LANDSCAPE ARCHITECTURAL DESIGN AND ABSTRACT GRAPHIC LANGUAGE: AN INVESTIGATION INTO THE USE OF ABSTRACT DIAGRAMS AS A TOOL FOR COMMUNICATION IN PROGRAMMING

by

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(ABSTRACT)

The goal of this research was to examine the commonality of abstract diagram use in landscape architectural design by meeting the objectives of: (1) developing a use-pattern profile of abstract diagrams for design communication in the programming process, i.e., determine which diagram type is used for the communication of which programmatic design issues by private-practice firms, and (2) determining the perceptions of landscape architects in regard to clarity of understanding, ease of preparation, and frequency of use of these diagrams, also identifying any association between these perceptions.

Data were obtained from a questionnaire survey of single-disciplinary landscape architectural firms nationwide in the period from August 13 to September 3, 1986. The analysis was based on a total of 93 responses out of 152 mail-outs.

A diagram type as paired to a Design Factor, which it was identified to be used for the communication of, is presented in a Table in descending order of the proportion of respondents who made that identification.

It was found that landscape architects perceive the average level of understanding to be in descending order of (1) self/landscape architects, (2) other professionals, and (3) their clients. There was a significant difference by diagram type in clear understanding, as landscape architects perceive it.

There was also a significant difference by diagram type in the ease of preparation. Significant difference was also observed by diagram type in the frequency of use. It was found that landscape architects "seldom" use abstract diagrams; on average, they are used for about 10% of the total projects landscape architects deal with. Positive associations were found, depending on diagram type, between clarity of understanding and frequency of use, and between ease of preparation and frequency of use.

It is suggested to the practitioners and educators to utilize the findings in this study as a guideline to evaluate their own paradigm by, or as a basis to build one of their own upon.

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First I would like to thank all the landscape architects who returned the questionnaire, from as far away as Alaska and Hawaii. I express my thanks to my committee: , and the committee chairman for their advice which greatly helped in making this effort easier. I extend my thanks to for serving as the proxy to at the defence of this thesis, and to for having initially served as a member of the committee. I would also like to thank Dr. Frederick Lacerda, ., and for their unsparing help along the way.

Finally, most of all, I feel that any word simply gets in the way to express my thanks to my parents, .

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1.0 CHAPTER ONE: AN INTRODUCTION

The goal in approaching this research effort was to examine the commonality of diagram use for the communication of design issues in the programming processes of physical design in private landscape architectural firms. The goal was achieved through a nationwide survey of practicing landscape architects. This Chapter, after a discussion of the role of abstract diagrams in programming processes, presents the objectives, purpose, and scope of the research.

1.1 THE ROLE OF INITIAL PROCESSES IN DESIGN

There is no doubt that the initial 'programming' process (Program and Analysis) is a crucial part of landscape architectural design-planning. As the landscape architect becomes involved in projects of greater scale and complexity, the value of the programming grows from a mere means of "getting to know the problem" to that of an instrument which limits and directs the design process. Whereas, in the past, programming was a basic involvement with familiar and uncomplicated functions, having only moderate influence on the design synthesis, it has been developing into a systematic, analytical 'discipline.' The increasing number of firms that specialize in this area is an indication of the importance placed on programming and of its recognition as a distinct component of the design process (White, 1985).

The role of programming could be described as developing a designer's "view to a design" with respect to various individual and specific factors or issues, but still resulting from his values and attitudes. The broader and more comprehensive the list of those factors and issues to which we relate our design method, the more complete our knowledge and awareness of this "view to a design" will be (White, 1972).

Specifically, the core of the programming process is an essential insurance that as many of the consequences of a design product as possible are anticipated and planned for, so that the product is more successful in respect to critical design factors and issues. White (1972) defines programming as a vital segment of design events, which leads to the prediction and realization of valued consequences: it finds, selects, and organizes pertinent "facts" and translates them from verbal to graphic expression so that they may in turn be translated into a "physical expression."

1.2 THE ROLE OF ABSTRACT DIAGRAMS IN DESIGN COMMUNICATION

Abstract diagrams, the focus of this study, have been indispensable tools for translating design ideas into a physical form in the programming process. Diagramming has been the language with which designers--among them landscape architects--"describe and understand the requirements of the project, and create, explore, and integrate design ideas that respond to programmatic issues" (White, 1985).

VanDyke (1982) writes:

> Design as a problem solving involves a cyclical process of evaluation, synthesis, and design ideas. Its success relies on solid and well organized concepts, which are the result of the cyclical process that is fundamental to design problem solving. Graphics is the visualization of this design process from beginning to completion (From Line to Design).

The significance of the design-graphics relationship is that it enables the communication of designer's ideas quickly and effectively (VanDyke, 1982). Graphic communication provides feedback to the originator (and to the user, in case these two are different), the effectiveness of which for "design generation" lies in the fact that it sends message at the spatial or multidimensional level (Faruque, 1984). This effectiveness may be because, as Arnheim (1969) suggests, thinking must be done on images of the world in which we live, and the thought element in perception and the perceptual element in thought are complementary--they make human cognition a "unitary process."

Visualized communication takes advantage of this power of perception by making visual images external and explicit; by putting them on paper, we give visual images an objectivity outside our brain (Faruque, 1984). In this regard, it seems externalized thinking has several advantages over internal thought: first, direct sensory involvement with materials provides "sensory nourishment"; second, thinking by manipulating an actual structure permits "serendipity"--the unexpected discovery; third, thinking in the direct context of sight, touch, and motion engenders a sense of immediacy, actuality, and action; finally, the externalized thought structure provides an objectivity for critical contemplation that can be shared with a colleague and mutually formulated (McKim 1980, Arnheim 1974). Perhaps these are the reasons most thinkers on design graphics agree that the primary mode of communication in the programming process, besides those written or verbal, is visual communication through the use of abstract drawings or sketches, i.e., 'abstract diagrams' (Lockard, Faruque, Laseau, VanDyke, Hill, Murgio, White, O'Connell).

The first reason that graphics--and that abstract form of it--is primary in effectiveness for this specific communicational process, is that the removal of detail from the environment, and the observation of things as abstract images, is the first step to understanding the basic elements and principles of the environment (VanDyke, 1982). Simplification of the environment into abstract forms and symbols enables us to evaluate the environmental elements without being overwhelmed by specifics.

In other words, abstraction releases a visualizer from demands of representing the finished final solution, thus allowing the underlying structural forces to surface, visual elements to appear, and techniques to be applied with direct experimentation, all of which comprise the major function of the programming processes (Dondis, 1973). In this case, abstractions are useful in predicting occurrences and also in "getting work done": "if they are properly and uniformly made from starting points from the external environment, the relations revealed by the symbols will be relations existing in the external world" (Hayakawa, 1978), while not being so specific as to unpurposefully curtail the possibilities for a better design product.

White (1972) writes:

> As architectural design is a physical--or visual-- expression of the problem statement, it is of value to express as much of the program graphically and diagrammatically as possible. This di-

agrammatic translation of the programming facts is the start of the formation of the physical product, as diagrams have direct implications on physically designed form. The designer's ability to design visual, graphic communication of programming data will largely determine the extent to which all the programming needs are met in design synthesis (Introduction to Architectural Programming, page 63).

Second, the usefulness of abstract diagrams lies in their effectiveness for the transmission of information. It is clear that, although self-communication is of the foremost importance for individual design thinking, architectural design rarely takes place in isolation. However strong an architect's personality, he will inevitably work as a member of a group (Broadbent, 1973); there still are needed many other groups of people - architects, technicians, consultants, contractors, clients, and even users--to translate his ideas into reality. As it always has been a fact of life that graphic communication plays a crucial role in the success of teamwork, team members are constantly required to share information and ideas with this medium to be truly effective.

Graphic thinking skills enable their contributions to design to be quickly presented to various groups, as well as to remain available for retrieval and manipulation (Laseau, 1982). Among various communicational skills, abstract diagrams can help eliminate--without compromising the vital 'fluidity'-- the barriers built by professional jargon, allowing persons of different disciplines to communicate with a project team that is comprised of professionals from various fields.

Professional jargon, while allowing for faster and more efficient communication between professionals in the course of their efforts, involves the considerable risk of negative reaction by outsiders, a reaction that "the nature of the landscape architectural profession, which is none other than making people's physical needs met, can never afford" (Marshall, 1981).

This point is critical, since these outsiders, who are basically 'clients' to designers, are assuming more importance as design participants. Their role as design participants has been given importance as a means of meeting two present challenges to architectural design: to be more responsible to needs in a problem-solving process, and to be more scientific, reliable, or predictable (Laseau, 1982); the meaning of these challenges is that design problem solving should be 'with' people instead of 'for' them, by helping them understand their needs and choices of designs that meet those needs, and by bringing them into the process of design itself.

This 'involvement' seems to have an additional advantage in achieving a responsible design product, as Lockard (1974) states: "openness and honesty in design are best achieved by initiating any other deciders than designer into the earliest stage of design process." This openness, which means allowing the early incorporation of the clients' visual thinking 'material' into that of the designers, can keep their clients "involved to the first attempts at design synthesis"--thus virtually eliminating the persuasion gap. Certainly an abstract diagram is one important tool for facilitation of this openness, for the elimination of the barrier built by jargon.

1.3 THE NEED FOR, AND OBJECTIVES OF, THE RESEARCH

Ironically, despite the potential for design communication, no comprehensive study has been conducted on the use of abstract diagrams in landscape architectural firms, of which single-disciplinary ones (practicing only in landscape architecture) number approximately 2000.[1] The lack of research concerning the use of abstract diagrams, be it on their use, or on their properties, seems not to be confined just to the landscape architectural profession.

In general, in many respects the concept of using a diagram--in other words "drawing upon the human visual system's capacity for perceiving, comparing and remembering forms, thus allowing the integration of multiple individual information items"--has not progressed much from the eighteenth century, when William Playfair initiated it (Turek, 1985). However scarce the works on graphics, they range over a broad spectrum of fields, from statistics, graphic arts and cartography to education and ergonomics; within this variety, and maybe because of it, there has developed no accepted theoretical basis for visual graphics, not even a consistent body of terminology nor a generally accepted classification of graphic techniques (Wainer, 1980). Over the years, to aid those people who employ graphics in their profession, a number of handbooks or manuals of techniques have appeared that are based on not much more than intuition and aesthetics; although it cannot be said that methods and forms of the

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[1] This figure is as counted from the roster of landscape architectural offices (In Practice 1985 edition) published by American Society of Landscape Architects.

graphic representation of data have made no progress since the time of Playfair, there has been little empirical evidence established, for example, for the preference of particular methods in a given circumstance, or for the use of particular features of a graphic type to best serve the intended function.

Perhaps landscape architecture is one of the professions in which the need for research is most acutely felt in view of its potential benefit. So far, due to the absence of any research directed toward the discovery of an effective paradigm, both the practice of and education in the use of abstract diagrams seem to have been engaged merely through custom and intuition; the weakness of this approach is that it operates on the premise that the past custom (including each landscape architect's academic training in the past) is not to be questioned and each diagrammer's intuition is sound.

In dealing with a design tool as 'abstract' as an abstract diagram, this assumption is now questionable, particularly when changes in landscape architectural design include (1) the increasing role of the programming process for the success of design, (2) the increasing participant role of people from outside the profession in the whole design process, (3) the increasing scale and complexity of projects that landscape architectural design deals with, and (4) the multiplication of new private landscape architectural firms that have to build a sound paradigm of abstract diagram usage on their own.

A part of this 'custom' will be the referential use of graphics publications of which the reliability has not been examined--in terms of the diagram types (and the informations they illustrate) that they provide the examples of. This 'blindness' may have a detrimental effect, to the point that a considerable amount of resources in terms of time and effort has been wasted in practice and graphic education.

At this point, the first step in order to find a paradigm acceptable for objective effectiveness, seems to lie in the examination of the commonality in the firms themselves. As a means of increasing their chances of survival, perhaps because of the intense competition, individual firms in environmental design tend to develop effective paradigms of their own for various aspects of the practice--the abstract diagram usage being one (White, 1985). This accumulated 'wisdom,' attained through the trial-and-error process in individual firms, has so far been lost to the profession due to the lack of any research into it.

Since an abstract diagram's primary purpose is 'visual' communication, its margin of effectiveness may be even more affected by the way it is utilized than are other communicational methods such as 'written' or 'oral'; therefore, an objective proof of agreement among landscape architects as to which diagram type is functionally appropriate for the communication of which design issue, and thus used as such, is surely needed. Also, there is a need to examine how landscape architects judge an abstract diagram's effectiveness: this knowledge is important because their judgment in this regard will inevitably affect their preference of diagrams in a specific communicational situation in the programming process.

Here a major distinction needs to be made between two 'specific situations': one situation in which the landscape architect should consider to-or-with-whom the communication will be made and how well the one being communicated to will understand; and the other in which the landscape architect should consider how 'economical' the job of preparing an abstract diagram is. The first situation is becoming more critical since increasingly people from outside the profession--clients being one primary group--are design participants.

The majority of behavioral psychologists (Underwood, 1978; Frith, 1976) agree that experience (which includes education in its broader sense) has a significant effect on how well a person understands a set of 'stimulus'--which, for the study at hand, will be an abstract diagram. Still others, such as Garner (1974), maintain that it still needs to be fully answered whether a human can perceive a stimulus as a 'meaningful object' only with experience or without, and that there are stimuli having properties that lead to understanding with little need for or effect of prior experience.

In whichever case, there is a possibility that landscape architects consider the level at which the 'outsider' understands an abstract diagram does not equal their own, which in turn may affect the landscape architect's choice of a diagram depending on whether he thinks the client's level of understanding equals his own or not, or on how well he thinks a diagram is understood by a design participant from outside the profession.

The second situation, in which the landscape architect must consider how 'economical' it is to prepare an abstract diagram, is also critical, since in most design situations the time and effort invested in the programming process - the use of abstract diagram in it being either as an aid to the 'visual thinking' process or as a means of presentation-- has not been considered as a distinct service in terms of fee structure

(White, 1972). It means that a landscape architect should be constantly reminded of the fact that the time and effort expended for the employment of an abstract diagram in the programming process eventually taxes the overall resources that he needs to accomplish a design task successfully. Whether he thinks there is any difference by diagram type in ease of preparation or not, and in the former case, which diagram type he thinks is easier to prepare, may significantly affect the pattern of his diagram usage.

However, discovering which diagram type is used by a landscape architect for the communication of which design issue would not answer how 'often' that diagram is being used; neither would the discovery of effectivenesses for clarity of understanding and of ease of preparation answer how frequently the diagram is used. Only through a separate inquiry may the question whether there is significant difference of use frequency by diagram type be answered, and subsequent examination on the existence of any association between use frequency and 'effectivenesses' will be possible.

Specifically, this thesis attempts, through a survey having private landscape architectural firms as its subjects, to meet the research objectives of:

(1) developing a use-pattern profile of abstract diagrams for design communication in the programming process, i.e. determining which diagram type is used for the communication of which programmatic design issues in private-practice firms, and

(2) discovering what the landscape architects perceive as to these diagrams' clarity of understanding, ease of preparation, and frequency of use, and identifying any association between these perceptions.[2]

This study does not present any formal test of hypotheses; rather, the objectives are to examine whether there exist any patterns in the commonality of abstract diagram usage agreed upon by practicing landscape architects, such that observations and conclusions as to these patterns may be developed, as well as suggestions for achieving an effective paradigm for both practice and education.

The results of this study will provide to a beginning firm a frame for building a paradigm of abstract diagram usage of its own; to an established firm a guideline by which to reassess its present paradigm. For landscape architectural education, this study provides information for assessing its conformity to real practice and for estimating better the "demand" for specific types of graphics education. This assessment will also enable some insights about whether present graphics publication presents potential concurrence or disparity with the true demand in the practice.

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[2] It is necessary to point out that the lack of any substantial inquiries in this area in the past makes the research objectives retain a degree of arbitrariness. To examine the study's relevancy to the profession's research needs, one of the survey questions asked for the respondents' opinion in this regard. Of those who answered this question (71 out of 93 total), 87% were positive about the research's relevancy and 13% negative (cf. APPENDIX D).

1.4 SCOPE

This study focuses on abstract diagrams used in larger, site-planning scale, physical design; by focusing on this specific project scale, in which the usefulness of abstract diagrams for programming tends to be the highest (Laseau, 1985), we may acquire the most accurate idea on the extent to which abstract diagrams are useful in every aspect of the design. That is, for example, if it is found that abstract diagrams are not considered truly 'useful' even for the larger scale projects, it could safely be assumed that their usefulness will be even lower in lesser scale projects. The same could be said for the confinement of this study's scope to the programming process: by examining the commonality of abstract diagram use in this segment of the total design process, where the need for the efficiency of its use is the most critical, an assessment on abstract diagram's relevancy to the whole design activity could reasonably made.

Overall, there are several limitations to this study due to its essentially subjective nature. First of all, the selection of abstract diagrams and programmatic design issues may not be representative of the whole population of landscape architecture; thus, its validity is confined to the author's own analysis.

Also, this study's aim is rather to find out how the commonality is in reality, than to find out why. The behavioral or Gestaldt aspect of this study will be left to the field of applied psychology. In the same vein, the semantical definition of 'clarity of understanding' and 'ease of preparation' will be left to practicing landscape architects' subjectivity.

This research is basically designed as a survey on the subjective judgment of landscape architects as to their own pattern of practice and perception; thus, the findings will not tell, for example, what the other user-groups such as clients perceive their own level of comprehension to be.

2.0 CHAPTER TWO: METHODOLOGY

2.1 INTRODUCTION

To collect data to meet the research objectives, a randomly selected sample of private landscape architectural firms was surveyed. First, design-related issues of the landscape architectural programming process were identified, through a study of relevant articles in the literature. Second, abstract diagrams used in landscape architectural design were identified through a literature search and classified according to function. For each functional category, prototypical diagrams were developed by finding the most representative forms of diagrams in it. Third, a questionnaire was designed and pre-tested, after which it was mailed to a randomly selected sample of private landscape architectural firms. Finally, the data were aggregated, analysed, and discussed. This chapter explains the procedure followed to accomplish the first, second and third steps.

2.2 IDENTIFICATION OF DESIGN FACTORS

As already stated, this study examines abstract diagrams in conjunction with the communication of design issues in the programming process (i.e., Program/Analysis stages), where their role as a means of communication is the most significant. Design issues and factors in this process were compiled, using guideline set by following definitions, and condensed into representative Design Factors.

In this study, a distinction is made within the programming process between the stages of 'Program' and 'Analysis': the Program stage is defined as having the function of identifying the goals/objectives of the project and research/gathering of facts; and the 'Analysis' stage as including analysis, evaluation, and organization of the facts identified in 'Program' stage. The following sections present the functions of these stages as defined in this study, and the Design Factors identified in each.

2.2.1 DESIGN FACTORS AND THEIR COMPONENTS IN THE PROGRAM STAGE

In the Program stage, the goals/objectives comprise the client/user goals, the purpose of the project, and its description; the facts would involve information both qualitative (required function and human sensory) and quantitative (site, climatic, budgetary, legal, utility, work scheduling and staff-organizational).

Specifically, the finding of facts is defined as consisting of the processes of research (discovery of new facts), and data/fact gathering (accumulation and organization of facts that are known). Namely, the former attempts to make a contribution to knowledge while the latter makes use of existing knowledge. Both of these fact-finding functions are intended to "establish greater certainty about the consequences of specific design decisions, so that these decisions may be made more knowledgeably and with greater predictability" (White, 1972). However, the degree to which the designer allows the facts identified to influence the final product will be largely affected by his own design philosophy. In the same way, the scale of fact-gathering format and the quality and amount of collected facts will more or less depend on his attitude about programming's role in the whole design process.

The typical facts that might warrant a research/finding in the Program process are identified through literature research and grouped into the following: Users' Functional Needs, Human Sensory Constraints, Geological Constraints, Topographic Constraints, Ecological Constraints, Climatic Constraints, Project Budget, Legal Regulations, Utility Availability, Work Scheduling, and Design Team Organization. These and Goals/Objectives comprise the twelve topics that were presented in the survey questionnaire as Design Factors in the Program stage.

Following are the list of similar components from which each Design Factor was derived. This list does not profess to be complete; it is also possible, depending on judgment, that some of the Design Factors and their components may overlap.

GOALS/OBJECTIVES

- Client goals
- User goals
- Goals and sub-goals of departmental divisions--role of each
- Philosophy of client

USERS' FUNCTIONAL NEEDS

- Users' physiological needs
- Users' psychological needs
- Needs as related to the identity of Projected users (age, physical capacity, sex, ethnic group, income, occupation, etc.)
- Users' biophysical needs (life-support systems--heating, cooling, illumination, water, fuel, etc.)
- Users' preliminary area/equipment needs

HUMAN SENSORY CONSTRAINTS

- First impressions, feelings, and reactions.
- Character and sequence of visual spaces.
- Views, vistas, and focal points
- Quality and variation of light, sound, and smell.
- Objectionable noise, odor, dust, smoke, and photosynthetic pollutants including smog.
- Mood or atmosphere
- Warmth and coolness.

GEOLOGICAL CONSTRAINTS

▪ Subsurface and Soil-Conditional Constraints
  - Soil composition (Loam, Gravel, Sand, Clay, Shale, Rock, Silt, and/or Peat/Muck).
  - Depth to bedrock.
  - Thickness of rock layers.
  - Erodibility.
  - Bearing capacity.
  - Permeablity.
  - Compactibility.
  - Suitability for septic tanks.
  - Adequacy/insufficiency of top soil.
  - pH range.
  - Seismic problems.
  - Depth of various soils.

▪ Hydrological Constraints
  - Existence and location of springs.
  - Existence and location of streams--continuous or intermittent.
  - Existence and location of rivers.
  - Existence and location of perched water table.
  - Depth to water table.
  - Quality of water.
  - Existence of flooding problems.
  - Time, depth, frequency of floods.
  - Existence of potable water.

TOPOGRAPHIC CONSTRAINTS

- Landform pattern (relatively flat, gently rolling, hilly, mountainous, etc.)
- Gradients and their percent of total site and acreage.
- Aspects (north, south,east or west) and their percent of slope.

ECOLOGICAL CONSTRAINTS

- Vegetative cover types (bare earth, sparse or dense grass, scrub growth, pasture, pine/hardwood, virgin stand, climax species, rare/endangered species, etc.).

- Vegitative successional stages.
- Vegetation size.
- Vegetation condition.
- Vegetation density.
- Wildlife density.
- Existence of rare/endangered wildlife species.
- Wildlife characteristics (terrestrial/aquatic/aerial, permanent/seasonal, harmless/harmful, desirable/undesirable).

CLIMATIC CONSTRAINTS[3]

- Existence, intensity and direction of seasonal prevailing winds.
- Amount of rain, snow and sleet.
- Months of the most and least precipitation.
- Average temperatures of day, night and season.
- Average monthly precipitation.
- Amount of arc of sun.
- Optimum solar orientation.
- Time and frequency of smog.
- Time and frequency of fog.
- Frost pockets.
- Average monthly humidity.
- Type and frequency of storms.

PROJECT BUDGET

- Establishment of economic limits/controls by client
- Funding methods (bonds, loans, fund raising, etc.)
- Timing considering construction costs, inflation, interest rates, concurrent similar projects taxing public support, etc.
- Construction phasing considering prices, local construction market, strong/weak local trades, incremental construction,etc.
- Comparison of cost data on similar projects.
- Price of the site.
- Firmness/degree of flexibility of budget.

LEGAL REGULATIONS

- Facility compatibility with present zoning.
- Possibility of zoning change.
- Zoning of surrounding areas.
- Accomplishment of title search/availability of clear title.
- Existence and particulars of liens against the property.
- Deed restrictions.
- Easements (surface, sub-surface and scenic).
- Mineral rights.
- Air rights.

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[3] These Constraints would be both macro- and micro-.

- EPA regulations.
- State and local agency requirements and approvals.
- State and local building regulations.
- Federal regulations.
- Existence and character of review/approval boards.

UTILITY AVAILABILITY

- Adequacy of public services (telephone, power, water, etc.) and their location, distance to site, depth and capacity.
- Adequacy of existing or proposed public highways/roads.
- Availability of public transportation facilities.
- Availability of police and fire protection.
- Adequacy of public or private waste treatment facilities.
- Proximity to railroad, airport, marina, etc.
- Educational institutions.

WORK SCHEDULING

- Sequence of tasks.
- Number, type, and relationships of tasks.
- Requirements for successful performance of tasks.
- Identification of possible sources of strain in performing tasks.

DESIGN TEAM ORGANIZATION

- Personnel/staff organization.
- Rank/role of personnel.
- Channels of communication for design team.
- Measures to keep the teamwork as organized.
- Clarification of each personnel's role and responsibility in decision making.

2.2.2 DESIGN FACTORS AND THEIR COMPONENTS IN THE ANALYSIS STAGE

This study assumes that, in the Analysis stage, design concepts for a specific issue are formulated through analysis, evaluation, and organization of the qualitative and quantitative facts derived in the Program stage, in the direction set by the goals/objectives. These design concepts will serve as criteria for evaluating the design alternatives in design development and eliminating those not in conformity with the goals. They also provide a guideline by which to discuss and arrive at decisions about critical issues in design synthesis. It is possible that several alternative concepts may be developed, from which the one which most closely meets the goals/objectives would have to be selected. Also, it must be acknowledged that these concepts will inevitably contain "value judgment based on the 'spirit of the problem' and other difficult-to-document factors" (White, 1972).

In the Analysis stage, the operations of analyzing, evaluating, and organizing facts from the Program stage in the direction set by the goals/objectives, are meant to bridge the gap between the "raw" data achieved in the Program stage and the design synthesis that succeeds the programming operation.

In his 'analysis,' the designer decomposes the facts into their components to support following two operations: to allow specific determination of the relative importance of their components in 'evaluation'; and to allow discovery of relationships between facts, and between facts and design consequences, in 'organization.'

Qualities of facts that establish their similarities and differences are determined through this decomposition into 'finer grain' in the 'analysis' operation. On the other hand, this decomposition process might result in overlap and repetition: the same kind of component may be found from different facts, which will have to be resolved in 'organization'. Either analysis will not fix the relationships between data that are used in the design synthesis; it will only discover 'potential' relationships and qualities for evaluation, organization, and design synthesis.

After or parallel to the processes of gathering (in the Program stage) and analysis of facts, their relative importance to the design problem must be determined through evaluation.[4] Here, the primary components of a fact, which may serve in the forming of concepts for the design synthesis, are identified. Also, a by-product of this operation will be the definition of the facts that are fixed or unchanging (such as site shape): the designer is made aware of the framework within which the more manipulable aspects of the problem must be worked. It means the greater the 'fixed' facts, the fewer alternative solutions available for the synthesis.

In a sense, 'analysis' and 'evaluation' are mere tools serving as bases for the following 'organization,' which will be the more formal, synthesizing and decision-making operation, in which the designer begins to make a commitment in terms of choosing relationships between qualities of the facts to be used in design synthesis. The designer begins to draw conclusions and make recommendations, i.e. to draw up design concepts about what should happen in schematic and design development, including statements about 'how' this might be achieved. This will be the point at which goals/objectives and their relationships with the facts gathered (in the Program stage), having been analysed and evaluated, are translated into the 'language of the designer.'

These operations of analysis, evaluation and organization, however, cannot possibly be strictly separated from one another. Here they only identify concentrations of similar kinds of activity; the separation is

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[4] Evaluation here needs to be distinguished from the evaluation of data relevancy in fact-gathering or evaluation of conceptual options in design synthesis or development.

made in this study not to propose that they occur as distinct 'packages' but to study and define their operational qualities.

The components of the concepts that will emerge as a result of these operations in the Analysis stage were identified through the literature search, and were grouped into Design Factors of: Users' Space Need, Function/Relation, Circulation Patterns, and Image. Following is the list of components of concepts from which each Design Factor was derived.

USERS' SPACE NEED

- Scaled area/space study for users' needs

FUNCTION/RELATION

- Priorities of required functions
- Relationship between functions

CIRCULATION PATTERNS

- Study of circulation flow in relation to functional relationships
- Circulation within the site as a whole
- Circulation related to external communication
- Ingress or egress sight problems

MATERIALS/UTILITIES

- Availability of all utilities
- Delivery of materials--points of origin and destination
- Degree of urgency for materials
- Role of materials in overall operation
- Form, size and weight of materials
- Plan for storage of materials

IMAGE

- Need-based analysis of emotional function (character, quality, 'feeling,' etc.)
- Image by outsiders
- Self-image by clients/users
- Symbolism in terms of history, geography, locality, etc.

2.3 TYPOLOGY AND PROTO-TYPIFICATION OF DIAGRAMS

2.3.1 BERTIN'S DEFINITION OF DIAGRAM AND ITS CLASSIFICATION

The diversity of graphic forms utilized in the overall landscape architectural design necessitates that an abstract diagram be operationally defined before any attempt is made toward its identification and typology. It is clear that any conclusive definition of the term 'abstract diagram' is not possible due to the lack of even an established terminology in this area.

On a simplistic level, a dictionary (Webster's New Collegiate Dictionary, 1975 edition) defines an abstract diagram as 'a graphic design that explains rather than represents, having only intrinsic form with little or no attempt at pictorial representation'. However, to define an abstract diagram in a more operational way that will leave no possibility for a misjudgment in this study's typological procedure, an approach other than only the semantical is required.

In 1786, William Playfair, in his book Atlas, put together his invention of statistical charts and graphs, in an attempt at surmounting the increasing complexity of the Industrial Revolution era. In his work Playfair illustrates graphic methods to convey information in a distinct and easy manner, but fails to provide any theory for the definition of 'graphics.'

A major work in this regard did not appear for two centuries, when Jacque Bertin's Sémiologie Graphique (1983) was published. His is considered the most thorough and virtually unique attempt presently existing at the definition of diagrams (Foreword to Sémiologie Graphique by Howard Wainer). His study of diagram forms as related in Sémiologie Graphique has been widely read and influential in many fields. His definition of diagrams and their classification is valuable for its uniqueness, and this definition will be discussed in this section.

By definition, Bertin states, a diagram (as the original French term 'graphique' is translated) differs from both figurative representation and mathematics. In order to define it in relation to other sign-systems, he adopts a 'semiological' approach, and beginning with two statements: a. the eye and the ear have two distinct systems of perception; b. the meanings that we attribute to signs can be either monosemic or polysemic.

According to Bertin, a system is monosemic when the meaning of each sign is known 'prior to' observation of the collection of signs. For example, an equation can be comprehended only when the unique meaning of each term has been specified. A diagram can be comprehended only when the unique meaning of each sign has been specified by legend.

Conversely, a system is polysemic when the meaning of the individual signs follows and is deduced by consideration of the collection of signs; significance becomes subjective and thus, debatable. Faced with the polysemic image, the perceptual process translates into the question "What does such an element or collection of elements signify?," and perception consists of decoding the image; in other words, the reading operation takes place 'between' the sign--to which belong the sign systems of language, music, and figurative imagery (representation)--and its meaning.

On the other hand, in a monosemic system such as a diagram, each element is defined beforehand. The perceptual process is significantly different, translating into the question "Given that such a sign signifies such a thing, what are the relationships among all the signs, among all the things represented?" Perception will consist of defining the relationships established within the image or among images, or between the image and the real world, which means the reading operation takes place 'among the given images.'

To employ a monosemic system is, Bertin states, to "dedicate a moment for reflection during which one seeks a maximum reduction of confusion"--it is when, for a certain domain and during a certain time, "all the participants" come to agree on certain meanings expressed by certain signs, and "agree to discuss them no further." This convention enables us to "discuss the collection of signs" and "to link propositions in a sequence which can then become undebatable," that is, logical.

On this point diagrams and mathematics are similar in constructing the "rational moment," but they differ in the perceptual structure which characterizes each of them: mathematics, which is an auditory perception according to Bertin, has only two sensory variables of sound and time at its disposal, and all the sign-systems intended for it are linear and temporal. On the other hand, visual perception has at its disposal three sensory variables which do not involve time: the variation of marks and the two dimensions of the plane.

Bertin maintains that sign-systems intended for the eye are spatial and atemporal and that, whereas linear systems communicate only a single sound or sign, spatial systems--including diagrams--communicate the relationships among three variables in the same instant. Bertin defines "the maximum utilization" of this perceptual power, within the framework of logical reasoning, as the true purpose of diagrams, "the monosemic domain of spatial perception."

He also classifies diagrams into three groups of representation: 'schéme,' 'réseau,' and 'carte géographique.' The construction of a diagram is 'schéme' when the correspondences on the plane can be established between all the divisions of one component and all the divisions of another component; 'réseau' when the correspondences can be established among all the divisions of the same component; and 'carte géographique' when the same correspondences can be established between all the divisions of the same component arranged according to a geographic order. Following is the Typology of diagrams identified through the discriminatory selection of graphic forms by the definition set by Bertin.

2.3.2 TYPOLOGY OF DIAGRAMS

As the second step of the methodology, after the identification of Design Factors in the programming process, distinctive abstract diagram types in all of the landscape architectural design processes were compiled through a study of graphics publications, landscape architectural project reports, project proposals, interviews with practicing landscape architects, and other available sources.[5] Landscape architects interviewed also provided freehand examples.

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[5] The sources include Newman library and its architecture branch at

Invocation of Bertin's definition of diagrams proved valuable for the procedure, enabling discrimination of graphic forms in an objective manner. However, his classification of diagrams, depending primarily on the nature of the correspondences on the plane, is judged to be too simplistic by itself for the study's purpose; since his classification is for the diagram as defined in an all-inclusive, or 'semiological,' sense, it is insensitive to the unique profession-specific functions abstract diagrams have in the communication of programmatic issues in landscape architectural design. Thus, the fashion in which each diagram compiled maps the correlation between the variables of the Design Factor it communicates was observed, and the following five Diagram Categories were achieved as the result of subdividing Bertin's classification into the groups of major fashion.

•Diagram Category I: Diagrams mapping relationship between TIME and variables of a Design Factor - Belongs to 'schéme' since the correspondences on the plane are established between all the divisions (variables) of one component (a 'Design Factor') and another component (time).

•Diagram Category II: Diagrams mapping PROPORTION of variables of a Design Factor - Belongs to 'réseau' in Bertin's sense since the corre-

Virginia Polytechnic Institute and State University, library of American Institute of Architects, library of American Society of Landscape Architects, U.S. Library of Congress, project files of private landscape architectural firms, and personal libraries of the faculty of the College of Architecture and Urban Studies, Virginia Polytechnic Institute and State University.

spondences can be established among all the divisions (variables) of the same component (a 'Design Factor').

•Diagram Category III: Diagrams mapping RELATIONSHIPS among variables of a Design Factor - Belongs to 'réseau' since the correspondences can be established among all the divisions (variables) of the same component ('Design Factor').

•Diagram Category IV: Diagrams mapping RANK OR SEQUENCE of variables of a Design Factor - Belongs to 'réseau' since the correspondences can be established among all the divisions (variables) of the same component (Design Factor).

•Diagram Category V: Diagrams mapping SYNTHESIS OF DESIGN CONCEPTS in context of site - This Category needs to be distinguished from the preceding Categories since the divisions, the correspondences of which are to be established, are themselves Design Factors of the Analysis stage which have been analysed, evaluated, and organized in that stage, instead of variables of a Design Factor. Here the component will be a synthesized design concept derived from the establishment of the correspondences between these Design Factors. This Category belongs to 'carte géographique' in Bertin's sense since the correspondences to be established are arranged according to a geographic order.

A diagram identified in Typology as belonging to two Categories simultaneously in serving (communicating) a Design Factor--for example, a Histogram showing the PROPORTION of a project budget required in different design phases in the TIME sequence--was assigned to the two pertinent categories of Category I (Diagrams mapping relationship between TIME and variables of a Design Factor) and Category IV (Diagrams mapping RANK OR SEQUENCE of variables of a Design Factor) simultaneously, for two practical reasons. First, it was the only way to include these diagrams in the survey without providing for additional Categories; second, in this manner, a partial validity check for the Typology can be done by observing how the survey result differs from it, in respect to these diagrams' communication of the specific 'Design Factor'. These diagrams, which for certain Design Factors serve multiple functions simultaneously, are Bar-Chart, Histogram, Matrix and Link-Node.

Similarly, to get an idea of how reliable the present graphics publications are, in terms of the diagram types and the Design Factor they illustrate, the test of two 'peculiar' diagram types, Log-Chart and Radial-Chart, that have been found only in graphics publications and not in the rest of the general Typology, were built into the survey. Thus, it is possible to do a partial check on the extent to which the illustrations in graphics publications accurately reflect practice in real-life situation. In Typology, besides these 'peculiar' diagrams, no significant disparity between the graphics publications and the rest of the sources could be found.

It would be useful for future discussion to see at this point which major Design Factors each of the diagram prototypes was found to communicate in Typology. An asterisk (*) following a name indicates that the diagram type--and subsequently its Design Factors also--is found in graphics publications only.[6]

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[6] However, it must be made clear that description of these 'major' De-

•Bar-Chart - Category I (Diagrams mapping the relationship between TIME and variables of a Design Factor): Design Team Organization; Category I and Category IV (Diagrams mapping RANK or SEQUENCE of variables of a Design Factor): Work Scheduling, Goals/Objectives, and Project Budget.

•Log-Chart* - Category I (Diagrams mapping the relationship between TIME and variables): Users' Functional Needs.

•Histogram - Category I (Diagrams mapping the relationship between TIME and variables of a Design Factor): Climatic Constraints; Category II (Diagrams mapping PROPORTION of variables of a Design Factor): Human Sensory Constraints and Work Scheduling; Category I and Category II: Project Budget.

•Fever-Chart - Category I (Diagrams mapping the relationship between TIME and variables of a Design Factor): Climatic Constraints, Project Budget.

•Radial-Chart* - Category I (Diagrams mapping the relationship between TIME and variables of a Design Factor): Climatic Constraints.

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sign Factors in any quantitative terms would not be feasible due to the essential ambiguity associated with the concept of Design Factor. Here the term 'major' means that the Design Factor was identified in Typology as being served by a diagram with such a frequency that the author decided it is significant enough to be mentioned in association with the diagram here.

•Volume-Flow Chart - Category II (Diagrams mapping PROPORTION of variables of a Design Factor): Users' Space Need, Function/Relation, Circulation Patterns.

•Link-Node - Category II (Diagrams mapping PROPORTION of variables of a Design Factor) and Category III (Diagrams mapping RELATIONSHIPS among variables of a Design Factor): Users' Functional Needs, Goals/Objectives, Users' Space Need, Function/Relation, Circulation Pattern; Category III: Design Team Organization; Category V (Diagrams mapping SYNTHESIS OF DESIGN CONCEPTS in context of site): Users' Space Need, Function/Relation.

•Matrix - Category II (Diagrams mapping PROPORTION of variables of a Design Factor): Utility Availability, Human Sensory Constraints; Category III (Diagrams mapping RELATIONSHIPS among variables of a Design Factor): Users' Functional Need, Work Scheduling. Category II and Category III: Ecological Constraints, Climatic Constraints.

•Pie Diagram - Category II (Diagrams mapping PROPORTION of variables of a Design Factor): Users' Functional Needs, Topographic Constraints, Ecological Constraints, Climatic Constraints, Project Budget.

•Bubble - Category III (Diagrams mapping RELATIONSHIPS among variables of a Design Factor): Users' Functional Needs, Human Sensory Constraints, Geological Constraints, Topographic Constraints, Ecological Constraints, Users' Space Need, Function/Relation, Circulation Pattern, Materials/Utilities, Image; Category V (Diagrams mapping SYNTHESIS OF

DESIGN CONCEPTS in the context of the site): Users' Space Need, Function/Relation, Circulation Pattern.

• Tree Diagram - Category IV (Diagrams mapping RANK OR SEQUENCE of variables of a Design Factor): Goals/Objectives, Work Scheduling, Design Team Organization.

• Critical-Path Chart - Category IV (Diagrams mapping RANK OR SEQUENCE of variables of a Design Factor): Goals/Objectives, Work Scheduling, Design Team Organization, Function/Relation.

• Schematic Plan - Category V (Diagrams mapping SYNTHESIS OF DESIGN CONCEPTS in context of site): Users' Space Need, Function/Relation, Circulation Pattern, Materials/Utilities, Image.

2.3.3 PROTO-TYPIFICATION OF DIAGRAMS

In each diagram category, assigned diagrams were sub-grouped according to their configurational homogeneity as observed by the author, and a prototype for each of these sub-groups was drawn up (Figure 1).

For ease of discussion of the findings, each prototype is given a name. In order to avoid misconception by the respondents as to the identity of the diagrams, these names were not presented in the questionnaire. To the extent possible, a name that had the least potential of confusing a diagram type with others in presenting the findings in this thesis was chosen.

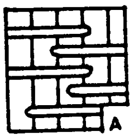
The name Link-Node was chosen for the diagram prototypes II-B and III-B because this name was found to be exclusively used for the diagram prototype, while its other names--such as "bubble"--are used on occasion for other diagram types as well.

The same can be said for Critical-Path Chart, which, while "flow chart" may actually be a name more widely used for the diagram prototype IV-C, is less likely to cause the identity of the prototype to be confused with others such as Tree Diagram or Bar-Chart. For the same reason, the name Fever-Chart is used in this study for the diagram prototype I-D while other names such as "polygon" or "line graph" might also be used. In the cases of 'peculiar' diagrams such as Log-Chart and Radial-Chart that can be seen in graphic publications only, the name given by the author of the particular graphics manual is used for the diagram prototypes I-B and I-E.

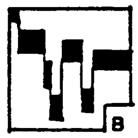
Figure 1 presents the diagram prototypes together with their assigned names, and APPENDIX A gives the pool of distinct diagram forms from which each of them were derived.

• Diagram Category I: Diagrams mapping relationship between TIME and variables of a 'Design Factor'

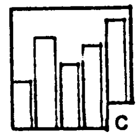
I-A Bar Chart



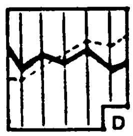
I-B Log-Chart



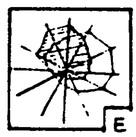
I-C Histogram



I-D Fever Chart

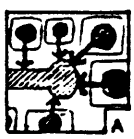


I-E Radial-Chart

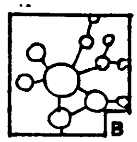


• Diagram Category II: Diagrams mapping PROPORTION of variables of a 'Design Factor'

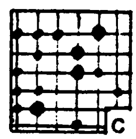
II-A Volume-Flow Chart



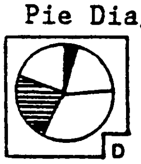
II-B Link-Node



II-C Matrix



II-D Pie Diagram



II-E Histogram

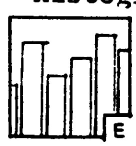
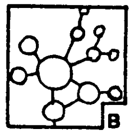


Figure 1. Diagram Prototypes

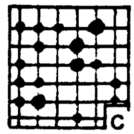
• Diagram Category III: Diagrams mapping RELATIONSHIPS among variables of a 'Design Factor'

III-A Bubble

III-B Link-Node

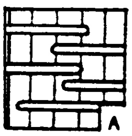


III-C Matrix

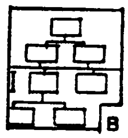


• Diagram Category IV: Diagrams mapping RANK OR SEQUENCE of variables of a 'Design Factor'

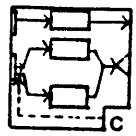
IV-A Bar Chart



IV-B Tree Diagram

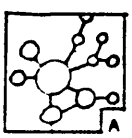


IV-C Critical-Path Chart



• Diagram Category V: Diagrams mapping SYNTHESIS OF DESIGN CONCEPTS in context of site

V-A Link-Node



V-B Bubble

V-C Schematic Plan

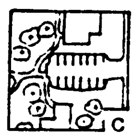


Figure 1. Diagram Prototypes (Continued)

2.4 IMPLEMENTATION OF THE SURVEY

2.4.1 SAMPLING

Landscape architects practicing in private firms were first identified with the aid of In Practice, 1985 edition, and American Society of Landscape Architects Members' Handbook, 1986 edition. The location of their firms was plotted by state, by which the sampling was first stratified. No way of differentiating the firms by their major project type or size was available, so the only method of stratification, other than by location, employed to reflect the firm size was by the number of member-and-higher-level ASLA members in a firm. A name of an ASLA regular member in each of the sampled firms was chosen. In case of a firm that had personal names, one of those names was selected.

The sample of 152 landscape architects was selected randomly, with the use of a random sample table, for it was desired to have a response rate of at least 75 (50 percent), which is judged to be appropriate for an exploratory data analysis such as this study.

2.4.2 DESIGN OF SURVEY QUESTIONNAIRE

The landscape architect to whom the questionnaire was addressed was requested to make his response reflective of his entire firm, to the extent possible. The questionnaire consisted of four independent parts with questions relevant to the study per se, plus a section with questions for the evaluation of the survey results (APPENDIX B). The respondent was asked to select and identify those diagrams being used by his firm with the prototypes in the questionnaire, as the preliminary step before answering questions in any of the Parts.

Basically the questionnaire was formatted to enable two statistical analyses: 'count data' for Part 1, with the purpose of learning what proportion of the total sample uses a certain diagram type for a certain Design Factor; and 'measurement' for Parts 2, 3 and 4, with the purpose of learning to what degree a diagram type is perceived to be effective by the landscape architects who actually use it. In Part 1 the respondents were asked to match the prototypes of the abstract diagrams that were selected in the preliminary step with Design Factors for which the prototypes are used.

In the 'measurement' section of the questionnaire (Parts 2, 3 and 4), to make it easier for the respondents to make evaluations of the diagrams' effectiveness, predetermined scales of effectiveness were provided. Part 2 asked respondents to evaluate the clarity of understanding for the diagrams identified in the preliminary step, by groups of self/landscape architects, other professionals,[7] and his clients, on the scale of 'clear,' 'moderate' and 'unclear'. Part 3 asked respondents to evaluate ease of preparing the diagrams identified, on the scale of 'easy,' 'moderate' and 'difficult'. Part 4 asked the respondent to evaluate the frequency of use for each of the diagrams identified, as

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[7] 'Other Professional' is defined in this study as a design participant other than a client or a future user whose participation in the design process is because of his own professional expertise, such as engineer, technician, business consultant, or contractor.

experienced in the past three years, on the scale of 'usually' (over 90% of total projects), 'often' (50% to 90% of total projects), 'sometimes' (10% to 49% of total projects) and 'seldom' (under 10% of total projects).

At the end of the questionnaire, a section was provided to ask respondents' opinions on the relevancy of the study itself, adequacy of the survey format,[*] any difficulty in filling out the questionnaire, and any suggestions for further research or comments on the issue of abstract diagrams in general.

The questionnaire was formatted in matrix form on a 8 1/2" x 14" paper, after which the original was copied on regular white paper by ordinary copying machine.

2.4.3 SURVEY PROCEDURE AND RESPONSE

In August 13, 1986, the questionnaire was distributed by mail to each landscape architect in the sample. A week after the questionnaire was mailed along with a covering letter and a self-addressed, stamped return-envelope, a first follow-up using postcards was sent to the entire sample, expressing thanks to those who responded and prompting those who

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[*] Actually relatively few of the respondents (28) answered this question, of which 23 were positive about the adequacy of the format (cf. APPENDIX D). The impression is that they did not grasp the meaning of the question well, which was to see how adequate the questionnaire format is in achieving data needed to address the research objectives. Some made comment that this question duplicates the item 5 of Question-4 (cf. Page Four of the questionnaire, APPENDIX B). A few of the respondents substituted an answer with a comment such as: "It is hard to judge; however, it seems that I would have used the same format to do a survey like this, if I were you."

had not. Two weeks after the initial follow-up, the second follow-up was sent to those who had not responded. This time a different covering letter with more emphasis on the importance of the study, with the same questionnaire and a return envelope, was mailed.

Ninety-one of the 152 questionnaires were returned, for a response rate of 60 percent. Sixteen questionnaires were returned with the questions unanswered, with statements either that abstract diagrams are not used in their firm or that the project types they deal with have no use for diagrams. These responses are included in the analysis. Also, two additional responses from two respondents (answered by different persons) are included. Thus, the total of responses put to the final analysis came to 93.[9] Repeated follow-ups, supplemented by long-distance telephone calls at the final phase of the survey procedure, seem to have been the primary reason for the relatively high response rate.

Probably a better way to ensure a high response rate might have been to telephone a list of landscape architects, and ask for their cooperation first. But this method was dropped because of the possibility that the result might be biased--more reflecting the practice of landscape archi-

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[9] The confidence interval for the sample proportions was achieved as .10 at the degree of confidence .95, using the formula

$$E = 1.96 \sqrt{\frac{1}{4n}} \sqrt{\frac{N-n}{N-1}}$$

where E stands for the standard error, n for sample size (93) and N for the size of population (1024). Here The Finite Population Correction Factor $\sqrt{(N-n)/(N-1)}$ is used because the sample constitutes a statistically substantial (more than 5%) proportion of the population at 9%.

tects who were willing to participate on the spot, perhaps in 'frequency of use.'

3.0 CHAPTER THREE: RESULTS AND DISCUSSION

The purpose of this study was to (1) develop a use-pattern profile of abstract diagrams for design communication in the programming process, i.e., to determine which diagram type is used for which design factor by landscape architectural firms; and (2) find out what the landscape architects perceive as to these diagrams' clarity of understanding, ease of preparation, and frequency of use, also identifying any relationship between these perceptions. For effective presentation of the findings from meeting these objectives, this chapter is divided into two sections of "Diagrams and Design Factors" and "Landscape Architects' Perception on Diagrams." Following section is presentation and discussion of the data obtained in meeting the first objective.

3.1 DIAGRAMS AND DESIGN FACTORS

Table 1 presents the pairs of diagrams and Design Factors in descending order of the number of responses (N) and their proportion to the total sample (%). In the Table, for conciseness, only Diagram/Design Factor pairs that show a 10% proportion or more are presented; also, the discussion in this chapter will concentrate on the diagrams as paired with a Design Factor with a proportion of 10% or more. Apparently there is the problem of ambiguity in deciding the level of proportion below which a proportion will be judged 'negligible,' rather than 'meaningful.'

For the study at hand, only proportions over 10% (of total respondents)--the Arithmetic Mean of all proportions--will be included. This division seems justified in view of the fact that there is a considerable gap between the proportion of 10% (Arithmetic Mean of the proportions) and that of 5%, which is the first proportion smaller than 10%: there is no diagram/Design Factor pair that has a proportion between 10% and 5%--i.e., the respondents' agreement on which diagram would (or should) be used for which Design Factor lags once the agreement becomes a proportion less than 10%.

For these reasons, any discussion of 'high' or 'low' proportion in this study is mainly for illustrative purposes--these terms are relative, derived from the collective observation of the proportions for all of the diagram/Design Factor pairs. From Table 1, it can be seen that there is no significant preponderance in proportion ranking between diagrams paired to Design Factors of Program stage and diagrams paired to those of Analysis stage; however, two distinct patterns can be observed regarding the relationship between Diagram Categories and programming stages. First, there are few diagrams of Diagram Category I paired to Design Factors of the Analysis stage that show a proportion of 10% or more. This fact suggests that in relatively few instances are diagrams used for analysis, evaluation and organization of information in a temporal context. The possibility of any diagram--singularly for the Analysis stage in temporal context--other than those presented in this survey existing is possible but unlikely, considering the lack of any substantial number of 'free response' diagrams in Diagram Category I matched with Design Factors in the Analysis stage.

Second, there are extremely few diagrams in Category V ('Design Synthesis') matched with Design Factors in the Program stage that show a proportion of 10% or more. Beside these two patterns, it is interesting to observe that there are few standard-form diagrams (diagrams of which the form is rather fixed, and not much subject to the user's free-hand manipulation--such as Bar-Chart, Log-Chart, Histogram, Fever-Chart, Matrix, Tree Diagram, and Critical-Path Chart) that serve as Design Factors of the Analysis stage at a proportion of 10% or more. This pattern underlines the value of 'manipulability' of diagrams in the analysis, evaluation, and organization of information in the Analysis stage. However, the fact that these diagrams are used, although minimally, in the Analysis stage shows that there is more versatility in diagrammatic communication of information in programming than might be expected.

On the other hand, there is no significant pattern that diagrams in a particular Diagram Category rank high in proportion. Some concentration of diagrams in Category III among those ranking relatively high (down to 30% proportion) is observed, but it should be noted that this Category relies for its relatively high ranking on one diagram type Bubble, and the other diagram types in Category I are not particularly concentrated in the high rank range.

From the top down to the range of 20% proportion, very often the same Design Factor is served by identical diagrams (each belonging to a different category) at the same or a close proportion level.

This pattern of identical diagrams (of different category) serving a same Design Factor with a proportion the same or close to each other's, can be observed for all of the diagrams belonging to multiple categories, with varying degrees in terms of the number of mutual Design Factors for each. The number descends in order of Bubble (8, Categories III and V), Histogram (6, Categories I and II) and Matrix (6, Categories II and III), Bar-Chart (5, Categories I and IV), Link-Node (3, Categories II and III), and Link-Node (3, Categories II, III and V).

At this point it seems necessary to discern the intent of landscape architects--i.e., whether these identical diagrams are used as separate diagrams or as one diagram serving the specific Design Factor. To do so, it proves helpful to check to what degree the dual-function diagrams--those the function of which was 'divided' into two Categories to serve a Design Factor--identified in the Typology show similar proportions in the two Categories for the same Design Factor: for all of these Design Factors, there is an apparent closeness between the two proportions, which are also 'high' ones. This concurrence is meaningful for it enables us to conclude that, depending on the specific Design Factor, these diagrams are used for multiple of functions simultaneously. Observations on this point for individual diagrams, concerning the exceptions and particulars of this concurrence, are made in Chapter Four: Diagrams Revisited. Subsequent discussions will be made in line with the judgment that identical diagrams showing the same or close proportions for the same Design Factor in concurrence with the finding of Typology, are used as one diagram in the communication of that Design Factor by the landscape architects.

Overall, this concurrence between the diagram use-pattern as a by-product of the Typology procedure and that derived from the aggregation of the survey data enables two observations. First, the purpose of the identical diagrams as a validity check served well, in proving the

Typology procedure's own external validity (cf. Section 3 of Chapter Two: Methodology). Second, it is observed that the closeness of proportions between identical diagrams in different categories serving the same Design Factor, becomes more apparent as the proportions get high: this tendency is strongly suggestive of a diagram's having more chance for choice by a designer when it can do multiple functions simultaneously, depending on the specific Design Factor it communicates.

If the Design Factors of Users' Functional Needs, Users' Space Need and Function/Relation are considered of a kind in that they all directly relate to making a design product's function meet the user's need itself--though this is not to be a strict categorization in this study--these user-need basis Design Factors are concentrated in the relatively high proportion range, accounting for approximately 40% of diagrams with a proportion of 20% or more. Even when duplication of diagrams is controlled for, i.e. when identical diagrams in different Categories (communicating the mutual Design Factor which is judged to be served by these functional categories simultaneously) are considered as one, they account for one third of diagrams with a 20% proportion or more. Bubble and Link-Node are akin in the sense that these two diagram types, regardless of the category, account for the majority of these user-need basis Design Factors that rank relatively high (20%). Following are observations made for individual Design Factors in the study.

▪Goals/Objectives

Diagrams in the Category IV ('Diagrams mapping RANK OR SEQUENCE of variables of a Design Factor') were the two highest for this Design Factor: IV-C Critical-Path Chart (proportion 37%) and IV-B Tree Diagram (proportion 30%). It is clear that verification of the Goals/Objectives in sequental order is the major reason for its diagramming in the programming process. One interesting observation can be made by comparing the proportions of I-A Bar-Chart (25%) and IV-A Bar-Chart (12%) among other diagrams which communicate this Design Factor. Though they are identical in form, the I-A Bar-Chart that maps the relationship of 'time' to the variables of Goals/Objectives shows considerably higher proportion than the IV-A Bar-Chart that maps 'rank or sequence' of the variables of Goals/Objectives, with seven other diagrams serving the same Goals/Objectives between them. This result is unusual since it would be reasonable to expect the IV-A Bar-Chart to rank as high as the I-A Bar-Chart in serving the Design Factor, in that it belongs to Diagram Category IV (to which the two highest ranking diagrams for the Design Factor Goals/Objectives belong); the implication of this difference is that Bar-Chart is used when the diagramming of a sequence specifically in a 'temporal' context (time) is needed for the communication of the Goals/Objectives.

▪Users' Functional Needs

Bubble, of both categories III and V, shows the highest and the second highest proportions (51% and 41%) for Users' Functional Needs. Also, Link-Node in all the categories it belongs to (Categories II, III and V) ranks high (30%, 30% and 26% respectively) for this Design Factor. It is interesting that this Design Factor is the only one among those in the Program stage for which all of the diagrams in Category V ('Design

Synthesis')--Bubble, Link-Node and Schematic Plan--show proportions of 10% or more, which are also relatively high proportions(41%, 26% and 19%). This pattern implies that the facts gathered concerning Users' Functional Needs are not only used as 'raw data' to be analysed, evaluated, and organized in the Analysis stage, but are also utilized in their 'raw' form in the design synthesis along with the concepts derived in the Analysis stage. This again speaks for the importance of consideration of user-need in the diagrammatic design synthesis, which has also been backed by the pattern that diagrams serving the user-need basis Design Factors account for about 40% of diagrams with a proportion of 20% or more.

▪Human Sensory Constraints

As for Users' Functional Need, which is the other of the two qualitative facts to be gathered in the Program stage, Human Sensory Constraints has III-A Bubble as its highest ranking diagram (proportion 28%). The difference of this Design Factor from Users' Functional Need, and also from all of other Design Factors that have III-A Bubble as the highest or second highest ranking diagram (Users' Functional Need, all of site-fact related Design Factors, all of Design Factors in the Analysis stage), is that III-A Bubble is not matched by V-B Bubble with an equal or close proportion. Bubble of Category V ('Design Synthesis') serving Human Sensory Constraints shows an extremely low proportion of 5%. This finding suggests that, while diagramming of Human Sensory Constraint is actually not unknown to firms, its priority in eventual design synthesis may be low. Also, there are relatively few diagram types with a proportion of 10% or more that serve this Design Factor (6 in all), and the proportion for each, other than Bubble, is singularly low, the proportion of the second highest ranking diagram (II-C Matrix) being 13%.

▪Geological, Topographic, Ecological and Climatic Constraints

For the pattern of diagram ranking for each of these Constraints to be effectively understood, the similarity between their patterns demands that they be discussed as a unit. They are common in that all relate to the site--and that 'physically' except for Climatic Constraints--and all show the pattern of having the proportion of III-A Bubble rank first and V-B Bubble rank second (Geological 38% and 27%, Topographic 38% and 29%, Ecological 33% and 24%, Climatic 26% and 19%). The pattern shown by all these site-related facts (Design Factors), that of Bubble of Category V ('Design Synthesis') having a relatively high proportion (approximately 20% or more), implies that, as in the case of Users' Functional Needs, these facts are used in design synthesis in the form of 'raw data' as well. However, interestingly enough, the other diagrams in Category V (Link-Node and Schematic Plan) do not show any proportion higher than 10% for these Design Factors: it seems that the use in the design synthesis of these facts as 'raw data' is rather confined to the diagramming with Bubble. On the other hand, the pattern in which Bubble of Category III ('relationships') ranks the highest for all of these site-related Design Factors suggests the importance of the registration of 'relationship' between their variables in the fact-finding process of the Program stage.

A similar pattern for these four site-related Design Factors is also shown in that, for each of them, both Matrix of Categories II and III, and Histogram of Categories I and II (with exception of Climatic Constraints) show proportions more than 10%, and the difference of the proportions between the two categories for the same diagram is none or extremely small. This pattern suggests that firms use Matrix for simultaneous mapping of 'proportion' and 'relationships' of variables of the site-related facts; and Histogram for simultaneous mapping of 'proportion' of variables of site-related facts in a temporal ('time') sequence. For Matrix this pattern concurs with Typology, partially in that only Ecological Constraints and Climatic Constraints were identified to be served by Matrix with a dual function in Typology. Also for Histogram, this finding concurs with the pattern identified in Typology, with the exception of Climatic Constraints, for which Histogram of Category I ('time') shows a low proportion of 5% while Histogram of Category II ('proportion') shows a 12% proportion. This is the only case in which the use-pattern of the diagram as identified in the Typology differs from the one that the data obtained in the survey shows. Based on the data from the survey, it is judged that Climatic Constraints are not widely diagrammed in a temporal context, contrary to what might be assumed; even other diagrams of Diagram Category I (Fever-Chart and Radial-Chart) that serve this Design Factor show an equally low proportion of 13%.

Also important to note here is the common presence of Pie Diagram (in Diagram Category II 'diagrams mapping proportion of variables of a Design Factor') with a proportion more than 10% for all of these site-related "Design Factors'. Considering that Histogram and Matrix mainly serve a dual function for these Design Factors, the role of Pie Diagram for singular mapping of 'proportion' of these site-related Design Factors' variables can be surmised.

▪Project Budget

Project Budget is the only Design Factor for which Pie Diagram of Category II (Diagrams mapping proportion of variables of a Design Factor) ranks the highest (proportion 40%). For this Design Factor, Histogram of Category I (32%) and Category II (23%), and Bar-Chart of Category I (24%) and Category IV (20%) rank with proportions 20% or more.

Relatively high proportions of these identical diagrams are in line with the result of Typology in which it was identified that Histogram is mainly used for the timing of budget proportions and Bar-Chart for the phasing of the budgetary allocation for each of the design activities.

▪Legal Constraints

The uniqueness of this Design Factor is that Bar-Chart of both Categories I and IV ranks at the top with the equal proportion of 22%. The diagramming of Legal Constraints to map the sequence of their variables, and that in temporal context, with the use of Bar-Chart is obvious. Also for this Design Factor, Link-Node of Categories III and II ranks at the same proportion (12%). For Legal Constraints, however not widely as the low proportions indicate, Link-Node is used for the function of mapping 'proportion' and 'relationships' of variables of the Design Factor simultaneously.

▪Utility Availability

For only this Design Factor Matrix (Category II 'Diagrams mapping proportion of variable of a Design Factor') ranks the highest with a proportion of 16%. The generally low proportion of the diagrams mapping this Design Factor, including that of Matrix which has the lowest proportion as a top ranking diagram for any Design Factor, shows the limitation of the extent to which firms do diagramming for this Design Factor. Again for this Design Factor, Bar-Chart of both Categories I and IV ranks at the same proportion (11%), implying the use for Legal Constraints of Bar-Chart for the simultaneous function of mapping the sequence of its variables in a temporal context.

▪Work Scheduling

It can be seen that this Design Factor has a special use for Bar-Chart of both Categories I (62%) and IV (37%). This Design Factors top ranking diagram I-A Bar-Chart is second highest in overall proportion ranking. The similarly high proportion (44%) of IV-C Critical-Path Chart, ranking next to I-A Bar-Chart, speaks for the relatively wide extent of this Design Factors diagramming with the use of Bar-Chart and Critical-Path Chart. One interesting finding is the similarity of the diagram-ranking pattern between Work Scheduling and Legal Constraints(cf. Table 1). Though the findings of this study are unable to conclusively account for this, perhaps an investigation into this similarity may be incorporated into future micro-level studies on individual diagram types.

▪Design Team Organization

This Design Factor's top ranking diagram, IV-B Tree Diagram, has the highest overall proportion (68%). The consistently high proportions for all of its ranking diagrams, along with the fact that this Design Factor is one of those having the fewest diagrams with a proportion of 10% or more, show that this Design Factor is the one that respondents had the strongest agreement on which diagrams would (or should) be used for its diagramming.

It is interesting to observe that the two top-ranking diagrams overall both serve Design Factors that are more administrative than related to design per se. This fact, along with the relatively low Frequency of Use for individual diagrams, which will be discussed in following sections, speaks for the limited extent to which designers employ diagrams in the programming process.

▪Design Factors in the Analysis Stage

These Design Factors are discussed here as a unit because the results show several particular similarities between their diagram ranking patterns, which also distinguish them from other Design Factors in the Program stage. The first of these similarities is that, for all of these Design Factors in the Analysis stage, diagrams in Category V ('Design Synthesis') rank the highest: V-B Bubble scores the highest for Users' Space Need (42%), for Function/Relation (51%), and for Circulation Pattern (58%); V-C Schematic Plan is the highest ranking diagram for Materials/Utilities (28%) and for Image (42%), as well as the third highest for Users' Space need (30%), for Function/Relation (40%) and for Circulation Patterns (37%).

This pattern that the diagrams in Category V conspicuously rank high for all of these Analysis-stage Design Factors proves that the concepts for these Design Factors, derived as the result of the Analysis stage, are what the design synthesis (for which the diagrams in Category V are) does 'synthesize'. This proof is valuable since it again speaks for the validity of the definition of the programming process for the study at hand (cf. Section 2 of Chapter Two: Methodology)--and also for the design of the questionnaire which was formatted according to this definition.

The second of the similarities is that Bubble of Category III ('relationship') consistently ranks high for all of these Design Factors, being the second ranking diagram for the Design Factors of Users' Space Need (40%), Circulation Patterns (56%), Materials/utilities (19%) and Image (27%), and being the top ranking diagram for Function/Relation with the same proportion (51%) as V-B Bubble. This second similarity seems to mean that the operations in the Analysis stage of analysis, evaluation, and organization of facts found in the Program stage, are mainly concentrated on the operations of analysis, evaluation, and organization of 'relationships' of the components of a fact. The conspicuously low proportions of other diagrams in Category III than III-A Bubble implies that these Analysis operations are mainly confined to ones with the use of Bubble.

It is interesting to observe that, notwithstanding these similarities, Design Factors of Users' Space Need, Function/Relation, and Circulation Pattern can be differentiated from Materials/Utilities and Image for a number of reasons.

Materials/Utilities and Image show a high resemblance in their diagram ranking patterns which does not apply to the other Design Factors in the Analysis stage: These two have V-C Schematic Plan ranking highest (28% and 42%), with Bubble of both Categories III and V immediately following each Schematic Plan. There are extremely small number of diagrams with a proportion of 10% or more for each of these two Design Factors (Materials/Utilities 3, Image 4). These patterns need to be considered together with the absence of any other diagrams of Category V among these diagrams with a proportion of 10% or more and the fact that these two Design Factors top ranking diagram (V-C Schematic Plan) is a highly representative one belonging one step closer to design development than to design synthesis (if these two processes are to be strictly separated); they imply that the development of concepts for these two 'Design Factors' is not widely served by a diagram on its own in the Analysis stage, before they are synthesized to other concepts concomitantly in the design synthesis with the use of Schematic Plan.

This point is further backed by the two findings that: Link-Node of Category V ('diagrams mapping SYNTHESIS OF DESIGN CONCEPTS in the context of the site'), which show minimal proportions for Circulation Patterns (5%) and Image (4%), rank with proportions more than 20% for the Design Factors of Users' Space Need (25%), Function/Relation (22%) and Circulation Patterns (20%); Bubble of Category V also shows minimal proportions for Materials/Utilities (5%) and Image (5%), while it serves as top ranking diagrams for other Design Factors in the Analysis stage. Since it is reasonable to think that in diagramming of design synthesis the concepts developed for the Design Factors in the Analysis stage are 'synthesized' in the design synthesis process collectively, the conspicuous alienation of concepts of Materials/Utilities and Image, from the design synthesis through the use of Link-Node and Bubble, speaks for the limited extent to which Materials/Utilities and Image are diagrammed in the Analysis stage.

At this point it seems important to note the similarity and the difference between V-A Link-Node and V-B Bubble in doing the function of design synthesis. It has already been noted that both V-A Link-Node and V-B Bubble synthesize the Design Factors from the Analysis stage excluding Utilities/Materials and Image (while V-C Schematic Plan includes these two in the synthesis); it also needs to be noted that both of these diagrams in Category V incorporate the 'raw' facts of Users' Functional Needs gathered in the Program stage directly into the design synthesis. In the sense of these similarities, besides the finding that these diagrams account for the majority of diagrams with a proportion of 20% or more that communicate user-need basis 'Design factors,' V-B Link-Node and V-B Bubble are especially akin as diagrams used for the purpose of design synthesis.

On the other hand, as has been noted in the discussion for the site-related Design Factors in the Program stage, the design synthesis with the use of V-B Bubble incorporates the facts of these site-related Design Factors in their 'raw' form (i.e. which did not go through the Analysis stage) as well, while V-A Link-Node does not. This disparity between the two diagrams shows the limited versatility that Link-Node has compared to Bubble, perhaps resulting from the more basic structural form it has. In the same sense, it could be said V-B Bubble or V-A Link-Node is less close to design development than is V-C Schematic Plan, since the latter synthesizes the concepts of Materials/Utility and Image as well, while the former two are not concerned with these less conspicuous concepts.

Interestingly enough, II-A Volume-Flow Chart, while seldom among diagrams with a proportion of 10% or more for Design Factors in the Program stage, shows a comparatively high proportion for User's Space Need (23%), Function/Relation (32%) and Circulation Pattern (20%). The fact that this diagram type is a rather free-form one, considered together with the pattern that all of high ranking diagrams for Design Factors in the Analysis stage are also free-form, implies the importance of manipulability for the user in the diagrammatic operations of the Analysis stage. However, this observation may only be inferential since it is not known which diagrams the respondents judged to be of 'standard' form and which to be of 'free' form.

Table 1. Diagrams/Design Factors--Number of Responses (Proportion)

DIAGRAM	DESIGN FACTOR	N(%)
IV-B Tree Diagram	Design Team Organization	63(68)
I-A Bar Chart	Work Scheduling	58(62)
V-B Bubble	Circulation Patterns	54(58)
III-A Bubble	Circulation Patterns	52(56)
III-A Bubble	Users' Functional Needs	47(51)
III-A Bubble	Function-Relation	47(51)
V-B Bubble	Function-Relation	47(51)
IV-C Critical-Path Chart	Work Scheduling	41(44)
III-A Bubble	Users' Space Need	39(42)
V-C Schematic Plan	Image	39(42)
V-B Bubble	Users' Functional Needs	38(41)
II-D Pie Diagram	Project Budget	37(40)
V-B Bubble	Users' Space Need	37(40)
V-C Schematic Plan	Function-Relation	37(40)
III-A Bubble	Geological Constraints	35(38)
III-A Bubble	Topographic Constraints	35(38)
IV-A Bar Chart	Work Scheduling	34(37)
IV-C Critical-Path Chart	Goals-Objectives	34(37)
V-C Schematic Plan	Circulation Patterns	34(37)
II-A Volume-Flow Chart	Function-Relation	32(34)
III-A Bubble	Ecological Constraints	31(33)
III-B Link-Node	Function-Relation	31(33)
I-C Histogram	Project Budget	30(32)
II-B Link-Node	Users' Functional Needs	30(32)
III-B Link-Node	Users' Functional Needs	30(32)
I-A Bar Chart	Design Team Organization	29(31)
II-B Link-Node	Function-Relation	29(31)
IV-B Tree Diagram	Goals-Objectives	28(30)
IV-C Critical-Path Chart	Function-Relation	28(30)
V-C Schematic Plan	Users' Space Need	28(30)
III-B Link-Node	Design Team Organization	27(29)
III-B Link-Node	Users' Space Need	27(29)
V-B Bubble	Topographic Constraints	27(29)
II-A Volume-Flow Chart	Users' Functional Needs	26(28)
III-A Bubble	Human Sensory Constraints	26(28)
V-A Link-Node	Users' Functional Needs	26(28)
V-C Schematic Plan	Materials-Utilities	26(28)
I-D Fever-Chart	Project Budget	25(27)
III-A Bubble	Image	25(27)
IV-C Critical-Path Chart	Design Team Organization	25(27)
V-B Bubble	Geological Constraints	25(27)
III-A Bubble	Climatic Constraints	24(26)
I-A Bar Chart	Goals-Objectives	23(25)
II-A Volume-Flow Chart	Users' Space Need	23(25)
V-A Link-Node	Users' Space Need	23(25)

Table 2. Diagrams/Design Factors--Number of Responses (Proportions) (Continued)

DIAGRAM	DESIGN FACTOR	N(%)
I-A Bar Chart	Project Budget	22(24)
II-B Link-Node	Users' Space Need	22(24)
II-D Pie Diagram	Users' Space Need	22(24)
II-E Histogram	Work Scheduling	22(24)
V-B Bubble	Ecological Constraints	22(24)
II-E Histogram	Project Budget	21(23)
I-A Bar Chart	Legal Regulations	20(22)
II-A Volume-Flow Chart	Circulation Patterns	20(22)
II-B Link-Node	Circulation Patterns	20(22)
II-D Pie Diagram	Users' Functional Needs	20(22)
IV-A Bar Chart	Legal Regulations	20(22)
V-A Link-Node	Function-Relation	20(22)
IV-A Bar Chart	Project Budget	19(20)
II-A Volume-Flow Chart	Goals-Objectives	18(19)
III-A Bubble	Materials-Utilities	18(19)
III-C Matrix	Ecological Constraints	18(19)
V-B Bubble	Climatic Constraints	18(19)
V-C Schematic Plan	Users' Functional Needs	18(19)
IV-C Critical-Path Chart	Legal Regulations	17(18)
I-D Fever-Chart	Goals-Objectives	16(17)
III-B Link-Node	Goals-Objectives	16(17)
III-C Matrix	Geological Constraints	16(17)
II-C Matrix	Ecological Constraints	15(16)
II-C Matrix	Utility Availability	15(16)
II-D Pie Diagram	Climatic Constraints	15(16)
III-B Link-Node	Utility Availability	15(16)
IV-B Tree Diagram	Work Scheduling	15(16)
II-B Link-Node	Goals-Objectives	14(15)
II-C Matrix	Climatic Constraints	14(15)
II-D Pie Diagram	Topographic Constraints	14(15)
III-A Bubble	Goals-Objectives	14(15)
III-C Matrix	Function-Relation	14(15)
IV-B Tree Diagram	Users' Functional Needs	14(15)
IV-B Tree Diagram	Users' Space Need	14(15)
IV-C Critical-Path Chart	Users' Functional Needs	14(15)
I-C Histogram	Ecological Constraints	13(14)
I-C Histogram	Users' Space Need	13(14)
II-C Matrix	Human Sensory Constraints	13(14)
III-C Matrix	Climatic Constraints	13(14)
III-C Matrix	Work Scheduling	13(14)
IV-B Tree Diagram	Function-Relation	13(14)
IV-C Critical-Path Chart	Circulation Patterns	13(14)
I-B Log-Chart"	Users' Functional Needs	12(13)
I-C Histogram	Goals-Objectives	12(13)
I-D Fever-Chart	Climatic Constraints	12(13)

Table 3. Diagrams/Design Factors--Number of Responses (Proportions)

(Continued)

DIAGRAM	DESIGN FACTOR	N(%)
I-E Radial-Chart	Climatic Constraints	12(13)
II-C Matrix	Topographic Constraints	12(13)
II-D Pie Diagram	Human Sensory Constraints	12(13)
II-D Pie Diagram	Geological Constraints	12(13)
II-E Histogram	Human Sensory Constraints	12(13)
II-E Histogram	Climatic Constraints	12(13)
III-A Bubble	Utility Availability	12(13)
III-B Link-Node	Circulation Patterns	12(13)
III-C Matrix	Human Sensory Constraints	12(13)
III-C Matrix	Topographic Constraints	12(13)
IV-C Critical-Path Chart	Users' Space Need	12(13)
I-C Histogram	Users' Functional Needs	11(12)
I-C Histogram	Geological Constraints	11(12)
II-C Matrix	Goals-Objectives	11(12)
II-C Pie Diagram	Geological Constraints	11(12)
II-E Histogram	Ecological Constraints	11(12)
III-B Link-Node	Legal Regulations	11(12)
III-B Link-Node	Materials-Utilities	11(12)
IV-A Bar Chart	Goals-Objectives	11(12)
IV-B Tree Diagram	Legal Regulations	11(12)
IV-C Critical-Path Chart	Human Sensory Constraints	11(12)
I-A Bar Chart	Utility Availability	10(11)
I-A Bar Chart	Function-Relation	10(11)
I-B Log-Chart	Work Scheduling	10(11)
II-B Link-Node	Legal Regulations	10(11)
II-C Matrix	Users' Functional Needs	10(11)
II-D Pie Diagram	Ecological Constraints	10(11)
II-E Histogram	Utility Availability	10(11)
III-B Link-Node	Work Scheduling	10(11)
III-B Link-Node	Image	10(11)
III-C Matrix	Users' Functional Needs	10(11)
IV-A Bar Chart	Utility Availability	10(11)
IV-B Tree Diagram	Human Sensory Constraints	10(11)
IV-C Critical-Path Chart	Geological Constraints	10(11)
IV-C Critical-Path Chart	Ecological Constraints	10(11)
IV-C Critical-Path Chart	Climatic Constraints	10(11)
I-C Histogram	Topographic Constraints	9(10)
I-D Fever-Chart	Utility Availability	9(10)
II-A Volume-Flow Chart	Human Sensory Constraints	9(10)
II-A Volume-Flow Chart	Utility Availability	9(10)
II-B Link-Node	Materials-Utilities	9(10)
II-E Histogram	Geological Constraints	9(10)
II-E Histogram	Topographic Constraints	9(10)
II-E Histogram	Users' Space Need	9(10)
III-C Matrix	Project Budget	9(10)

3.2 LANDSCAPE ARCHITECTS' PERCEPTIONS ON DIAGRAMS

3.2.1 INTRODUCTION

For the analysis, each of the ordinal scales in Parts 2, 3 and 4 of the questionnaire was assigned a number, adopting the following procedure suggested by Cureton (1965): for Parts 2 and 3, the lowest rank ('Unclear' and 'Difficult') was assigned the lowest number of 1, and each successively higher rank was assigned the next higher number: 'moderate' 2, and 'clear' and 'easy' 3. For Part 4, number 0 was assigned to 'non-use' for its apparent advantage in making observation; successively, 1 was assigned to 'seldom', 2 to 'sometimes,' 3 to 'often,' and 4 to 'usually'.

Means for each of the Diagrams, for each of the topics, are computed and presented in a Table pertaining to each of the topics. To observe the average of means, accounting for the relative importance(weight) of each diagram, the Overall Mean for each Part was computed with the use of formula

$$\bar{x}_o = \frac{\sum n \cdot \bar{x}}{\sum n}$$

where $\sum n\bar{x}$ stands for the sum of the products obtained by multiplying each $\bar{x}$(mean for each diagram) by the corresponding weight n (sample size for a diagram), and $\sum n$ the sum of the weights (sum of all sample sizes).[10]

[10] Sample size here is the number of Landscape Architects who actually use a certain diagram.

To see whether the differences of mean scores are statistically significant, i.e. whether the difference of means actually reflect the difference in the population and is not by chance, ANOVA (Analysis of Variance) was done using the formula for F value for unequal numbers (sample sizes for diagrams)

$$\frac{\sum^{k}(n_j - 1)\sum^{k}_{j}[n_j(\bar{X}_j - \bar{X})^2]}{(k-1)\sum^{k}\sum^{n}[(X_{ij} - \bar{X}_j)^2]}$$

where n_j stands for the size of jth sample (number of responses for a diagram), k for the number of samples (number of diagrams), $\bar{X}_j$ the mean of jth sample (mean for a diagram), $\bar{X}$ for the Grand Mean of all the data (mean computed regardless of diagram type), and X_{ij} for the ith observation (a value) of the jth sample (a diagram). The attained F-value was compared to the value of F0.05 (at the level of significance $\alpha = 0.05$) to see whether it exceeds the latter so that the null hypothesis (i.e. population means are the same and the difference is by chance) can be rejected.

On more specific level, to decide whether a difference between 'two' sample means can be attributed to chance or not, the Test of Significance was done by finding the z-statistic (number of the standard error of the difference between two means) using the formula

$$z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where $\bar{x}$ stands for mean of a sample (mean for a diagram), s for sample standard deviation (standard deviation of the mean for a diagram), and n for the sample size (number of responses for a diagram).

The obtained value was compared with z=1.96 of the standard normal distribution at the level of significance $\alpha=0.05$.[11] If the obtained z value exceeds $z_{0.05}=1.96$, then the difference is judged to be significant. This test was done for all the possible pairs of means between the groups (Self/Landscape Architects, Other Professionals and Clients) of questionnaire Part 2 ('Clarity of Understanding'); and between identical diagrams of Part 2, 3 ('Ease of Preparation') and 4 ('Frequency of Use') to detect any significant difference by the Diagram Category.

To measure the degrees of association between the ordinal scales of Parts 2, 3 and 4, Goodman and Kruskal's Coefficient (Gamma, γ) was computed for each diagram using the formula

$$G = \frac{f_a - f_i}{f_a + f_i}$$

where f_a stands for the frequency of agreements (e.g. between the values of Part 2 for a diagram and those of Part 3 for the same diagram) and f_i for the frequency of inversions.

If a significant association was shown by an attained value (i.e. if $|\gamma| - 2\times ASE > 0$, at the Level of Significance $\alpha=0.05$), then its magnitude was observed in relation to perfect agreement (+1), perfect inversion (-1), and no association (0).[12]

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[11] All of sample sizes (number of responses for a diagram) are not less than 30 and thus the obtained z value is approximated to have the standard normal distribution.

[12] ASE is the Asymptotic Standard Error ($\gamma - 2\times ASE <$ population Gamma $(\Gamma) < \gamma + 2\times ASE$).

3.2.2 ON 'CLARITY OF UNDERSTANDING'

The ANOVA test showed a significant difference in clarity of understanding by diagram type, for all of the groups (Self/Landscape Architects, Other Professionals, and Clients). However, the z-statistic Test of Significance showed no significant difference between the mean scores of identical diagrams, for all of the three groups: this absence of any significant difference by Diagram Category indicates that how clearly a diagram is understood per se is not affected by the Diagram Category (as defined in this study) to which the diagram belongs--i.e., what kind of function the diagram does.

Table 4 shows clarity of understanding by Self/Landscape Architects, in the descending order of mean score for each diagram. Note should be taken of the fact that the highest ranking diagram for Self/Landscape Architects Schematic Plan is a diagram type indigenous to the profession, while Pie Diagram, the highest ranking diagram for Other Professionals and Clients (cf. Tables 5 and 6), is not. Not only these top ranking diagrams, but most of other diagram types, when compared individually by their ranking between groups, show that the highly profession- indigenous diagram types such as Bubble, Volume-Flow Chart and Link-Node rank consistently higher for Self/Landscape Architects than for Other Professionals and Clients. It is interesting to observe that, concerning these profession-indigenous diagrams, Other Professionals' means do not consistently rank higher than Clients'.

These observations enable two conclusions: first, since this difference between profession-indigenous diagrams and 'common' diagrams may be accounted for by the different amounts of the user's exposure to them--i.e. how familiar or experienced with a diagram he is--rather than by personal intelligence, it underlines the possibility that 'familiarity' with a diagram type plays an important role in its clear comprehension; second, Landscape Architects think that those diagrams well understood by themselves are not understood by Other Professionals at the same level as theirs, and they think there is not much difference between Other Professionals and their Clients concerning which diagram types are well understood.

The Overall Mean was highest for Self/Landscape Architects (2.67) and dropped in order of Other Professionals (2.35) and Clients (2.15). They consider themselves to understand diagrams, in average, between 'highly' clearly (3.00) and 'moderately' clearly (2.00)--more on the side of 'highly'. It is noticed that the top-ranking diagram for Self/Landscape Architects (V-C Schematic Plan) has the mean score of 3.00 and the Standard Deviation of 0.00: there was an absolute agreement among the respondents that this diagram type is understood 'highly' clearly by themselves.

Table 5 presents what the Landscape Architects think the level of understanding for Other Professionals to be, in descending order of mean score for each diagram. The Weighted Total Mean score of 2.35, higher than that of Clients but lower than Self/Landscape Architects, indicates what Landscape Architects think: Other Professionals actually understand better than lay people (Clients), but their average level of understanding still does not equal that of Landscape Architects.

Table 6 shows what the Landscape Architects perceive their Clients' level of understanding to be. Here, as already stated, 'common' types of diagrams score high. As might be expected, V-C Schematic Plan also ranks high (mean 2.53): it is not surprising that their clients easily understand highly representative graphics as this, i.e. which is for them "what is seen is what is." Related to this finding is a particular comment by a respondent:

> The relationship between the intent and the perception of diagrams, between Landscape Architects and clients, is very important. Most Landscape Architects are visually oriented and tend to forget that much of the public is not. This firm tends to emphasize representational rather than abstract graphics as a means to minimize client misinterpretation.

It would be meaningful to prove, in a future study, the extent to which representative or abstract graphics are used for communication with clients by the firms.

The Overall Mean for clients was the lowest; however, the score of 2.10 shows that Landscape Architects consider their clients to understand diagrams at least 'moderately' well on average.

Table 7 presents the diagram types for which any significant difference between groups in clarity of understanding was found. It can be seen that for about 50% of the diagrams surveyed (11 out of 19) any significant difference exists, either between Self/Landscape Architects and Other Professionals, or between Other Professionals and Clients.

In a sense the group of Self/Landscape Architects can be considered better 'professionalized' than Other Professionals, and Other Professionals better than Clients; all of the significant differences are common in that a more professional group shows a higher mean score than the other. Also, for all of these diagrams, a group's level of comprehension showing a significant difference from a group less-professionalized does not show any significant difference from that of a group more-professionalized--e.g. a significant difference shown between Self/Landscape Architects and Other Professionals is not shown between Other Professionals and Clients.

Also, except for the Histogram, all of the diagrams showing any difference among user groups are profession-indigenous diagrams, to different degrees. These patterns again underscore the possibility that a user's 'familiarity' with the diagram type plays an important role in his clear understanding.

Somewhat unexpectedly, from Table 7 it can be seen that, for a substantial proportion of diagrams that show any significant difference between groups (7 out of 11), Landscape Architects do not think Other Professionals' level of clear understanding equals their own. Actually, for few diagrams they think Other Professionals are as good enough in this regard as themselves to be different from Clients; also, those diagrams showing higher level of understanding for Self/Landscape Architects than for Other Professionals (Other Professionals' level being the same with that of Clients) are mostly profession-indigenous diagrams. When considered collectively with the importance of 'familiarity,' these findings hint at the limited extent to which diagrams are used for the communication with Other Professionals.

Also, it can be seen that there is no particular preponderance between the number of 'common' diagrams and that of profession-indigenous diagrams in showing significant difference by group.

3.2.3 ON 'EASE OF PREPARATION'

Table 8 presents the ease of preparation in descending order of mean score for each diagram. As might be expected, the simpler forms of diagrams (Histogram, Pie Diagram and Fever-Chart) score high. The Overall Mean was 2.43, which means that landscape architects think the general ease of prepation is about between 'easy' (3.00) and 'moderate' (2.00); even the lowest ranking diagram (II-C Matrix) shows the mean score of 1.85, which is closer to 'moderate' (2.00) than to 'difficult' (1.00). The z-statistic Test of Significance showed that only for Link-Node is the difference between identical diagrams significant (Table 9). Since this case is too isolated to allow any general observation, a future micro-level study better suited for concentrating on specific types of diagrams might explain this peculiarity.

3.2.4 ON 'FREQUENCY OF USE'

The ANOVA test showed that there is significant difference in frequency of use by diagram type (Table 10). However, the z-statistic Test of Significance between identical diagrams in different Categories showed that a significant difference exists only between Link-Node of Diagram Category II ("proportion") and its double in Category V ("synthesis")(Table 11).[13]

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[13] The logic demands that the score for Link-Node of Category V be significantly lower than that of Category III as well, an expectation which is not backed by the data. However, a relatively high--though

The data show no particular preponderance of ranking between 'common' and profession-indigenous diagrams. On the other hand, it can be observed that diagrams in Category V (Diagrams mapping synthesis of design concepts in context of site) rank conspicuously low. Notably Schematic Plan, which is among the highest ranking diagrams in Clarity of Understanding and still scores in the middle range in Ease of Preparation, is the lowest in the ranking of Frequency of Use, with the mean score of 0.87. Similarly, it was identified through the z-statistic Test of Significance that only Link-Node of Category V shows a mean score (1.11) significantly lower than its double in the other Category (cf. Table 11), among identical diagrams.

The uniqueness of this pattern tells something about the Category: while the diagrams in Diagram Category V (Diagrams mapping synthesis of design concepts in context of site) are 'abstract diagrams' in every meaning, the Category they belong to is not truly of the 'programming' process--by definition it belongs to the process of design synthesis that follows the 'programming' process, if these two processes are to be strictly separated. It seems that two different interpretations of this finding can be made: either diagrams for the purpose of design synthesis are not frequently used, or the respondents were affected by the professed objectives of the survey - which are to find out the commonality of abstract diagram use in 'programming' processes--in making judgment on the Frequency of Use for these diagrams which belong to 'design synthesis'

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not significant-- z-value (1.82) found in the Test of Significance between Category V and Category III of Link-Node shows there is some consistency of the pattern.

process (Category V). In whichever case, the pattern speaks for the internal validity of the classification of programming processes as defined in this study.

Perhaps one of the study's most important findings will be that, on average, abstract diagrams are actually seldom used in the design process, as the Total Weighted Mean score of 1.33 indicates: landscape architects use diagrams in not much more than 10% of total projects they deal with.

Table 4. Clarity of Understanding--Self/Landscape Architects

DIAGRAM	MEAN	S.D.	N
V-C Schematic Plan	3.00	0.00	58
V-B Bubble	2.96	0.18	60
III-A Bubble	2.94	0.93	70
II-D Pie Diagram	2.87	0.57	55
II-A Volume-Flow Chart	2.81	0.52	53
IV-B Tree Diagram	2.77	0.65	69
III-B Link-Node	2.72	0.45	48
IV-C Critical-Path Chart	2.70	0.63	62
IV-A Bar-Chart	2.68	0.52	41
II-E Histogram	2.66	0.80	33
I-C Histogram	2.65	0.78	41
I-D Fever-Chart	2.62	0.89	50
II-B Link-Node	2.59	0.77	49
V-A Link-Node	2.46	0.91	39
I-A Bar-Chart	2.44	0.96	56
I-E Radial-Chart	2.29	0.78	31
III-C Matrix	2.25	0.89	29
I-B Log-Chart	2.21	0.97	27
II-C Matrix	2.17	0.86	34

F-VALUE=2.74
F0.05=1.61
Df.numerator=18
Df.denominator=886

Overall Mean = 2.67

Table 5. Clarity of Understanding--Other Professionals

DIAGRAM	MEAN	S.D.	N
II-D Pie Diagram	2.85	0.48	56
II-E Histogram	2.83	0.45	35
I-C Histogram	2.76	0.57	42
IV-B Tree Diagram	2.61	0.96	66
V-C Schematic Plan	2.51	0.94	52
I-D Fever-Chart	2.48	0.98	48
IV-C Critical-Path Chart	2.48	1.01	56
V-B Bubble	2.28	0.90	54
II-B Link-Node	2.28	0.89	47
II-A Volume-Flow Chart	2.25	0.94	49
III-A Bubble	2.24	0.94	62
I-A Bar-Chart	2.21	1.16	51
IV-A Bar-Chart	2.21	1.17	34
III-B Link-Node	2.10	1.06	40
V-A Link-Node	2.02	1.12	35
I-B Log-Chart	1.97	1.23	22
II-C Matrix	1.97	1.01	32
III-C Matrix	1.77	1.18	24
I-E Radial-Chart	1.67	1.08	26

F-VALUE=2.63
F0.05=1.61
Df.numerator=18
Df.denominator=812

Overall Mean = 2.35

Table 6. Clarity of Understanding--Clients

DIAGRAM	MEAN	S.D.	N
II-D Pie Diagram	2.70	0.73	54
V-C Schematic Plan	2.53	0.90	53
I-D Fever-Chart	2.51	0.91	50
I-C Histogram	2.34	1.00	39
IV-B Tree Diagram	2.31	1.09	62
II-E Histogram	2.26	1.12	29
II-A Volume-Flow Chart	2.18	0.95	50
II-B Link-Node	2.11	0.86	47
I-B Log-Chart	2.10	1.04	26
IV-A Bar-Chart	2.04	1.13	34
I-A Bar-Chart	2.02	1.12	52
V-B Bubble	2.01	0.83	54
IV-C Critical-Path Chart	1.95	1.03	54
III-A Bubble	1.95	0.98	60
V-A Link-Node	1.81	1.10	35
III-B Link-Node	1.68	1.06	39
II-C Matrix	1.62	0.84	32
III-C Matrix	1.48	1.06	24
I-E Radial-Chart	1.35	0.80	28

F-VALUE=2.51
F0.05=1.61
Df.numerator=18
Df.denominator=803

Overall Mean = 2.10

Table 7. Significant Difference of Clarity of Understanding Between Groups

DIAGRAM	GROUPS COMPARED	ATTAINED Z-VALUE
I-A Bar Chart	OP > C	4.00
I-C Histogram	OP > C	2.33
I-E Radial-Chart	S/LA > OP	2.48
II-A Volume-Flow Chart	S/LA > OP	3.73
II-E Histogram	OP > C	2.59
III-A Bubble	S/LA > OP	5.83
III-B Link-Node	S/LA > OP	3.44
I-A Bar Chart	S/LA > OP	2.14
IV-C Critical-Path Chart	OP > C	2.79
V-B Bubble	S/LA > OP	5.67
V-C Schematic Plan	S/LA > OP	3.77

$z0.05 = 1.96$ (α=0.05)

Table 8. Mean Scores--Ease of Preparation

DIAGRAM	MEAN	S.D.	N
II-E Histogram	2.86	0.36	35
I-C Histogram	2.79	0.47	43
II-D Pie Diagram	2.75	0.43	57
I-D Fever-Chart	2.72	0.68	54
III-A Bubble	2.70	0.46	70
V-B Bubble	2.58	0.67	60
II-A Volume-Flow Chart	2.53	0.61	54
IV-B Tree Diagram	2.51	0.63	72
II-B Link-Node	2.50	0.70	52
III-B Link-Node	2.50	0.62	48
I-B Log-Chart	2.41	0.78	29
V-C Schematic Plan	2.36	0.79	58
IV-A Bar-Chart	2.31	0.61	41
I-A Bar-Chart	2.25	0.79	61
IV-C Critical-Path Chart	2.10	0.74	64
V-A Link-Node	1.97	1.10	43
I-E Radial-Chart	1.90	0.94	31
III-C Matrix	1.90	0.65	31
II-C Matrix	1.85	0.73	35

F-VALUE=2.35
F0.05=1.61
Df.numerator=18
Df.denominator=919

Overall Mean = 2.43

Table 9. Significant Difference in Ease of Preparation Between Identical Diagrams

DIAGRAM	DIAGRAM CATEGORIES COMPARED	ATTAINED Z-VALUE
Link-Node	II("Proportion") > V("Synthesis")	2.79
Link-Node	III"Relationships") > V("Synthesis")	2.78

$z_{0.05}=1.96$
($\alpha=0.05$)

Table 10. Mean Scores--Frequency of Use

DIAGRAM	MEAN	S.D.	N
II-D Pie Diagram	1.92	1.77	
IV-B Tree Diagram	1.90	1.33	
IV-C Critical-Path Chart	1.75	1.47	
II-B Link-Node	1.70	1.65	
I-D Fever-Chart	1.65	1.67	
I-A Bar-Chart	1.56	1.57	
II-A Volume-Flow Chart	1.47	1.53	
II-C Matrix	1.37	1.79	
III-B Link-Node	1.33	1.46	93
I-C Histogram	1.25	1.46	
III-C Matrix	1.23	1.75	
III-A Bubble	1.12	0.92	
I-B Log-Chart	1.12	1.65	
IV-A Bar-Chart	1.12	1.50	
V-A Link-Node	1.11	1.51	
V-B Bubble	1.03	0.96	
II-E Histogram	0.94	1.46	
I-E Radial-Chart	0.88	1.44	
V-C Schematic Plan	0.87	0.85	

F-VALUE=3.98
F0.05=1.61
Df.numerator=18
Df.denominator=1748
Overall Mean = 1.33

Table 11. Significant Difference in Frequency of Use Between Identical Diagrams

DIAGRAM	DIAGRAM CATEGORIES COMPARED	ATTAINED Z-VALUE
Link-Node	II("Proportion") > V("Synthesis")	2.57

$z_{0.05}=1.96$
($\alpha=0.05$)

3.2.5 ASSOCIATIONS BETWEEN 'EFFECTIVENESSES'

For measurement of associations between these survey topics, Goodman and Kruskal's Coefficient (γ) was computed between the values for ordinal variables of Clarity of Understanding and those of Frequency of Use, between the values for ordinal variables of Ease of Preparation and those of Frequency of Use, and between the values for ordinal variables of Clarity of Understanding and those of Ease of Preparation.

No significant association was found between the ordinal variables of 'Clarity of Understanding' and 'Ease of Preparation'. Significant associations, depending on diagrams, were found between ordinal variables of 'Clarity of Understanding' and those of 'Frequency of Use,' and between ordinal variables of 'Ease of Preparation' and those of 'Frequency of Use'.

Each of Tables 12, 13 and 14 presents the diagrams showing significant association between a user-group's Clarity of Understanding and Frequency of Use in descending order of gamma value (γ) for each diagram. The significant associations existing between the Clarity of Understanding and Frequency of Use are in agreement for all of the diagrams and for all of the groups. Also, all of the significant associations between Ease of Preparation and Frequency of Use are in agreement. Twelve diagram types showed that Frequency of Use is significantly associated with Clarity of Understanding by Self/Landscape Architects; six diagram types by Other Professionals; and ten diagram types by Clients. Twelve diagrams showed significant associations between Ease of Preparation and Frequency of Use.

To tell whether there is any cause-effect relationship between Clarity of Understanding and Frequency of Use, a comparison between the diagram ranking by Frequency of Use and that by Gamma value (γ), and another comparison between the diagram ranking by Clarity of Understanding for each of the groups and that by Gamma value were done--so that it could be concluded whether intensity of one effectiveness (e.g. high Frequency of Use) affects that of the other effectiveness (e.g. high Clarity of Understanding) and not vice versa, if one comparison shows concurrence (e.g. between the diagram ranking by Frequency of Use and that by Gamma value) while the other comparison (e.g. between the diagram ranking by Clarity of Understanding and that by Gamma Value) does not.

It is seen that there is no concurrence between the diagram ranking by Frequency of Use and that by Gamma value, nor between the diagram ranking by Clarity of Understanding and that by Gamma value. It is concluded that generalization of any cause-effect relationship between Frequency of Use and Clarity of Understanding is not feasible.

However, through a comparison of the three Tables (each for a user group) for the Gamma value between Clarity of Understanding and the Table for Frequency of Use, it can be observed that overall magnitude of the association drops from Self/Landscape Architects to Other Professionals to Clients. Also, the fact that there is no significant association in inversion for any of the diagrams, along with the decline of the magnitude of association as the group becomes less 'professionalized,' hints that Frequency of Use has an effect on Clarity of Understanding to a limited extent, depending on diagram types and the user-groups as identified in this study. This assertion is in line with the finding that 'familiarity' may play a role in clear understanding, as previously discussed. The same procedure of observation indicates that there is no true cause-effect relationship between Ease of Preparation and Frequency of Use.

The implication of these findings is that a landscape architect does not use a diagram frequently just because it is well understood by himself, or because he considers it to be well understood by other professionals or by his clients. Neither does he use a diagram frequently just because he considers it to be easy to prepare.

Table 12. Clarity of Understanding for Self/Landscape Architects and Frequency of Use--Significant Associations

DIAGRAM	GAMMA(γ)	ASE
I-C Histogram	1.00	0.00
II-E Histogram	1.00	0.00
III-A Bubble	1.00	0.00
IV-A Bar-Chart	0.90	0.08
V-B Bubble	0.85	0.10
Iv-B Tree Diagram	0.75	0.11
V-A Link-Node	0.69	0.18
I-D Fever-Chart	0.65	0.23
IV-C Critical-Path Chart	0.63	0.15
I-B Log-Chart	0.62	0.23
II-C Matrix	0.57	0.20
I-A Bar-Chart	0.55	0.19

Table 13. Clarity of Understanding for Other Professionals and Frequency of Use--Significant Associations

DIAGRAM	GAMMA(γ)	ASE
II-E Histogram	1.00	0.00
IV-A Bar-Chart	0.91	0.08
I-B Log-Chart	0.84	0.13
V-A Link-Node	0.59	0.19
V-B Bubble	0.55	0.17
II-C Matrix	0.54	0.21

Table 14. Clients' Clarity of Understanding and Frequency of Use--Significant Associations

DIAGRAM	GAMMA(γ)	ASE
V-C Schematic Plan	0.76	0.14
V-A Link-Node	0.71	0.16
III-B Link-Node	0.61	0.13
V-B Bubble	0.57	0.27
IV-B Tree Diagram	0.55	0.16
I-A Bar-Chart	0.54	0.16
IV-A Bar Chart	0.54	0.22
I-B Log-Chart	0.53	0.24
III-A Bar-Chart	0.52	0.18
II-A Volume-Flow Chart	0.47	0.15

Table 15. Ease of Preparation and Frequency of Use--Significant Associations

DIAGRAM	GAMMA(γ)	ASE
I-C Histogram	0.87	0.10
I-B Log-Chart	0.79	0.20
IV-A Link-Node	0.72	0.16
II-E Histogram	0.69	0.24
III-C Matrix	0.67	0.15
II-C Matrix	0.67	0.17
II-A Volume-Flow Chart	0.60	0.17
V-B Bubble	0.47	0.21
I-A Bar-Chart	0.46	0.16
IV-C Critical-Path Chart	0.43	0.20
III-B Link-Node	0.42	0.20
V-A Link-Node	0.40	0.20

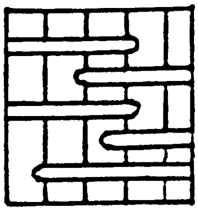
4.0 CHAPTER FOUR: DIAGRAMS REVISITED

In this chapter, each individual diagram is discussed in regard to: (1) the Design Factor for which it is most widely used (in terms of the proportion of the respondents), and (2) the concurrence of its use-pattern as identified in the Typology with that as derived from the survey data. Also any free-response Design Factor for a diagram is noted. In the tables for individual diagrams, showing Design Factors with proportion of 10% or more, an asterisk (*) following a value of proportion indicates that the corresponding Design Factor had been identified in the Typology as being served by the diagram type. Overall, all of the Design Factors that had been identified as served by a certain diagram type in Typology scored a proportion of 10% or more for the diagram, with one exception: Climatic Constraints as paired to I-C Histogram showed a low proportion of 5%. As the result indicates, every diagram that the survey questionnaire presented has unexpected Design Factors (i.e., Design Factors with which the diagram type had not been identified in Typology) that score proportions of down80010% or more, with the exception of Radial-Chart.

Besides, with no exception, a Design Factor that had been identified in Typology as being served by a diagram type with a dual function (which was thus made to belong to two Diagram Categories to serve the same Design Factor) has a proportion for one Category (of the same diagram) the same or close to that for the other Category (of the same diagram), or both proportions score relatively high. The proportions of these Design Factors are marked with double asterisks (**).

Also, the findings affirm the 'peculiarity' of the two diagrams that were selected from the graphics manuals to enable examination of the extent to which graphics publications conform to the need of the practice: for both (Log-Chart and Radial-Chart) there is little agreement among the landscape architects on what Design Factor they should (or would) be illustrating. However, graphics manuals are relatively correct in the sense that the Design Factors on which those few agreements are made by 10% or more of the total respondents coincide with the ones the manuals illustrate. Following are the discussions for individual diagrams, presented with the Design Factors they were found to communicate.

Bar-Chart

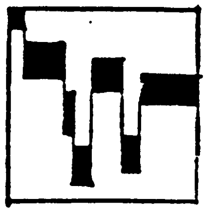


DESIGN FACTOR	CATEGORY I	CATEGORY IV
Goals/Objectives	25**	12**
Project Budget	24**	20**
Legal Regulations	22	22
Utility Availability	11	11
Work Scheduling	62**	37**
Design Team Organization	31*	-

Observations: This diagram shows the second strongest agreement--i.e., the second highest proportion (62%) overall--among landscape architects on what Design Factor it should (or would) illustrate: Work Scheduling. No site-related Design Factor scored a proportion more than 10% (of the total respondents) for this diagram. Also, no Design Factor in the Analysis stage showed a proportion more than 10% for this diagram.

It is interesting to observe that Legal Regulations and Utility Availability, which had not been found to be served by Bar-Chart in Typology, have Bar-Chart scoring an equal proportion in Category I and Category IV. This finding suggests the diagram's service for the communication of these Design Factors with the simultaneous dual function of showing the 'sequence' of their variables in the 'temporal' context.

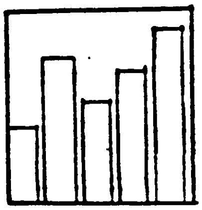
Log-Chart



DESIGN FACTOR	CATEGORY I
Users' Functional Needs	13*
Work Scheduling	11

Observations: This diagram type, which is one of the two diagrams which had been found only in graphics publications, has only two Design Factors scoring proportions of 10% or more; all of these proportions are also extremely low in general. However, the manuals are correct in the sense that Users' Functional Needs, the mapping of which in a temporal context was the only purpose of the diagram type identified in the Typology, showed the highest proportion (13%).

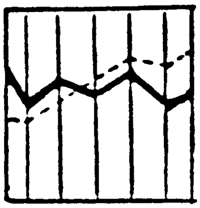
Histogram



DESIGN FACTOR	CATEGORY I	CATEGORY II
Goals/Objectives	13	-
Users' Functional Needs	12	-
Human Sensory Constraints	-	13*
Geological Constraints	12	10
Topographic Constraints	10	10
Ecological Constraints	14	12
Climatic Constraints	-*	13
Project Budget	32**	23**
Utility Availability	-	11
Work Scheduling	-	24*
Users' Space Need	14	10

Observations: The Design Factor which this diagram type was found to show the highest proportion for was Project Budget (32%). Surprisingly many Design Factors (eight in all) that had not been found in Typology showed up for this diagram. This diagram is the only one that has a free-response Design Factor that was agreed on by more than two respondents: seven respondents agreed that 'population growth projection' is communicated with this diagram type in the Program stage. Of them, five checked both Diagram Categories I and II, and two checked Category II only. From this finding it can be seen that Histogram, with the function of mapping 'proportions' of population growth in a 'temporal' context, is used to a considerable extent in firms.

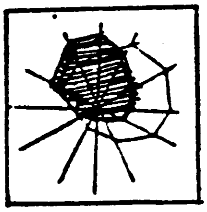
Fever-Chart



DESIGN FACTOR	CATEGORY I
Goals/Objectives	17
Climatic Constraints	13*
Project Budget	27*
Utility Availability	10

Observations: It can be seen that this diagram's versatility of use is low (only four Design Factors with proportions of 10% or more) and that all of the proportions are low in general. Project Budget is the Design Factor on which respondents showed the highest agreement (27%) concerning the purpose of this diagram. Two Design Factors--Goals/Objectives and Utility Availability--that had not been found in Typology were found to be communicated with this diagram by 10% or more of the total firms.

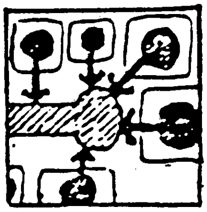
Radial-Chart



DESIGN FACTOR	CATEGORY I
Climatic Constraints	13*

Observations: This diagram, that had been found in graphics manuals only along with the Log-Chart, shows low versatility of use; also, agreement on its purpose (i.e., "which Design Factor to use the diagram for") is weak among landscape architects. However, the result that Climatic Constraints is the highest scoring Design Factor--also the only one that scored a proportion more than 10% for this diagram--implies that illustrations in graphics publications are relatively correct in showing what Design Factor a diagram should (or would) communicate. This diagram's Frequency of Use, Ease of Preparation, and Clarity of Understanding (for all of the user-groups) were among the lowest.

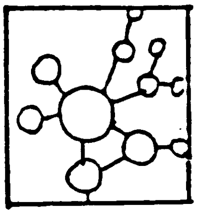
Volume-Flow Chart



DESIGN FACTOR	CATEGORY II
Goals/Objectives	19
Users' Functional Needs	28
Utility Availability	10
Users' Space Need	25*
Function-Relation	34*
Circulation Pattern	22*

Observations: Function/Relation showed the highest proportion for this diagram. Notable is the fact that Users' Functional Needs, which had not been found in Typology to be served by this diagram type, scored a considerably high proportion of 28%.

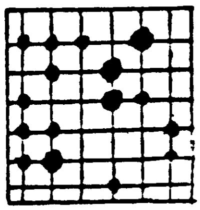
Link-Node



DESIGN FACTOR	CATEGORY II	CATEGORY III	CATEGORY V
Users' Functional Needs	32**	32**	28
Goals/Objectives	15**	17**	-
Legal Regulations	-	12	-
Utility Availability	-	16	-
Work Scheduling	-	11	-
Design Team Organization	-	29*	-
Users' Space Need	24**	29**	25*
Function-Relation	31**	33**	22*
Circulation Pattern	22**	13**	15*
Materials-Utilities	10	12	-
Image	-	11	-

Observations: The fact that relatively many Design Factors were found to be served by this diagram speaks for this diagram's versatility. However, the diagram type in Category V actually does not serve many Design Factors. All of the user-need basis Design Factors (Users' Functional Need, Users' Space Need, and Function/Relation) scored high proportions for this diagram.

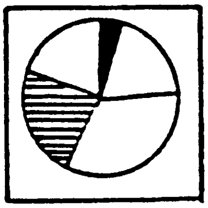
Matrix



DESIGN FACTOR	CATEGORY II	CATEGORY III
Goals/Objectives	12	-
Users' Functional Need	-	11*
Human Sensory Constraints	14*	-
Geological Constraints	12	17
Topographic Constraints	13	13
Ecological Constraints	16**	19**
Climatic Constraints	15**	14**
Project Budget	-	10
Utility Availability	16*	-
Work Scheduling	-	14*
Function/Relation	-	15

Observations: While landscape architects' agreement regarding which Design Factor this diagram would be used for is not very strong--the highest proportion being 19%, for Ecological Constraints--relatively high versatility of use can be observed. There is no Design Factor in the Analysis stage scoring a proportion of 10% or more for this diagram. The Clarity of Understanding (for all of the user-groups) and Ease of Preparation were among the lowest. All of the Design Factors found to be served by this diagram in Typology scored proportions more than 10%. One interesting finding is that Geological Constraints and Topographic Constraints, which are site-related Design Factors and had not been found in Typology for this diagram, show proportions in Category II and III close to one other. In view of the fact that Ecological Constraints and Climatic Constraints--which are also site-related and had been found to be served by this diagram in Typology--show the same pattern, it seems that Matrix has the dual function of mapping proportions and relationships of variables of Geological and Topographic Constraints as well.

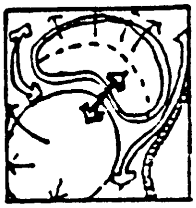
Pie Diagram



DESIGN FACTOR	CATEGORY II
Users' Functional Needs	22*
Human Sensory Constraints	13
Geological Constraints	13
Topographic Constraints	15*
Ecological Constraints	11*
Climatic Constraints	16*
Project Budget	40*
Users' Space Need	24

Observations: Project Budget is the Design Factor for which this diagram is used by 40% of landscape architects. All of the Design Factors that had been found to be served by this diagram in Typology scored proportions more than 10%. It is noticeable that Geological Constraints, which is the only Design Factor that had not been found to be served by this diagram in Typology, also scored a substantial proportion of 13%.

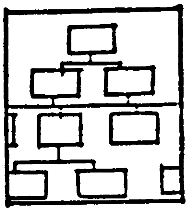
Bubble



DESIGN FACTOR	CATEGORY III	CATEGORY V
Goals/Objectives	15	-
Users' Functional Needs	51*	41
Human Sensory Constraints	28*	-
Geological Constraints	38*	27
Topographic Constraints	38*	29
Ecological Constraints	33*	24
Climatic Constraints	26*	19
Utility Availability	13	-
Users' Space Need	42*	40*
Function-Relation	51*	51*
Circulation Pattern	56*	58*
Materials-Utilities	19*	-
Image	27*	-

Observations: This diagram is notable in that it shows high versatility of use (thirteen Design Factors) as well as a high agreement among respondents on which Design Factors would be served by this diagram type (the proportions for all of the Design Factors are generally high). The Design Factors are evenly distributed between the Program stage and the Analysis stage. It seems this diagram, overall, is one of the diagrams that are most widely used by, and familiar to, landscape architects. All of the Design Factors that had been found to be served by this diagram in Typology showed up with proportions more than 10%.

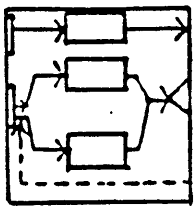
Tree Diagram



DESIGN FACTOR	CATEGORY IV
Goals/Objectives	30*
Users' Functional Needs	15
Work Scheduling	16*
Design Team Organization	68*
Users' Space Need	15
Function-Relation	14

Observations: Diagramming of Design Team Organization, using Tree Diagram, was found to be done by the highest proportion of respondents (68%). Relatively few Design Factors (six in all) scored proportions more than 10%; also, the proportions are generally low except for Design Team Organization. These findings imply that this diagram's use is rather confined to the communication of Design Team Organization.

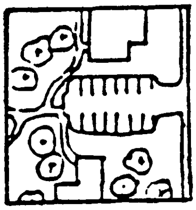
Critical-Path Chart



DESIGN FACTOR	CATEGORY IV
Goals/Objectives	37*
Human Sensory Constraints	12
Geological Constraints	11
Ecological Constraints	11
Climatic Constraints	11
Legal Regulations	18
Work Scheduling	44*
Design Team Organization	27*
Users' Space Need	13
Function-Relation	30*
Circulation Pattern	14

Observations: For this diagram the highest ranking Design Factor is Work Scheduling (proportion 44%). Relatively high variety of Design Factors, with proportions more than 10% (eleven in all), speaks for this diagram's versatility of use. Note should be taken that this diagram type is the only standard-form diagram that had been found in Typology to serve a Design Factor belonging to the Analysis stage--Function/Relation. A relatively high proportion (30%) that Function/Relation scored concurs with the result of Typology.

Schematic Plan



DESIGN FACTOR	CATEGORY V
Users' Functional Needs	19
Users' Space Need	30*
Function-Relation	40*
Circulation Pattern	37*
Materials-Utilities	28*
Image	42*

Observations: This diagram's function as a diagram 'mapping the synthesis of design concepts in the context of the site' is pronounced by the fact that its highest ranking Design Factor is Image (42%), for which other diagrams generally show low proportions. Similarly, Materials/Utilities--which is a Design Factor rather insignificant for other diagrams--scored a relatively high proportion of 28%. All of the Design Factors in the Analysis stage, which had been found in Typology to be served by this diagram, scored generally high proportions.

Free-Response Diagrams

There was one free-response diagram that was agreed upon by more than two landscape architect: Critical-Path Chart, in the Diagram Category I ('time'). Of the total of eight landscape architects who responded to this diagram, five matched it with the Design Factor of Work Scheduling, two with Design Team Organization, and two with Goals/Objectives. It is interesting that most also matched IV-C Critical-Path Chart with these Design Factors. It seems that they considered this diagram type to have the dual function of mapping a 'sequence' of variables of a Design Factor in a 'temporal' context, not just the single function of mapping 'rank or sequence' as was suggested in the questionnaire. The result speaks for the considerable extent to which Critical-Path Chart is used for the communication of these Design Factors in the context of the 'temporal sequence'.[14]

[14] Five of the respondents actually drew a Critical-Path Chart in the blank box provided for Diagram Category I in the questionnaire. The rest of them simply marked "IV-C" in the blank.

5.0 CHAPTER FIVE: SUMMARY AND IMPLICATIONS

5.1 SUMMARY

This study was initiated primarily as an "exploratory" effort through which baseline information could be compiled concerning private landscape architectural firms' use-pattern of abstract diagrams in communicating design issues in the programmatic design process, and what average landscape architects perceive those abstract diagrams' clarity of understanding, ease of preparation, and proportion of use to be. By obtaining this information, the practice and education of landscape architecture should be better equipped to find the most effective ways of using abstract diagrams.

In order to accomplish these objectives, data were obtained from a survey of private landscape architectural firms during the period from August 13 to September 3, 1986. The study was based on a sample of 93 respondents who returned the survey questionnaire from a diversity of national regions. The questionnaire was divided into four parts: Part 1 asked respondents which programmatic design issues the diagram prototypes presented in the questionnaire are used for; Parts 2, 3 and 4 each questioned how the landscape architects perceive the clarity of understanding, ease of preparation, and frequency of use for the diagrams that they use. Noting that caution must be exercised in generalizing from the findings to develop 'the average use pattern,' the observations and discussions in this study are primarily illustrative.

The aggregated data on the pattern of diagram usage for various Design Factors are tabulated and presented in Table 1. It was found that the firms most widely diagram the two administrative issues of Design Team Organization, using Tree Diagram, and Work Scheduling, using Bar-Chart.

The results indicate that how widely a diagram is used may not be affected by which functional category (as identified in the study) it belongs to or which particular programming process (also as identified in this study) it is used in; rather, its widespread use may depend on how 'fit' a landscape architect thinks it is in doing the function required to communicate a specific Design Factor. It was found that a diagram that can serve a multiple of functions simultaneously is more likely to be adopted to communicate a Design Factor than is one whose function is singular.

The data concerning the clarity of understanding, as landscape architects perceive it, for the groups of Self/Landscape Architects, Other Professionals, and Clients is tabulated and presented in Tables 4, 5 and 6. It was found that landscape architects think that level of clearly understanding abstract diagrams descends in order of Self/Landscape Architects, Other Professionals and Clients. A few of the diagrams showed no difference between groups, and for others the difference is only between Self/Landscape Architects and the rest of groups, or between Clients and the other more specialized groups.

The results imply that 'familiarity,' i.e. how well a user is accustomed to a diagram type, is important for clear understanding. The results also indicate that diagrams may not be more often used for communication with Other Professionals than for Clients. It was found that landscape architects think their clients understand diagrams at least moderately well.

On ease of preparation, it was found that landscape architects think there exists a significant difference between diagrams in the ease of preparation. Also, they think the diagrams in simpler forms are easier to prepare; expertise by itself derived from using a diagram repeatedly does not play much of a role in ease of preparing it.

A significant difference was observed between diagram types in frequency of use. It was found that diagrams are used in the process of design synthesis, but not as frequently as in the programming processes. Overall, abstract diagrams are considered by landscape architects to be seldom used--for only about 10% of the total projects they deal with.

No significant associations were found between ease of preparation and clarity of understanding. Positive associations were found between clarity of understanding for all the groups and frequency of use, and between ease of preparation and frequency of use. Not a single diagram showed a negative association in the examination of relationships between these variables. However, the results indicate that these associations may not be cause-effect relationships; a possible explanation is that the variables of ease of preparation and clarity of understanding affect frequency of use--or vice versa--to a degree, but not over the limit that landscape architects think a diagram is appropriate in serving a specific function for visualization of a design issue.

Examination of current graphics publications' reliability, enabled by building into the survey a test of 'peculiar' diagrams seen only in the graphics manuals, indicates that these 'peculiar' diagrams are neither often nor widely used; however, their illustration of Design Factors seems to reflect the reality fairly accurately.

The indication is that the possible intention of the authors of these books to provide a variety in diagram usage--by propagating the use of these 'peculiar' diagrams--is not rewarded by their wide use in actual practice. However, this implication cannot be more than an assumption since it is not possible to find to what extent these publications are familiar to the average landscape architects. Beside these 'peculiar' diagram types, no proof that graphic publications significantly differ from real practice, in terms of diagram types and the Design Factors which they illustrate, could be found in the general Typology.

5.2 IMPLICATIONS FOR DESIGN AND EDUCATION

The purpose of this research was to obtain objective information on the use-pattern of abstract diagrams by the firms, regarding the programmatic design issues they communicate and on the average landscape architects' perception as to how effective these diagrams are, in terms of clarity of understanding, ease of preparation, and frequency of use. This information is important if the landscape architectural firms are to evaluate the extent to which their own practice conforms or deviates from the 'average' which 'in all probability will be the most effective or accurate way of abstract diagram use, developed through their own experience' (White, 1985). This information is also meaningful as a partial check on the extent to which current graphics education provides experiences which tend to satisfy a potential 'demand' in real-life practice.

Information obtained in this research is the first step in approaching the effective use of abstract diagrams in some other way than merely following custom and intuition.

The result of this study shows that there exists a distinct pattern of agreement among landscape architects on which diagram is best used for the communication of which design issues. Using this pattern as a reference, landscape architects may want to revise or supplement their own vocabulary of abstract diagrams.

It may be reasonable to suggest that, in practice, landscape architects do not need to impose a particular restriction on the choice of abstract diagrams for easy communication to a particular user-group. The results indicate that there does exist a difference in the level of understanding by user-groups, but the general level as landscape architects judge it to be is reasonable enough not to warrant the process of discrimination. However, if they really feel a need for certainty that the people to be presented with a diagram clearly understand it, the differences between diagrams as identified in this study could serve as a reference. It is also suggested that landscape architects, to the extent possible, prefer a 'common'--or familiar in everyday life-- type of diagram over highly specialized ones, when the presentation is made to the people from outside the profession for their clear understanding.

The data obtained in this study concerning the varying degrees of ease of preparation for different diagram types may be helpful for landscape architects in making a choice between diagrams in regard to resource constraints they have--including time: e.g., they may want to choose a diagram that was found --through this study--to be easy to prepare, in case they do not have extra time. However, since whether a diagram is easy to prepare or not is a matter of personal perception, the finding regarding this 'effectiveness' is mainly for the purpose of seeing what average landscape architects think: accordingly caution should be taken when utilizing the data from this study.

It is true, as White (1985) states, that a considerable proportion of time has been allocated to training in the use of abstract diagrams in undergraduate- or graduate-level graphics education. The finding that diagrams are actually being seldom used on average--for not much more than 10% of the total project they deal with--should prove helpful in coordinating the allocation of time to the relative importance of abstract diagrams in the overall programming process, as identified through this study.

Also, it may be meaningful for the education of landscape architects if an emphasis is put on the development of versatility in using diagrams: i.e. one should learn to be able to adapt a diagram type to a variety of functions--and thus to a variety of design issues.

It is suggested that educators take whatever steps possible to achieve the goals of: developing and teaching methods for more easily (in terms of time and effort) arriving at the completion of an abstract diagram, and teaching by the guideline that a diagram should be as clearly understandable as possible, no matter who is being communicated with.

The findings of this study seem to prove that graphics publications exhibit an acceptable degree of reliability: Design Factors that the diagrams in the manuals illustrate concur with those for which the same diagrams are used in real-life. However, the consistently low scores for the 'peculiar' diagrams in every topic that was questioned here--clarity of understanding, ease of preparation, frequency of use, and prevalency of use among landscape architects--indicate that these publications should be used with caution, by educators and practitioners alike. Though making a suggestion to the authors of graphics publications is not a purpose of this study, it seems reasonable to suggest that a graphics manual may better serve its users by reducing the number of 'peculiar' diagrams--perhaps the authors' idea is to introduce these diagrams of their invention to their general readers--and providing instead more diverse examples of design issues or informations illustrated by practically 'accepted' diagram types.

5.3 FUTURE RESEARCH

Future research on the commonality of abstract diagram use might investigate, on a more micro-level, clarity of understanding, ease of preparation, and frequency of use for each diagram type as it is paired to a specific Design Factor. The questionnaire was divided into the statistical analyses of 'count data' (Part 1 "Design Factors") and 'measurement' (Parts 2 "Clarity of Understanding," 3 "Ease of Preparation" and 4 "Frequency of Use") for the sake of making the questionnaire more manageable for the respondents[15] - thus, the data from Parts 2, 3

[15] A question was provided in the questionnaire to see what kind of difficulty the respondents had in filling out the questionnaire, if any. Of those who answered this question (44 out of 93 total), about 76 % checked "it took too much time and effort (to fill out the questionnaire)" (cf. Page Four of the questionnaire, APPENDIX B).

and 4 cannot be related to Part 1. The 'measurements' are done for a diagram only as a totality, not as paired to a specific Design Factor. In the suggested fashion, the question as to the existence of any relationship between the prevalency of use, i.e. how widely a diagram is used, and the frequency of use might be also answered.

In the future, a similar study with a sample stratified by the firm size or by a firm's main project type would help a study of this kind outgrow from being only exploratory. Somewhat surprisingly, in the course of groundwork research for the study, it was found that any inventory of firms by their main project type or even by their size does not exist at the present time. Thus, the only method of sample stratification available was by the region (state), and the number of Landscape Architects (ASLA member-and-higher level) in a firm.

A multi-faceted study examining the relative importance of visual communication (including abstract diagrams) in relation to verbal communication (written and/or oral) in the programming process is also suggested for completeness of knowledge in this area. It is judged that discovery of the commonality of visual communication only--of which this study was a part--cannot provide a complete picture on the extent to which the function of communication plays a role in the success of a programming process in design.

Considering the possibility that a format even more complicated than the one adopted would have redoubled the difficulty--thus affecting the response rate negatively--the trading of 'more information' for 'making response easier' is judged to have been justified.

Also, it is suggested that experiments concerning questions such as 'clarity of understanding' be conducted with a control group from a different population, such as clients. In this fashion, it could be possible to examine how this perception level self-assessed by a user-group differs from one that is assessed by another (as Self/landscape architects in this study) group.

6.0 CONCLUSIONS

The success of this study depends on its ability to shed a light on the question of the abstract diagram's place in design and what its meaning for a landscape architect is.

It has been observed that average landscape architects think abstract diagrams are seldom used in the programming process. Also, the data show that diagrams are in general not widely used among landscape architects. Then, what would be the meaning of abstract diagrams for an average landscape architect? Does the fact that abstract diagrams are actually seldom used mean their significance as a means of thinking and communication is so minimal that they are best put on the course of extinction for the benefit of the profession's unencumberedness?

One particular comment, similar to those made by most of the responding landscape architects, is as following:

> Diagrams are used in minimal form, if at all, depending upon the relative complexity of the problem or the number of variables involved with a design problem. This is partially because of the resources they will eventually take up in the overall design process. As experience and practice increase, dependence on graphic analysis may tend to diminish, and the process of programming moves from drawing board to the designer's brain --- However, this does not mean abstract diagrams are not important: this development is made possible because the abstract diagrams are there at the very beginning.

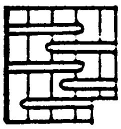
If the seldomness of abstract diagram use implies a favorable progression of this development into the 'conceptual' programming process in landscape architectural practice, then the purpose of abstract diagram is being well served, which again speaks for its 'raison d'être'.

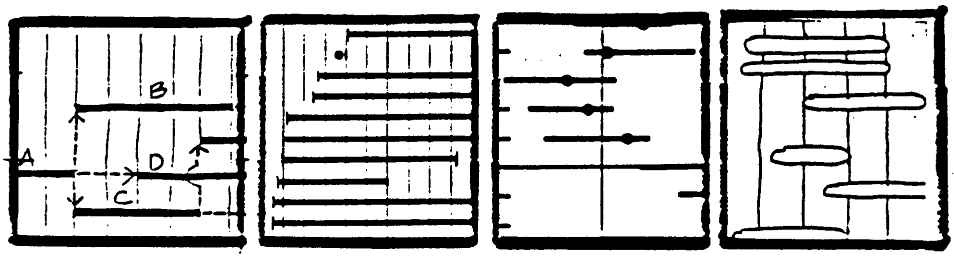
The meaning of this implication is that it is the 'spirit' of a diagram rather than the ephemeral technique of how to draw a diagram that has more meaning. The true reason for the existence of an abstract diagram may be that it can accustom the user to the essence of its function to the point that its use is only an auxiliary to the communication, not an aim in itself. Thus, here the inevitable paradox: abstract diagrams should be used in order that dependency to them becomes little necessary for the designer. They will serve for the success of a landscape architectural design, when their place on a designer's drawing board is so secure that he cannot accomplish his task satisfactorily without one even in his brain.

Such will be the continuing importance of abstract diagrams for us, the landscape architects.

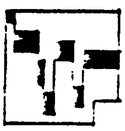
APPENDIX A. DIAGRAM EXAMPLES

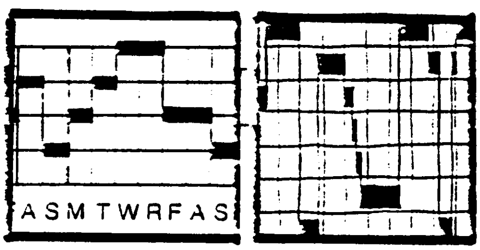
Bar Chart



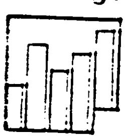


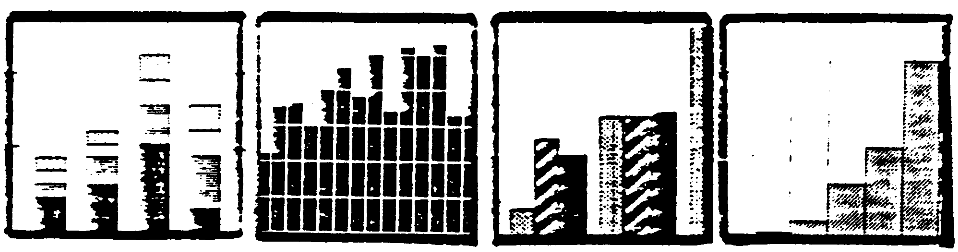
Log-Chart



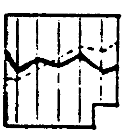


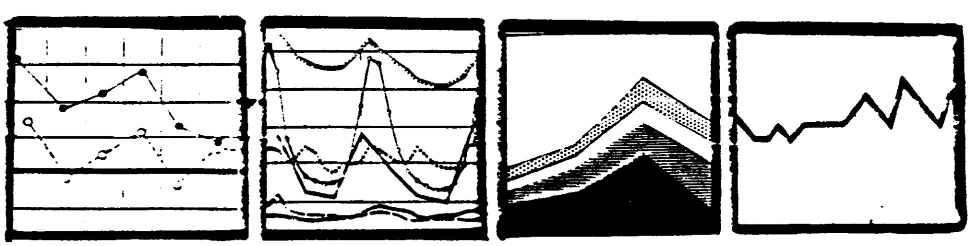
Histogram



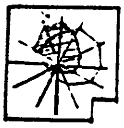


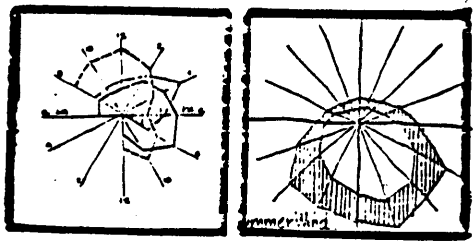
Fever Chart



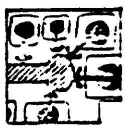


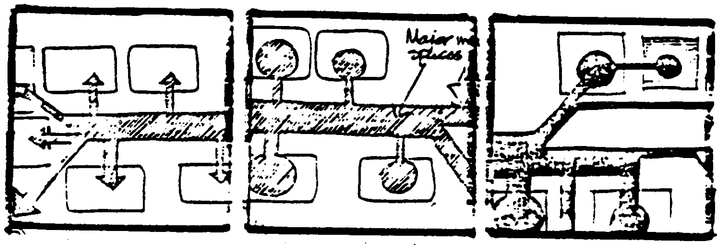
Radial-Chart



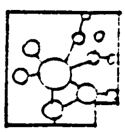


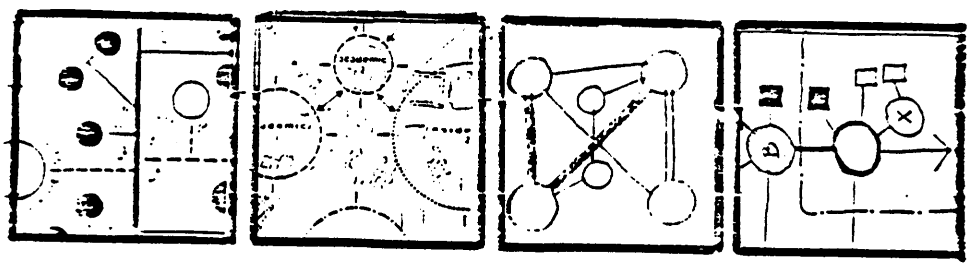
Volume-Flow Chart



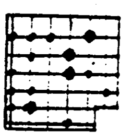


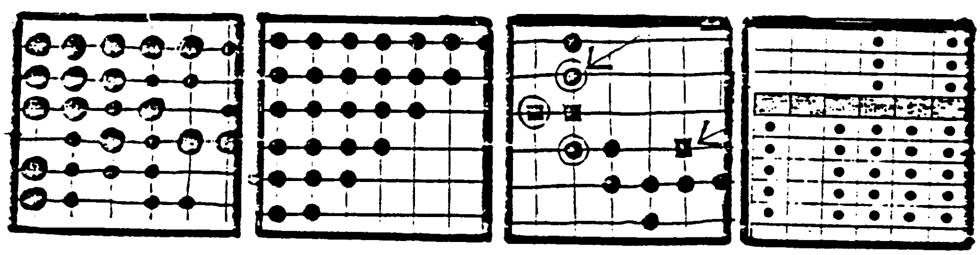
Link-Node



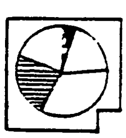


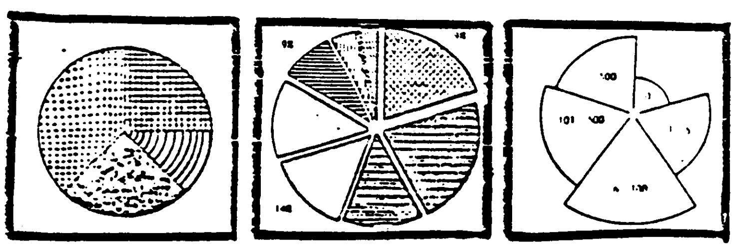
Matrix



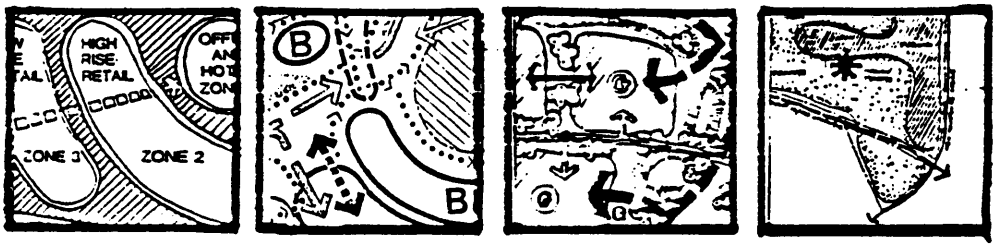


Pie Diagram

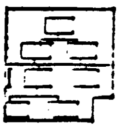


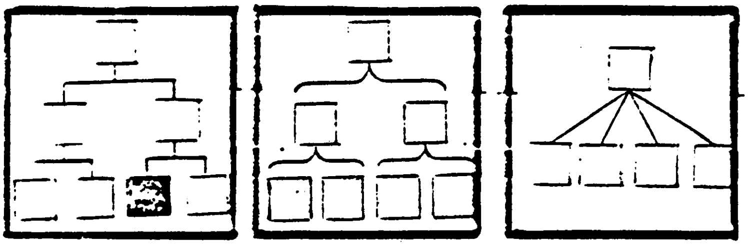


Bubble

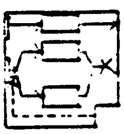


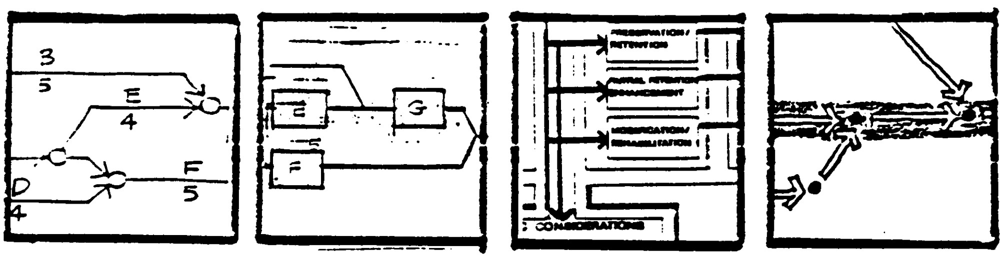
Tree
Diagram



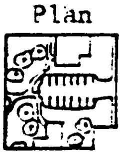


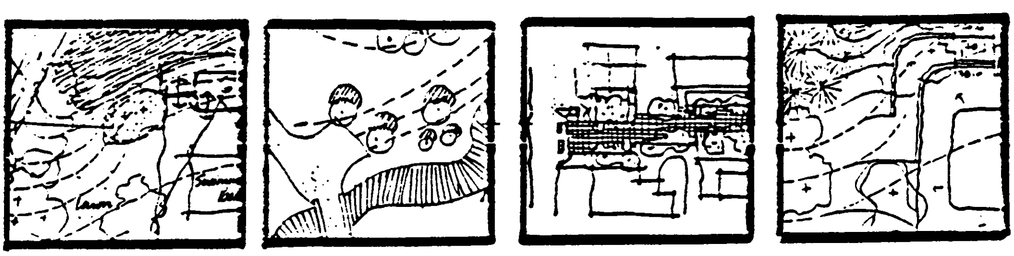
Critical-
Path
Chart





Schematic
Plan





APPENDIX B. THE QUESTIONNAIRE

A SURVEY ON THE USE OF ABSTRACT DIAGRAMS IN LANDSCAPE ARCHITECTURE

This survey has four aims. First, it is to see which types of abstract diagrams are used by landscape architects for the communication of design factors in the early stages (i.e. program and analysis) of large physical design (i.e. site-planning scale). Second, it is to see to whom and how clearly those diagrams communicate. Third, it is to see how easy you think it is to prepare those diagrams. Fourth, it is to see how frequently you use them, as experienced in past three years. We request that to the extent possible the response be reflective of the whole firm that you work in, rather than your personal practice. Step-by-step directions on how to complete this questionnaire are provided on the left side of the questionnaire.

Page 1 of The Questionnaire

DIRECTIONS

For each category of diagrams to the right (I - V), read the heading and examine diagrams. The diagrams are prototypes: select the diagrams which illustrate those that you use. If there is any diagram that you would like to add, draw it in the blank box (or you may use a seperate sheet). Next, follow steps on the lower left side. Please take caution to evaluate ONLY those diagrams you identified and selected.

1. In PART 1, match the diagram(s) identified with Design Factors they illustrate or communicate. Check the corresponding box(es). If there is any Design Factor you would like to add, write it in the 'Other' row (rows 'm' and 's').

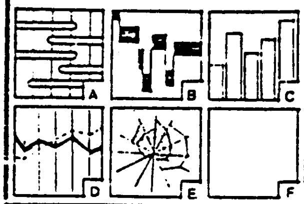
2. In PART 2, see which group(s) of people each diagram identified is used for, and rate how clearly it is understood by them. Check appropriate box(es).

3. In PART 3, judge how easy it is for you to prepare each diagram identified. Check appropriate box.

4. In PART 4, rate the frequency of use for each diagram identified. Check appropriate box.

5. After you finish, see reverse side for additional questions.

I Diagrams mapping relationship between TIME and variables of a Design Factor.



PART 1 DESIGN FACTORS				A	B	C	D	E	F
PROGRAM	a. GOALS/OBJECTIVES		a						
	b. USERS' FUNCTIONAL NEEDS		b						
	c. HUMAN SENSORY CONSTRAINTS		c						
	d. GEOLOGICAL CONSTRAINTS		d						
	e. TOPOGRAPHIC CONSTRAINTS		e						
	f. ECOLOGICAL CONSTRAINTS		f						
	g. CLIMATIC CONSTRAINTS		g						
	h. PROJECT BUDGET		h						
	i. LEGAL REGULATIONS		i						
	j. UTILITY AVAILABILITY		j						
	k. WORK SCHEDULING		k						
	l. DESIGN TEAM ORGANIZATION		l						
	m. OTHER:		m						
ANALYSIS	n. USERS' SPACE NEED		n						
	o. FUNCTION/RELATION		o						
	p. CIRCULATION PATTERNS		p						
	q. MATERIALS/UTILITIES		q						
	r. IMAGE		r						
	s. OTHER:		s						

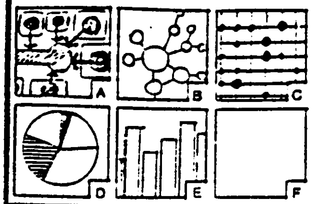
PART 2 CLARITY OF UNDERSTANDING			A	B	C	D	E	F
SELF/ LANDSCAPE ARCHITECTS	CLEAR	CLEAR						
	MODERATE	MODERATE						
	UNCLEAR	UNCLEAR						
OTHER PROFESSIONALS (ENGINEERS,etc.)	CLEAR	CLEAR						
	MODERATE	MODERATE						
	UNCLEAR	UNCLEAR						
CLIENTS	CLEAR	CLEAR						
	MODERATE	MODERATE						
	UNCLEAR	UNCLEAR						

PART 3 EASE OF PREPARATION			A	B	C	D	E	F
	EASY	EASY						
	MODERATE	MODERATE						
	DIFFICULT	DIFFICULT						

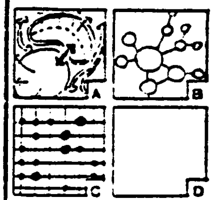
PART 4 FREQUENCY OF USE		A	B	C	D	E	F
USUALLY (Over 90% of Projects)	USUALLY						
OFTEN (50 - 90% of Projects)	OFTEN						
SOMETIMES (10 - 49% of Projects)	SOMETIMES						
SELDOM (Under 10% of Projects)	SELDOM						

Page 2 of The Questionnaire

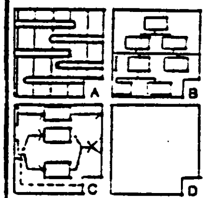
II — Diagrams mapping PROPORTION of variables of a Design Factor.



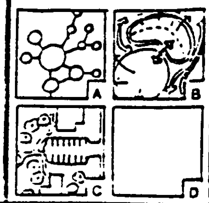
III — Diagrams mapping RELATIONSHIPS among variables of a Design Factor.



IV — Diagrams mapping RANK OR SEQUENCE of variables of a Design Factor.



V — Diagrams mapping SYNTHESIS OF DESIGN CONCEPTS in context of site.



II

DIAGRAM	A	B	C	D	E	F
a						
b						
c						
d						
e						
f						
g						
h						
i						
j						
k						
l						
m						
n						
o						
p						
q						
r						
s						

	A	B	C	D	E	F
CLEAR						
MODERATE						
UNCLEAR						
CLEAR						
MODERATE						
UNCLEAR						
CLEAR						
MODERATE						
UNCLEAR						

	A	B	C	D	E	F
EASY						
MODERATE						
DIFFICULT						

	A	B	C	D	E	F
USUALLY						
OFTEN						
SOMETIMES						
SELDOM						

III

DIAGRAM	A	B	C	D
a				
b				
c				
d				
e				
f				
g				
h				
i				
j				
k				
l				
m				
n				
o				
p				
q				
r				
s				

	A	B	C	D
CLEAR				
MODERATE				
UNCLEAR				
CLEAR				
MODERATE				
UNCLEAR				
CLEAR				
MODERATE				
UNCLEAR				

	A	B	C	D
EASY				
MODERATE				
DIFFICULT				

	A	B	C	D
USUALLY				
OFTEN				
SOMETIMES				
SELDOM				

IV

DIAGRAM	A	B	C	D
a				
b				
c				
d				
e				
f				
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h				
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l				
m				
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	A	B	C	D
CLEAR				
MODERATE				
UNCLEAR				
CLEAR				
MODERATE				
UNCLEAR				
CLEAR				
MODERATE				
UNCLEAR				

	A	B	C	D
EASY				
MODERATE				
DIFFICULT				

	A	B	C	D
USUALLY				
OFTEN				
SOMETIMES				
SELDOM				

V

DIAGRAM	A	B	C	D
a				
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	A	B	C	D
CLEAR				
MODERATE				
UNCLEAR				
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MODERATE				
UNCLEAR				
CLEAR				
MODERATE				
UNCLEAR				

	A	B	C	D
EASY				
MODERATE				
DIFFICULT				

	A	B	C	D
USUALLY				
OFTEN				
SOMETIMES				
SELDOM				

Page 3 of The Questionnaire (Joined to Page 2)

Finally, here are a few questions to help us evaluate the survey results. Please make comments, if any, in the space provided.

Q-1 Do you think the research objectives are important enough to warrant a survey like this? (Circle number of your answer)

1 YES
2 NO

Comment: ______________________

Q-2 Do you think the questionnaire format is adequate to serve the research objectives? (Circle number of your answer)

1 YES
2 NO

Comment: ______________________

Q-3 If you had any difficulty in filling out this questionnaire, please note the reason(s) (Circle all that are applicable)

1 IT TOOK TOO MUCH TIME AND EFFORT
2 IT WAS HARD TO UNDERSTAND THE DIAGRAMS
3 IT WAS HARD TO UNDERSTAND THE DESIGN FACTORS
4 NOTES AND/OR DIRECTIONS WERE AMBIGUOUS OR CONFUSING
5 QUESTIONS ASKED CANNOT SATISFY THE RESEARCH OBJECTIVES
6 OTHER (Please specify) ______________________

Q-4 Do you have any suggestions for further research, or comments on the issue of abstract diagrams in general, etc.?

Your contribution to this effort is greatly appreciated. If you would like a summary of the findings, please print your name and address on the back of the return envelope. We will see that you get it. Thank you very much again.

Page 4 of The Questionnaire

APPENDIX C. THE COVERING LETTER TO THE QUESTIONNAIRE

Mr. Kenneth Pendleton
Land Design North, Inc.
2701 Fairbanks St., Suite 202
Anchorage, AK 99503

Dear Mr. Pendleton:

Abstract diagrams (bubbles, flowcharts, matrices, etc.) can play a key role in the communication of various design factors, and thus in the development of sound design ideas, during the initial stages of the landscape architectural design. Unfortunately, there is no research done on the types of abstract diagrams used by practicing landscape architects for the communication of various design factors, to whom, how effectively, and how frequently. Answers to these questions will help to make the use of abstract diagrams more effective.

I am currently working on this research with Professor C. David Loeks, under the aegis of the College of Architecture and Urban Studies at Virginia Tech. To collect data, this questionnaire is sent to a selected sample of practicing landscape architects. Since the sample is limited, your response is of great importance. You may be assured of complete confidentiality.

The result of this research will be made available to educators and practitioners of landscape architecture. You may receive a summary of findings by printing your name and address on the back of the return envelope. I sincerely hope you will return the completed questionnaire at your earliest convenience. If you have questions, please call me at (703) 961-2365.

Thank you for your help.

Sincerely,

Jin Mo
M.L.A. Candidate
Landscape Architecture Program
Virginia Tech

Encl: 1 Questionnaire and 1 Return Envelope

APPENDIX D. APPENDED QUESTIONS--RESPONSES AND COMMENTS

Q-1 Do you think the research objectives are important enough to warrant a survey like this?

▪1) YES - 62 Respondents (67% of Total)

Comments:
- We don't always know how well our ideas are communicated.
- Especially if it is for communication evaluation.
- It will help all L.A.s to know what methods are being practiced and then see their success.
- Undergrad training in the use of abstract diagrams would be helpful - as would a publication.
- Particularly for newer firms.
- It may help develop a language better for clients.
- Especially for what clients can understand.
- I have not found a good reference book on this topic.

▪2) NO - 9 Respondents (9% of Total)

Comments:
- Each L.A. has a certain style that flows from initial communication to final presentation: there may be many.
- At this point in my career I have developed habits that work well and quickly, meeting my needs.
- Everyone's office and practice develop their own style.

▪No Answer - 22 Respondents (24% of Total)

Comments:
- Don't know.
- Depends on use.
- You have stated purpose to your four aims --- How can I judge the importance.

Q-2 Do you think the questionnaire format is adequate to serve the research objectives?

▪1) YES - 23 Respondents (25% of Total)

Comments:
- Very thorough.
- Well organized.
- Well thought out.
- It is an ingenious format and looks very interesting.

▪2) NO - 5 Respondents (5% Of Total)

Comments:
•Not complete.
•Needs more diagrams and Design Factors.

▪No Answer - 65 Respondents (70% of Total)

Comments:
•As with any data - the answer lies within the interpretation. I believe the study area to be rather subjective.
•In order to obtain a true picture opinions should be eliminated - i.e. answering for clients and other professionals.
•Hard to say, might need another survey asking similar questions and have people fill in the diagrams they use.
•Unsure.
•You might ask people to choose from the grouping what the most frequent formats are and than(sic) apply the questions to their own grouping.
•I feel it would be meaningful to ask L.A.s for examples of diagrams they use and then to examine commonalities.
•Not sure - seems it is the best format attainable.
•Hard to judge, but it seems I would have used the same format to do a survey like this.

Q-3 If you had any difficulty in filling out this questionnaire, please note the reason(s).

▪1) IT TOOK TOO MUCH TIME AND EFFORT - 33 Respondents (35% of Total)

▪2) IT WAS HARD TO UNDERSTAND THE DIAGRAMS - 8 Respondents (9% Of Total)

▪3) IT WAS HARD TO UNDERSTAND THE DESIGN FACTORS - 2 Respondents (2% of Total)

▪4) NOTES/DIRECTIONS WERE AMBIGUOUS OR CONFUSING - 1 Respondent (1% of Total)

▪OTHER - 8 Respondents (9% of Total)

•It looks imposing.
•Wide arrangement of matrix made it difficult to locate corresponding columns.
•Too complicated.
•Complex.
•Without verbal communication, I am not so sure that I have responded to this questionnaire as you had intended.
•A larger return envelope is needed.
•At first look, it is overwhelming.
•Make diagrams larger.

▪No Answer - 41 Respondents (44% of Total).[16]

Q-4 Do you have any suggestions for further research, or comments on the issue of abstract diagrams in general, etc.?

• I like the research concept; however, I would ask different kinds of professions how they illustrate various concepts then use those answers as the basis of the survey.

• Many of the diagrams illustrated are used not only in program and analysis stages, but in design development, a step that seems not specifically addressed in the survey. Also, despite ease of preparation, diagrams noted are used in a very minimal form if at all in the analysis stage, and in some cases, in program stage.

• We very rarely use any diagrams except for working out the time scale of a project or showing the management structure to a client. So far as the communication is concerned, diagrams only baffle people. Training in the use of diagrams is helpful in that it helps one to think in more organized way.

• Each office may use standard diagrams to emphasize their special expertise and are not really concerned with ease of preparation or understanding. Too often presentations to clients are "boilerplate" and do not directly address specific problems. Diagrams are useful for developing the ability to clearly visualize the design concepts.

• Abstract diagrams are rarely used in this office. In a small office with clients on a relatively tight budget, they are not cost effective. A verbal explanation is often all that is required in these types of relationships.

• We appreciate being asked to participate in the survey you are undertaking, but in studying it we find that we do not utilize abstract diagrams in our work, nor do we study the ramifications of variables. Probably our approach is cursory. We work almost wholly in the residential field and pursue a design/build business. Most of the factors you indicate in Part 1 we follow intuitively rather than in a diagramed sequence.

• The use of abstract diagrams in my practice occurs most often in large land planning projects or public oriented presentation done in collaboration with other design professionals. The graphics developed and used

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[16] This number includes 16 questionnaires that were returned without being answered.

grow from the functions and conclusions, projecting patterns that are created by group thinking or in-put.

•We do use abstract diagrams quite a bit in the initial design stages of our projects to lead the client through an understanding of the site and the rationale for the particular design solutions we have proposed for his project. In this sense, your survey seems to be well directed in its coverage of the subject.

•I would like to see that a study of published schematics and plans be done besides a "which-when" survey.

•Diagrams are not used very often; if the company pays for it, then we do presentational diagrams upon client's demand. We find diagramming rather time consuming. Most of us do it directly in our head - we become accustomed to - or prefer small-size drawings. Diagrams are used sparingly with clients, since they often misunderstand the reality: it is better to show them in rather concrete forms.

•We really don't do much diagramming. It is mostly done in one's head. We do draw doodles, which are thrown away afterwards. Diagramming may depend on who the client is: if the project is a controversial one, or if there are many who will be affected by the project, then presentational diagrams are useful.

•For us, design is a sub-conscious effort that may not need much diagramming. The extent of diagramming, and which diagrams are used, depends on the scale of a project (the larger a project scale, the more often diagrams tend to be required). One needs to be careful of what he wants to show his clients: sometimes they are 'insulted' or 'frightened' by what they see. We find diagrams to be useful when a project is controversial and a presentation to a multiple of groups is needed.

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