--------&gt;</td>
<td>Present</td>
</tr>
<tr>
<td>Frequency of use</td>
<td>Infrequent</td>
<td>&lt;--------&gt;</td>
<td>Frequent</td>
</tr>
<tr>
<td>Source</td>
<td>External</td>
<td>&lt;--------&gt;</td>
<td>Internal</td>
</tr>
<tr>
<td>Information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scope</td>
<td>Wide</td>
<td>&lt;--------&gt;</td>
<td>Narrow</td>
</tr>
<tr>
<td>Type</td>
<td>Qualitative</td>
<td>&lt;--------&gt;</td>
<td>Quantitative</td>
</tr>
<tr>
<td>Age</td>
<td>Older</td>
<td>&lt;--------&gt;</td>
<td>Current</td>
</tr>
<tr>
<td>Response time</td>
<td>Varies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Decision-making for site planning

Enhancement of a decision maker's capacity to concentrate on critical information implies an evolutionary medium capable of reflecting the changing structure of the decision maker's perceptions (Wofford, 1985, p.390). In cases where 'semi-structured' decisions are being made the criteria for systems development are "learning, interaction, support, and evolution rather than replacement, solutions, procedures, and automation" (Keen and Morton, 1978, p.12).

Defining a DSS

The key concepts and methods of decision-support systems include:

- an 'interface', or mode of interaction between user and machine, that isolates the user from the technicalities of the computer and fosters a dialogue based on the user's concepts, definition of the decision problem, decision criteria, and judgments rather than imposing the hardware engineer's or computer programmer'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 problems; and

- an interface that enables the user to examine the decision problem from a variety of perspectives--introducing alternative solutions, modifying assumptions and decision criteria, and using sensitivity and risk analysis as appropriate (Langendorf, 1985, p. 425).
### Table 3: Characteristics of DSS (Langendorf, 1985, p.430)

<table>
<thead>
<tr>
<th>Characteristics of Decision Process</th>
<th>Computer Algorithms</th>
<th>Behavioral Approaches to Understanding</th>
<th>Hardware/Software Environment</th>
<th>User Interface</th>
<th>Methodology of System Development/Implementation</th>
<th>Artificial Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iterative, interactive, multiple objectives</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Preferences, judgment</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Adaptability, incomplete problem definition, incomplete data uncertainty</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

### 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 mode 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. 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. The initial step

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 subdivision" (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 determine the "objectives of the client, alternatives that are acceptable, and decision rules" (Epley and Boykin, 1983, p. 34). Whether motivated 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 development process usually starts with or rapidly progresses to an identification of the attributes of the investment asset (site and/or buildings) and numerous limitations for development" (Vernor, 1981).

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

The "static or physical attributes are matters of size, shape, topography, soils, drainage, and vegetation. Dynamic attributes relate to aesthetics, prestige, status, and reputation of the site and its immediate 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 matters of what is permissible currently and prospectively, and the extent to which the game rules can be changed over time" (Vernor, 1981, p.4).

The dynamic attributes of a site are the subject of a market study. The market study includes 'economic base studies or other related aggregate data review' to identify market trends that indicate opportunities consistent with the objectives (Graaskaep, 1981). Databases for analysis of market factors are becoming increasingly available; sources include: local planning department studies, census information,
building permits, land ownership patterns, utility company capacity and population forecasts. Data on public attitudes and political factors may also be significant in a market 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 merchandising study may be undertaken in conjunction with the financial analysis to identify specialized markets and competitive properties, estimate market capture or adsorption rates, and generate consumer profiles (Graaskaep, 1981; Epley and Boykin, 1983). A determination 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 determination of development 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 economist and the landscape architect overlap within the realm of establishment of the initial program goals. A recent survey conducted by Norman 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 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 program goals in terms of economic value is essentially defensive. In situations where "the goals of the program, developed by an economist, may be at odds with the needs and the aspirations of ordinary people. The program itself, then, may 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 commitment to 'stewardship of the land'. For the discipline of landscape architecture this calls for a search for methods of integrating economic 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.

30 See also:
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. 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?

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:

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 "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" (Pountain, 1986, p. 366).
Anderson's (1983) survey indicated a strong belief (69%) that some type of programing knowledge should be acquired by an environmental design professional. The programing 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 programing' language. "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." (Pountain, 1984, p. 343) 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 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 programing was advanced by researchers at Xerox. "What the researchers were looking for was a style of programing in which objects that mirror those in the real-world application are the only program entities" (Pountain, 1986, p. 363).

33 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

"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."

3a "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 mechanism for improving their practice. Perceptions of individuals in private practice within a common geographic area were surveyed. The geographic delimitation 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 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.

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.

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.
The results of the survey are presented in two sections. The demographic and size characteristics of the responding firms are presented to give a sense of the composition of the sample population. The small sample size does not permit accurate interpretation 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.

<table>
<thead>
<tr>
<th>City</th>
<th>Mailed</th>
<th>Responses</th>
<th>Returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Louis</td>
<td>23</td>
<td>7</td>
<td>30.4%</td>
</tr>
<tr>
<td>Kansas City</td>
<td>13</td>
<td>6</td>
<td>46.25%</td>
</tr>
<tr>
<td>Denver</td>
<td>44</td>
<td>19</td>
<td>43.2%</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>32</td>
<td>40.0%</td>
</tr>
</tbody>
</table>

Table 4: Location of firms surveyed

Size of Firms

Multidisciplinary and LA Firms

<table>
<thead>
<tr>
<th>Standard deviation</th>
<th>Number of responses</th>
<th>Total Personnel</th>
<th>Number of LAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.7</td>
<td>32</td>
<td>32</td>
<td>5.1</td>
</tr>
</tbody>
</table>

Minimum size 1
Maximum size 230
Mean size 31.3

Size category | Total | Percent |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very small</td>
<td>10</td>
<td>31.2%</td>
</tr>
<tr>
<td>Small</td>
<td>7</td>
<td>21.9%</td>
</tr>
<tr>
<td>Medium</td>
<td>7</td>
<td>21.9%</td>
</tr>
<tr>
<td>Large 31 or more</td>
<td>8</td>
<td>25.0%</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Figure 3: Group distribution by size
Landscape Architecture Firms (P1)

<table>
<thead>
<tr>
<th>Size Category</th>
<th>Total Number of Personnel</th>
<th>Number of LAs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.8</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Number of respondents: 16
Minimum size: 1
Maximum size: 27
Mean size: 9.2

<table>
<thead>
<tr>
<th>Size Category</th>
<th># of Firms</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very small 1-2</td>
<td>3</td>
<td>9.3%</td>
</tr>
<tr>
<td>Small 3-5</td>
<td>6</td>
<td>18.7%</td>
</tr>
<tr>
<td>Medium 6-9</td>
<td>2</td>
<td>6.2%</td>
</tr>
<tr>
<td>Large 10 or more</td>
<td>5</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

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

Multidisciplinary firms (P2)

<table>
<thead>
<tr>
<th>Size Category</th>
<th>Total Number of Personnel</th>
<th>Number of LAs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>65.7</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Number of respondents: 15.0
Minimum size: 1
Maximum size: 230
Mean size: 54

<table>
<thead>
<tr>
<th>Size Category</th>
<th># of Firms</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very small 1-5</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Small 6-15</td>
<td>4</td>
<td>12.5%</td>
</tr>
<tr>
<td>Medium 16-30</td>
<td>3</td>
<td>9.4%</td>
</tr>
<tr>
<td>Large 31 or more</td>
<td>8</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

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

44
Questionnaire responses

The questions as they appeared on the survey form 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 are 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.

<table>
<thead>
<tr>
<th>A to both</th>
<th>B to both</th>
<th>4A, 3B</th>
<th>4B, 3A</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>11</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

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 thee, the polarity was either not sufficiently stated or irrelevant 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
   b. Preliminary design
   c. Final design
   d. Construction documentaion
   e. Other:
   g. Please explain

Responses to question 6.

<table>
<thead>
<tr>
<th></th>
<th>LA</th>
<th>MD</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>14</td>
<td>27</td>
</tr>
</tbody>
</table>

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 prograde is a reflection of the point at which a landscape architect is nearly 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 questionnaire 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 comprehending the efforts of a separate profession. It may also indicate that there is an unmet 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 proble" [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

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Market study (based on a potential investment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Feasibility analysis (based on a program)</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Budget estimate (based on a schematic design)</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Initial conceptual estimate (based on a preliminary design)</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Final design estimates (based on a site development plan)</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Bid estimates (based on construction documentation)</td>
</tr>
</tbody>
</table>

Responses to Question 11.

<table>
<thead>
<tr>
<th>Market Study</th>
<th>Feasibility Analysis</th>
<th>Estimate of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Medium</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Low</td>
<td>11</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Initial Budget</th>
<th>Final Conceptual Budget</th>
<th>Final Design Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>Medium</td>
<td>10</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Low</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Allowing for the fact that some firms may specialize in a particular 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:

<table>
<thead>
<tr>
<th></th>
<th>Market Study</th>
<th>Feasibility Analysis</th>
<th>Budget</th>
<th>Initial Final Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
<td>4</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>Medium</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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 occurring 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.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Market</th>
<th>Feasib.</th>
<th>Budget</th>
<th>Initial</th>
<th>Final</th>
<th>Final</th>
<th>Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>12</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Perception of quality indicated by Question 6.

<table>
<thead>
<tr>
<th>Size</th>
<th>Type</th>
<th>All</th>
<th>LA 6</th>
<th>7</th>
<th>9</th>
<th>10</th>
<th>Market</th>
<th>Feasib.</th>
<th>Budget</th>
<th>Initial</th>
<th>Final</th>
<th>Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>2</td>
<td>1</td>
<td>A</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>P2</td>
<td>50</td>
<td>1</td>
<td>C</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>P2</td>
<td>24</td>
<td>17</td>
<td>B</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>P1</td>
<td>6</td>
<td>5</td>
<td>A</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Y</td>
</tr>
<tr>
<td>P1</td>
<td>25</td>
<td>20</td>
<td>B</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Y</td>
</tr>
<tr>
<td>P1</td>
<td>10</td>
<td>B</td>
<td>C</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Y</td>
</tr>
<tr>
<td>P1</td>
<td>5</td>
<td>4</td>
<td>B</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>N</td>
</tr>
</tbody>
</table>

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
8 Landscape architectural firms
8 Multidisciplinary firms

No 15
7 Landscape architectural 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 (Clement, 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)
   ( ] 1 I economic studies are not prepared.
   ( ] 2 I manual estimates are prepared.
   ( ] 3 I outside cost consultants are hired.
   ( ] 4 Other; please explain

______________________________

52
Responses to Question 13.

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not prepared</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Manual</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Outside</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

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

Outside: (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 type(s) or brand names of software used and the date of purchase.

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Approximate date of purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>too many to name</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>3 IBM PCs</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>Apple 512 Jazz</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Fortran based self written for Vax 11780</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiplan for Macintosh</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Digital PDp-11 Hardware 10/83, Alpine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>software</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>See attached</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Lotus 1,2,3; Wordstar; PFS Write &amp; Report, Multiplan</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Developed our own software w/Multiplan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>spreadsheet</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>IBM Means Estimating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spreadsheet pro. Lotus 1-2-3</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>PC NEC 1982, PC IBM 1985, PC Leading Edge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1986</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Lotus 1983 We have several specialized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>spreadsheets we have developed. We</td>
<td></td>
</tr>
<tr>
<td></td>
<td>normally provide a cost estimate by</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid-programming, using a cost model</td>
<td></td>
</tr>
<tr>
<td></td>
<td>built on project parameters, historic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>data &amp; modified by our perception of the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>client's attention to quality. Our</td>
<td></td>
</tr>
<tr>
<td></td>
<td>last 6-7 bids have been within 5% (none</td>
<td></td>
</tr>
<tr>
<td></td>
<td>over) on above 3 million in construction.</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>IBM XT Dec. 1985</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Symphony spreadsheet 3-86 our own ROI &amp;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>other investment programs</td>
<td></td>
</tr>
</tbody>
</table>

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)

- [ ] 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 specify

**Comments:**

**Responses to Question 15**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not suited for practice</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Insufficient flexibility</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Lack of integration</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Excessive manual adjustment</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Insufficient growth capacity</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**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
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 must be very careful not to overstep the bounds of a given discipline's 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 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 designed, 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 problem 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 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" (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 might not contribute as much dynamism as two specialists who must 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 from 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 market’s demands for privacy have made creative land planning an absolute necessity....the cost for such planning is generally minor 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 components 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 sufficient 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 artistically 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


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.
Dear Sir or Madam:

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

The enclosed questionnaire 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 development environment. This questionnaire is being mailed to landscape architects in St. Louis, Kansas City, and Denver. Your participation will assist an accurate assessment of the current opinions of professionals in private practice in this area. All information will remain confidential and will be reported in an aggregated form without reference to specific firms.

The questionnaire is concerned with the perceptions of private practitioners on the role economic analysis should play in landscape architectural practice, the process of economic decision making, and the technical support for economic analysis available to site planners. We would also like to determine the level of formal education in real estate development 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 development in the past five years with 76% of planning schools, 63% of architecture schools, and 36% of landscape architecture schools offering regular courses in real estate development.

The questionnaire takes about five minutes to complete; additional comments 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 questionnaire. Further information 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 separately from design services.
   b. economic feasibility studies and design services are included in the same contract.

5. Economic feasibility analysis is site planning in:
   a. a separate 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-programing
   b. Program
   c. Schematic design
   d. Preliminary design
   e. Final design
   f. Construction documentation
   q. 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 no, 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  

<table>
<thead>
<tr>
<th>Level</th>
<th>Study Description</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Market study (based on a potential investment)</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Feasibility analysis (based on a program)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Budget estimate (based on a schematic design)</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Initial conceptual estimate (based on a preliminary design)</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Final design estimate (based on a site development plan)</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Bid estimate (based on construction documentation)</td>
<td></td>
</tr>
</tbody>
</table>

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.  
   [ ] Annual 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)  
   [ ] Inadequate 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

Comments:

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 respondents 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 architectural 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 assessment of the current opinions on economic analysis within the Kansas State University sphere of influence,
the confidentiality of the data -- the privacy of business information will be protected by aggregating any published data so that no individual person or individual firm can be identified,
their right -- to refuse to answer all or part of the questionnaire.

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

PRIVACY
The questionnaire 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 emergencies anticipated? No

Describe the benefits of the research to the subjects:
The questionnaire will provide an assessment of the opinions of private practitioners on the role economic 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 Committee and the Subcommittee 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 through the Subcommittee of the College Of Architecture and Design.

SIGNATURE

--------------------------------- April 29, 1986
Arnold Waters, Applicant
MEMORANDUM

TO: Arnold Waters
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.
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 biding. 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.
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.

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.

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.

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.

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

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.

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".
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?

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, 1982).

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).

\(^1\) "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 model is essentially intended for use by a design/build firm 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 estimation model is to formulate conceptual estimates at the preliminary design phase. It is anticipated that by structuring the relationships between cost items and productivity a model would provide a means to rapidly assess information specific to a project (design information) by permitting an estimator to provide experiential information that normally is not considered until construction documentation is completed. The preliminary design phase is the point at which program concepts, design concepts, and cost concepts have essentially the same impact on the potential use of a site.

The following description of the computer system assumes the reader is familiar with microcomputers and software. A spreadsheet software program will be used to develop the model.

"Spreadsheets are particularly well suited to economic modeling. Unlike most 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 model output because you can see your intermediate calculations. It is also less bother to generate reports because you can easily change the report format. Input forms are also easier to generate" (Miller and Kelso, 1985, p.202).

It is anticipated that this will provide a model that is accessible and readily usable by the average person. The other components of the system are described below.

System Shell

The implementation of a modular system is dependent upon some form of system management capable of switching from task to task. The modular nature of the system being advocated requires the integration of the various applications needed to perform the tasks necessary for producing a site plan. Integration can be achieved in a number of ways; the method selected was the use of a menu/tracking/help system implemented by Keywords™, 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 AltF51 (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. Keywords™ 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 Templates

The use of spreadsheet templates requires a means for communicating the structure of the model. A help map is one means of conveying this information. The illustration below (Figure 7) is a help map displayed by a Keywords™ text screen. The layout of the spreadsheet is outlined as blocks of major components. Sub-components of the major components are identified using named ranges (see page 85).

### Figure 7: Help map screen

The areas defined for data entry are organized as entire screen pages (indicated by the I lines) while the areas for calculations or data storage are organized to minimize file size. This worksheet was implemented using version 1A of Lotus 1-2-3™ which requires clustering blocks of activities as closely as possible to reduce file size. The upper left hand corner of the map represents the summation screen shown in figure B.

The summation sheet is the same for all construction activities so that several construction activities can be summed using the Lotus /WEAN command. This is the initial screen viewed when the spreadsheet is loaded. An area is provided for entry of project identification.
**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 option 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 CtrlM 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.
<table>
<thead>
<tr>
<th>Units servicesd</th>
<th>0</th>
<th>Job Cost Subto</th>
<th>Trench &amp; Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor day of</td>
<td>10 hrs.</td>
<td>Sub Contracts</td>
<td>Apportionment</td>
</tr>
<tr>
<td>Wages multiplier</td>
<td>123.00%</td>
<td>Overhead</td>
<td>Equipment</td>
</tr>
<tr>
<td>Job time adjust</td>
<td>0 days</td>
<td>Contingency</td>
<td>Rental Equipment</td>
</tr>
<tr>
<td>Production time</td>
<td>0.0 days</td>
<td>Profit</td>
<td>Direct Cost</td>
</tr>
<tr>
<td>Job days bid</td>
<td>0 days</td>
<td></td>
<td>Sub-Contracts</td>
</tr>
<tr>
<td>Cost per unit</td>
<td>$0.00</td>
<td>TOTAL C</td>
<td>Other material</td>
</tr>
</tbody>
</table>

**Figure 9: Options Menu overlay**

For example, selection of 'Trench & Pipe' displays the screen shown in figure 10. From this point pipes are specified for all sizes and areas. Selection from the menu copies the appropriate formulas to the active area and displays a data entry screen (Figure 11). The cursor is restricted to the cells required for data entry (using the Lotus/R1 command), the worksheet titles are set and a text message is displayed. Note that the cell indicator registers an unprotected status.

<table>
<thead>
<tr>
<th>Pipe</th>
<th>Type</th>
<th>Size</th>
<th>Quantity</th>
<th>Depth</th>
<th>Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV</td>
<td>SDR35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encasement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron, Cast Iron</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitrified Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinenter Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 10: Pipe selection screen and menu**
Figure 11: Entry of data for laying pipe

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

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 (Figures 7) or by a knowledgeable user. The figures generally will not vary on a job-to-job basis.

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.

<table>
<thead>
<tr>
<th>Appurtenance</th>
<th>Production Normal rate of</th>
<th>Adjusted</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>daily production % production Days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 End of Line Cleanout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Manholes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Service Tape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual line, single trench</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single line, branch tap</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Listing of component parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Manholes</td>
<td>1 - precast manhole section 4' x 4'</td>
</tr>
<tr>
<td>1 - precast lid section 4ft. dia.</td>
<td></td>
</tr>
<tr>
<td>1 - manhole rim &amp; cover (+or- 270#)</td>
<td></td>
</tr>
<tr>
<td>4 - adjustable rings/precast 6&quot; each</td>
<td></td>
</tr>
<tr>
<td>1 - cu.yd. gravel</td>
<td></td>
</tr>
<tr>
<td>1.75 - cu.yd. concrete</td>
<td></td>
</tr>
<tr>
<td>2 - steel fence posts</td>
<td></td>
</tr>
<tr>
<td>10 - concrete blocks</td>
<td></td>
</tr>
<tr>
<td>10 - steps</td>
<td></td>
</tr>
<tr>
<td>10 - mastic sealant</td>
<td></td>
</tr>
</tbody>
</table>

Figure 15: Listing of component parts
If the material list requires editing, a message to place the cellpointer on the row in which the item is located is then displayed. If the item is to be replaced, the cellpointer is placed on an existing listing. If an additional item is required, the cellpointer is placed at the bottom of the list. After the item is selected a check branch is displayed (Figure 16).

<table>
<thead>
<tr>
<th>MANHOLE LIST of Appurtenance components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0 Manholes</strong></td>
</tr>
<tr>
<td>1 - precast manhole</td>
</tr>
<tr>
<td>1 - precast lid sect</td>
</tr>
<tr>
<td>1 - manhole rim &amp; co</td>
</tr>
<tr>
<td>4 - adjustable rings</td>
</tr>
<tr>
<td>1 - cu.yd. gravel</td>
</tr>
<tr>
<td>1.75 - cu.yd. concrete</td>
</tr>
<tr>
<td>2 - steel fence post</td>
</tr>
<tr>
<td>10 - concrete blocks</td>
</tr>
<tr>
<td>10 - steps</td>
</tr>
<tr>
<td>10 - mastic sealant</td>
</tr>
</tbody>
</table>

**Figure 16: Alteration of component listing**

The indicated cell is marked and the screen display shifts to the data base. A text overlay of instructions appears, as soon as the cursor key is moved this text overlay disappears.

<table>
<thead>
<tr>
<th>COMPONENT PARTS SUMMARY AND DATA BASE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantity</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>1.5&quot; check valve S</td>
</tr>
<tr>
<td>1.5&quot; nipple PVC S</td>
</tr>
<tr>
<td>1.5&quot; x 6&quot; PVC nipp</td>
</tr>
<tr>
<td>1.5&quot; PVC cap</td>
</tr>
<tr>
<td>1.5&quot; PVC tee SW</td>
</tr>
<tr>
<td>1.5&quot; adaptor MTxSW</td>
</tr>
<tr>
<td>1.5&quot; ball valve SW</td>
</tr>
<tr>
<td>2&quot; x 3&quot; saddle 1PT</td>
</tr>
<tr>
<td>2&quot; galv. str. cap</td>
</tr>
<tr>
<td>12&quot; Apco #55 sewer</td>
</tr>
<tr>
<td>1/2&quot; brass gate valve</td>
</tr>
<tr>
<td>1/2&quot; brass gate valve</td>
</tr>
</tbody>
</table>

**Figure 17: Data base of parts**
Equipment entry

Selection of equipment from the options menu clears the screen and queries for a daily or monthly 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).

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Use per eight hour day</th>
<th>Daily</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trencher</td>
<td>Vermeer 6008</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Backhoe #1</td>
<td>Case 5808</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Backhoe #2</td>
<td>Case 5808</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Dozer</td>
<td>Cat D-3</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Loader</td>
<td>Cat 931</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Trencher</td>
<td>Davis 40+4</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

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 Keyworke™ 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.

<table>
<thead>
<tr>
<th>Check Named Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctl C.... Cost of Materials</td>
</tr>
<tr>
<td>Ctl G.... Database</td>
</tr>
<tr>
<td>Ctl P.... Production</td>
</tr>
<tr>
<td>Ctl Q.... Quit</td>
</tr>
</tbody>
</table>

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
   ABM M22..BH22
   CONCRETE M25..BH25
   ENCASE M27..BH27
   IRDN M26..BH26
   SDR25 M21..BH21

B. APPURT TITLE
   MHDLE AP30..BH32
   TAPS AP35..BH35
   CLEAN AP37..BH37

C. SUBCRT B213..B238

D. DIRCOST B243..B257

E. RENT M62..I7B

F. LABOR A21..K40

G. EQUIPMENT A41..K60

II. Materials

CDST PIPE AJ4..AJ19
CDST CLOUT AJ34..AJ51
CDST MH AJ54..AJ71
CDST TAPS AJ74..AJ89

III. Data base

A. System
   DATA BI20..BQ73

B. Pipe & Trench
   PIPELDDK BL1..BZ17

C. Appurtenance
   LIST L70..A832
   LIST CL DUT M22
   LIST MH M32
   LIST TAPS M72

IV. Crew Definition

   LTME A23..A39
   EQUIP TIME A44..A60

V. Location

A. Formula
   UNITS C11
   DAYS BID C1B
   EQUIP DAILY M42
   LABDR CDST DAY I21
   EQUIP MONTHLY I42
   ADVERSE PIPEBAY B64
   NORMAL PIPE DAY BF4

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

C. Pointers
   1. Database Routine
      PRICE BD68..BP68
      CHOICE BK68
      SPDT D96
      NEW BK72

   2. Print routine
      COUNT M9
      PRINT M7:

   3. Equipment rate
      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.
With sparse matrix files major worksheets can be grouped by either sequence of occurrence 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 assist 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


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


Decision support systems


90


Models


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. Comparative lease analysis and the electronic spreadsheet. *Site Selection and Industrial Development*. 30(6), 1-10

**Economic analysis**


**Market and Feasibility analysis**


Costs


APPENDIX E

DEFINITIONS

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

<table>
<thead>
<tr>
<th>Terms</th>
<th>Page</th>
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<td>1</td>
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<tr>
<td>investment land use plan</td>
<td>3</td>
</tr>
<tr>
<td>decision calculus</td>
<td>31</td>
</tr>
<tr>
<td>decision support system (DSS)</td>
<td>7,25</td>
</tr>
<tr>
<td>design methodology</td>
<td>17</td>
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<td>direct leverage</td>
<td>11,12</td>
</tr>
<tr>
<td>dynamic attributes</td>
<td>28</td>
</tr>
<tr>
<td>'fourth-generation' languages</td>
<td>11</td>
</tr>
<tr>
<td>highest and best use</td>
<td>15</td>
</tr>
<tr>
<td>incrementalist</td>
<td>20</td>
</tr>
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<td>investment land use plan</td>
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<td>8</td>
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</table>
APPENDIX F

AUTHORS

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

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Page(s)</th>
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<tbody>
<tr>
<td>Ackoff and Sasieni</td>
<td>16</td>
</tr>
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<td>Adrian</td>
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<td>Miller and Gardner</td>
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</table>
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
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.