# Information Technology in Landscape Architecture

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## Development of Tools, Methods, and Professional Role

Licentiatavhandling

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# Contents

# Abstract

This paper discusses the impact of information technology on the tools, methods, and professional role of the landscape architect. This profession is presently expanding into new fields, resulting in an increased specialization. The new tools made available through information technology adds to the difficulties – and possibilities – facing the individual landscape architect.

The landscape architect is active in a system aimed at information processing. The study starts off in this system, focusing on the following elements: *information*, *technology*, *data structure*, *role*, *communication*, and *result*.

As a foundation for the discussion, the general history of the computer is described. With the start in mainframe computing in the 1960s, the computer today provides personal computing power, as well as access to a worldwide network for communication and information retrieval.

The historical description also covers the tools of the landscape architect – mainly maps, drawings, and images. The emphasis lies on presentation techniques, showing their evolution from the Egyptian multi-view tradition to the Renaissance single-point perspective, still dominating today. However, computer use has inspired a new form of presentation technique with several views and projections, thereby closing the circle.

One of the problems facing the digital landscape architect is access to data and information. The processing itself is also complicated by the fact that many architectural problems fall outside the range of the software, especially in conceptual design. Knowledge engineering and expert systems are only giving rudimentary support to the process. Still, the computer is used in many fields of the profession, to a rapidly increasing extent. Computer aided drafting is today standard software in landscape architectural practices. Two areas of special interest in the future are geographic information systems, and three-dimensional modeling in design and presentation as well as in construction.

Data structure is of utmost importance for the further development of computer tools. As communication and digital information retrieval increases, standards must be agreed upon. This is a complex and slow process. Digital product modeling will be equally slow in acceptance.

The range of software today covers much of the information processing that takes place in planning and design. Up till today, they have had its largest impact on communication and presentation. As a design tool, the computer has yet to prove its use to most landscape architects. Still, it use can in some respects strengthen the professional role, and give opportunities to new fields of expertise.

Acquiring the ability to evaluate computer support, and to use it in a professional situation, is largely up to the individual. The parties surrounding the landscape architect provide the framework in terms of possibilities and expectations. Customers demands for the use of digital methods are rising.

All these changes show the importance of IT strategies. First of all, the organizations employing the landcape architects need dynamic and up-to-date documents.

However, since the choices of methods and tools have a large bearing on how individuals can and will function in planning and design systems, the choices must in the end be made individually.

If the decisions are based on knowledge and insight, they can increase the possibilities for the profession to adapt to a changing society, and enhance its role as an active and creative part of this development.

# SAMMANFATTNING

Denna rapport diskuterar hur informationsteknologin påverkar landskapsarkitektens verktyg, metoder och yrkesroll. För närvarande expanderar yrket in i nya arbetsfält, vilket leder till en ökad specialisering. De nya redskap som ställs till förfogande genom informationsteknologin ökar svårigheterna – och möjligheterna – för den enskilde landskapsarkitekten.

Landskapsarkitekten medverkar i ett system ägnat åt informationshantering. Studien utgår från detta system, och fokuserar på följande element: *information, teknologi, datastruktur, roll, kommunikation* och *resultat*.

Som en bas för diskussionen beskrivs den allmänna datorhistorien. Med sin start i stordatorsystemen på 1960-talet erbjuder datorn idag personlig "datakraft", liksom tillgång till ett världsomspännande nätverk för kommunikation och informationshantering.

Den historiska beskrivningen omfattar också landskapsarkitektens redskap – huvudsakligen kartor, ritningar och bilder. Tyngdpunkten ligger på presentationstekniker, och visar utvecklingen från den egyptiska traditionen med flera samtidiga projektioner till renässansens enpunktsperspektiv, som dominerar än idag. Dock har datoranvändandet inspirerat till en ny typ av presentationsteknik med flera vyer och projektioner, och har därmed slutit cirkeln.

Ett av problemen som möter den digitale landskapsarkitekten är tillgång till data och information. Förädlandet av informationen kompliceras också av det faktum att många arkitektproblem, speciellt rörande grundläggande design, inte går att hantera i dataprogram. "Knowledge engineering" och expertsystem ger bara rudimentära bidrag till denna process. Dock används datorstöd i många av yrkets arbetsfält, och i en snabbt ökande grad. Ritprogram (CAD) är idag vanligt förekommande bland landskapsarkitektkontor. Två områden av speciellt intresse i framtiden är geografiska informationssystem och tredimensionell modellering i design, presentation och konstruktion.

Uppbyggandet av datastrukturer är av yttersta vikt inför den framtida utvecklingen av datoriserade redskap. I takt med att kommunikation och digital informationshantering ökar, höjs kraven på standardisering. Detta är en komplex och långsam process. Införandet av digital produktmodellering kommer att vara motsvarande svår att få allmänt accepterat.

Dagens mjukvara täcker en stor del av den informationshantering som sker i planering och projektering. Fram till idag har de haft störst inflytande inom kommunikation och presentation. Som designredskap har datorn fortfarande att bevisa sin användbarhet för de flesta landskapsarkitekter. Användningen av IT kan dock inom vissa områden stärka yrkesrollen, och ge tillgång till nya expertuppgifter.

Det är upp till individen att skaffa sig kunskap om hur datorstödet kan utvärderas och användas i en yrkessituation. De parter som omger landskapsarkitekten ger förutsättningar i form av möjligheter och förväntningar. Kundernas krav på användandet av digitala metoder ökar.

Alla dessa förändringar visar vikten av IT-strategier. Inledningsvis behöver de organisationer som anställer landskapsarkitekter dynamiska och uppdaterade dokument.

Eftersom valen av metod och redskap har stor inverkan på individens roll i planerings- och designsystemen måste de slutgiltigt fattas individuellt.

Om besluten baseras på kunskap och insikt kan de öka yrkets möjligheter att anpassa sig till ett föränderligt samhälle, och öka dess betydelse som en aktiv och kreativ del av denna utveckling.

# Preface

This study is the result of my employment at the Department of Landscape Planning Ultuna. I can not imagine a more pleasant way to earn a living, surrounded as I am by friendly, humorous, inspiring, and creative people. The department has given me the opportunity to engage in the tasks I enjoy the most, mixing teaching, research, advice, and hands-on computer work. It is a true favor to be allowed to contribute to the development of the department, of the students, and perhaps even to the  landscape architect profession.

The many tasks I engage in naturally compete with the research efforts. The time schedule for the work has therefor been rewritten on several occasions. I do not however pity myself, since it is a situation I probably share with most people trying to produce scientific work. On the contrary, most of the work I do provide me with input into my thoughts concerning the research task. This is especially true for the teaching I participate in. The reactions and efforts from students are often valuable for my investigation in the professional attitudes to information technology. The increased demand for IT courses also deepens my motivation for evaluating the use of computer tools.

There are a number of people to whom I especially want to express my gratitude. First of all my tutor, professor Örjan Wikforss. He encouraged me to start the work, convinced me that it was doable, and gave me invaluable and strategically important advice on the overall design of the paper, as well as on details. Torbjörn Suneson, head of the department, has with his never ceasing energy and commitment given me a steady base to stand on. Tuula Eriksson gave me valuable advice concerning the use of qualitative methods. Professor Clas Florgård, Kurt Löwnertz and Fredrik Wallin all read a preliminary version of the report, and made many important suggestions. Susan Paget advised me on several occasions when my knowledge of the English language reached its limits. My wife Kicki helped me find a number of misspeled words and incomplete.

The generosity of the interviewees to share their opinions has made the work possible, and others have courteously permitted me to reproduce images. Thank you!

Finally, I am grateful to the Swedish National Board for Building Research (Byggforskningsrådet), for providing the economical base on which to do the work.

Uppsala, November 1999

Klas Eckerberg

# Chapter 1
# Purpose and Study Design

The development of a profession over time is influenced by a number of factors – the political and economical changes of the society, the development of tools, research results, the evolvement of other related professions and so forth.

The professional field of the landscape architect has over time become wider and wider. The traditional task of designing gardens and public spaces is still alive, but more and more landscape architects have come to work with city and regional planning, assessment studies and other environmental issues. This widening forces a specialization, which decreases the bondage in the corps of landscape architects and increases the competition from other professions.

Atop of this comes the fast technological progress. The access to information technology can lead to changes in tools and methods in all of the professional fields of the landscape architect. Traditional tools like perspective drawings, ink drawings and maps now get competition from – or are complemented by – computer-made virtual realities, digital product models and geographical information systems (GIS).

## Purpose and Questions

After a dozen years as a professional landscape architect, working mainly with designing housing and industrial projects, I had gathered a great deal of experience in the use of computers. After thousands of hours with CAD, photo manipulation and desktop GIS, I started teaching these tools to landscape architect students. The obvious interest from the students, and their firm belief that computer experience was necessary for a successful career, pushed me on in my thoughts concerning ”the use of it all”.

These thoughts have a tendency to dominate the mind when the computer systems fail to deliver their fine promises. The seemingly eternal frustration over poor software programming, slow computers, unstable networks and jamming printers kills a great deal of the joy one could feel, being a part of a system with high and important goals. Why does this happen so often? The poor performance of the products of the computer industry is inconceivable in any other business.

Who would buy a car that halts every time you press the gas pedal too hard; that uses gasoline you can buy in only one station; that only runs on certain roads that meet obscure specifications; that has ten varieties of trailer hooks which seldom seems to fit with the trailers'; where spare part cease to exist after a year; which is hopelessly old after 2-3 years? What forces makes us customer accept these realities when buying a computer? Are the benefits really greater than the troubles it causes?

Still we use computers, some of us more than others, hoping that it will help us in performing professional tasks. I use computers because I enjoy it – it seems to fit my personality. Other people use them because advertisement, colleagues, or their bosses have convinced them that computers are one important factor on the road to success.

When asking my students why they attend the IT courses, I get all kinds of answers, ranging from very concrete goals of mastering AutoCAD, to vague hopes that it will be useful in the future. These examples show different attitudes, or perhaps levels of maturity, when reflecting over one's own situation as a professional or a student.

This reflecting is difficult, mainly because of the complexity of the changes facing us. The development of information technology can perhaps be scaring, making some people keep the computer at arms length. This is applicable for students as well as for the staff at the department. Some still use the computer only for "typewriting" and for e-mail, and take no IT courses.

This picture is however steadily changing – newer students seem to be somewhat more used to the computer, and IT use is spreading in traditional courses.

Another source of inspiration was the colleagues at the department. The history of the landscape architect profession and the importance of the professional methods are two issues that are often debated in seminars (and in the coffee room).

These discussions have been greatly stimulated by Donald Schöns' *The Reflective Practitioner* (1991). In this work, Schön strongly advocates reflective research. By conducting studies concerning for instance the tools and methods of a profession, the professional schools may raise their standard and status in compassion to the traditional scientific institutions, and help the profession itself.

So why are computer skills so important? What does it mean to the landscape architect to use the computer? According to Schön, new technologies changes the demand on the architect[1].

After a great deal of thought and discussion, my concerns were boiled down to this: how do the methods and tools of the landscape architect affect the professional role and the results of the work? How does the use of information technology come in to this question?

The availability of the computer has already meant greatly widened possibilities in a long range of fields:

❊ Landscape analysis can handle much larger data sets, and make more complex weighting of factors, with the use of GIS.
❊ Design ideas can be explored and examined in the exact environment of computer-aided design (CAD).
❊ The traditionally artistic work with presentations can today be replaced with photo-realistic computer images.
❊ Manually made drawings can be replaced with digital product models, which can be used for specification, cost analysis and production management.
❊ Product models built up during the design process can be reused for maintenance purposes. Maintenance of parks and other green spaces can also be handled using GIS, to give fast and accurate basis for calculations and purchase.
❊ The Internet has brought a number of new tools for communication, between individuals and for project cooperation.

The possibility to use the personal computer is still so new that a lot of prejudices surround it. I found a typical example of the opinion that the computer has a restraining effect on artistic work at such an unlikely place as the cover of some Swedish stamps. The motifs on the stamps were the result of a competition among art students, and were commented by Lasse Åberg, artist and film director.[2]

*1. [A]rchitects will have to function in radically new ways as a consequence of the introduction of new building technologies, new patterns of real estate and land development, and new techniques of information processing in design. As the tasks change, so will the demands for usable knowledge, and the patterns of task and knowledge are inherently unstable. (Schön, 1991, p. 15)*

*2. I am glad to see that the winning stamps possess an aura of kindergarten, which must mean that the students still use such relic ["K-märkta"] tools as paper, knife, pens and other nice tactile tools.*

*I don't want to seem hostile to technology, but it has become much too easy for people without formal training to produce complete works on computers that later hits us as typographical pollution. (…)*

*But perhaps I'm just jealous because I haven't succeeded (or wanted to succeed) in learning to handle computers and surf the Internet (Åberg, 1996).*

The following questions arise from the quotation:

❊ Does the computer really give the user access to short cuts that make professional skills obsolete?
❊ Or, perhaps worse, does IT force the user to think, behave and produce in such a way that it hinders the professional and creative processes?
❊ Is there a cultural barrier between those who use computers and those who don't?

These are the questions of a person addicted to manual methods. One could of course easily turn the questions around:

❊ Does the computer enhance professional skills?
❊ Does the use of computers promote the creative process?

These questions could act as starting points in the effort to examine IT use among the professional landscape architects. They will be elaborated into more specific questions in the part describing *Research Design*.

Originally, my main reason for entering the research world was to share my experiences, to raise the awareness of the information technology and its implications, and to test and perhaps even improve computer tools that would help landscape architects in their work. I wanted to "spread the word" among my colleagues, make them "see the light".

These well-meaning but perhaps naive goals have been adjusted as my "scientific maturity" has grown. The rapid evolution of IT, especially the explosive growth of the Internet, has already made "everyone" aware of the fact that it is hard to escape the reach of the computers.

Nevertheless, I hope that this paper in some way can contribute to the understanding of the questions stated above. Hopefully, the work will be continued, both in the scientific form and for a broader audience. Awareness of the tools and methods is *one* part of the thinking of the reflective practitioner. According to Schön, moving back and forth between practice and reflective research careers can be very rewarding – for the individual as well as for the profession.

## Problem Limitation

The study is concentrated on the situation of the landscape architect. Many aspects of this profession are common with others in the field of planning, design, and maintenance. Most parallels can be drawn with other architects – a fact that has made this study possible.

The study is aimed at the architectural aspects of computing. The use of computers to aid in office management – document flow, budget making, project management, archiving et cetera – is only mentioned in passing.

The question of how clients and the public react to the work of the landscape architect is not studied in depth. Studies of the interpretation of e.g. pictures and drawings is a vast field, interesting and in a sense central to the professional planner and designer. Nevertheless, this study concentrates on the *profession* of the landscape architect, not how the rest of the world judges the results that comes out of their efforts.

Another important limitation is that personal, in terms of *psychological*, factors are only hinted at. This is not because I consider them less important. On the contrary, they are of course the very foundation of everything we do that affects the world around us. Even such a prosaic subject as a person's attitude to the use of computers is partly caused by personality, confidence, early experiences in life, emotional stability, and the ability to cope with stress[1], just to mention a few personal factors.

*1. Especially caused by malfunction in computer system!*

However, this does not mean that psychological phenomena are excluded from the statements and interpretations of the study. The latter are inspired by existential hermeneutics, which takes great interest in emotional aspects of empirical sources.

This paper is  a licientiate thesis, and thus planned to be the first of two parts. It has three main purposes:

1. To paint a historical background to the use of information technology in landscape architecture.
2. To describe the most common IT uses.
3. To make an introductory case study.

The second part of the study will broaden the case study, to encompass landscape architect with only little experience of IT use – some of them skeptical or negative to computer support.

## Definitions

In everyday language, there is a sometimes-confusing lack of borders between the three concepts knowledge, information, and data. Even Webster's Dictionary (1979) mixes the words in its definitions. So is e.g. information described as "knowledge acquired in any manner; facts; data; learning; lore". For scientific purposes however, definitions that are more stringent are needed.

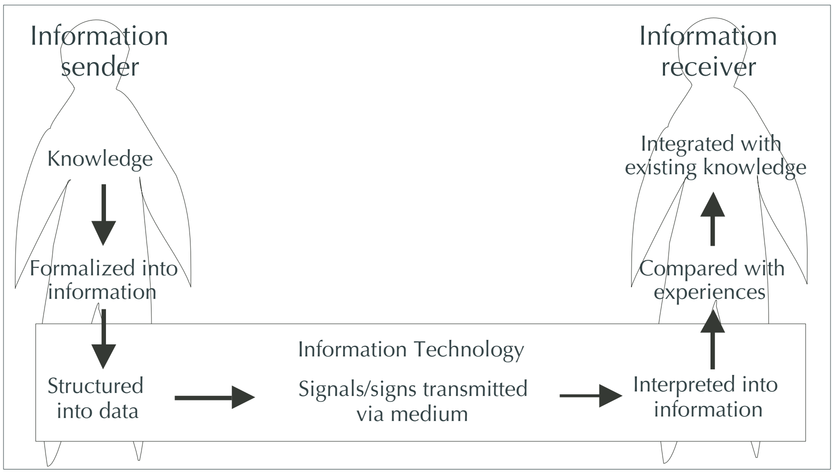



*Figure 1. Information and communication*

Knowledge

Webster's Dictionary has a more useful explanation of the concept of knowledge. "A clear and certain perception of something; […] understanding", but also "practical experience; skill". The important factor is the personal level – human knowledge is always based on personal experience. Facts must be experienced, analyzed, valued, and internalized before they become part of an individual's knowledge.

There is however one collective meaning of the word knowledge that is commonly used, namely to designate the whole body of information of mankind. However, this use of the word can easily be disputed. The amount of information is growing at a rate that is impossible for a single individual to grasp. For many people, the growth of information does not lead to increased knowledge, but rather to "information stress". This stress leads to quite contrary effects. Too much information, served at too high a speed, can cause people to isolate themselves. Instead of relying on new information, it is a very human reaction to cling on to old prejudices.

Knowledge acquired by practical experience is sometimes denominated *tacit knowledge*. The trainee learns from his master, not by his instructions (information) but by watching, practicing, and occasionally get a hint on how to do. Acquiring of tacit knowledge also requires a shared reflection by the master and the apprentice over techniques, means, and goals. The reflection must also be made by using a language appropriate for the trade (Lundequist, 1995:2)

Information

The Latin origin of the word information – *informare* – means ”to give form to, to represent”. This distinction makes it much more useful than the definition in Webster’s, cited above. Most often, the word is used to designate a *representation of knowledge*, possible to transmit between two parties. When trying to convey knowledge, it has to be transformed, i.e. represented in a more simple form.

In order to be successful, the representation must be adjusted to fit the receiver. The receiving party interprets the information, ideally to again convert it into personal knowledge. These interpretations are complicated, because many terms and concepts are biased, loaded with values, conflicts, and other personal, societal and political attitudes.

For a long time – perhaps up to the 1970s – professional knowledge was largely unquestioned. The professional’s interpretations of information have since then had a large number of setbacks, which has led to an increasing crisis of confidence in professional knowledge. Most people have today at least a healthy skepticism towards ”experts”, and are well aware of the problems of interpreting information.

Data

When transferring information by use of digital tools, it must be structured in a way that can be represented by binary data. Data: ”things known or assumed; facts or figures from which conclusions can be inferred; information” (Webster’s Dictionary, 1969). Once again, terms are mixed; here an equal sign between data and information. More often, data is viewed as the ”building blocks” of information, or message carriers from the sender (Lundequist, 1995:2).

According to the SIS definition, data is a representation of facts, concepts, or instructions in a form suitable for transferring, interpretation, or processing by humans, or by automatic tools.

Data can be stored in many forms – letters, digits, images, video, and sound recordings, drawings and so forth. All of these forms are possible to represent in digital form, for use in computers. By storing data in a simple form, computers can quickly perform different tasks – searching, retrieving, combining, calculating and so on[1].

*1. This ability is the basis of the Swedish term for the computer: dator, or datamaskin.*

This transfer is not possible for all sorts of knowledge. Many skills and a great part of the personal knowledge cannot be formalized, and thus not transformed into information. It is impossible to computerize tacit knowledge . Emotions and other subtle facets of the human mind are also hard to simplify into well-defined concepts.

Jerker Lundequist presents this description of the relationship between knowledge, information and data.[2]

*2. Information is in fact a concept of something that only exists as the possibility of knowledge that a certain amount of data can give (Lundequist, 1995:2, p.x)*

Technique

Technique is a term that is used in many ways. The broad definition is, again from Webster's: "the method of procedure (with reference to practical or formal details) in rendering an artistic work or carrying out a scientific or mechanical operation". Most dominant of these examples is the mechanical side.

Technique can also be a personal property, as in skill in using tools, instruments, and so on. For example, a golfer scoring par after par is demonstrating good technique.

Technology

Technology is originally the science of technique. In daily speech, however, the term is often used as a synonym to technique. In this paper, the term is used with both of these meanings – hopefully in ways that makes it understandable. It is here limited to the use of electronically based techniques – mainly computers and networks, peripheral equipment, and computer programs needed to use the machines ("hardware" and "software").

Information Technology

The concept of information technology is in this paper defined as *technique used for storing, processing, and transferring information*. In the last decade, the concept has been centered on the use of computers for this purpose. However, the span of information technology is rapidly growing, now encompassing large parts of the computer industry, telecommunications, mass media, and even power supply.

The fact that only a small part of human knowledge can be represented by information greatly limits the use of information technology. However emotional the IT discussion can become, computers are very clumsy tools when trying to convey something more than dry facts. The spirit of a garden in spring; the expression of a new building in an old city; the beauty of a road that harmonizes with a landscape – these are all difficult to express by use of computers.

Most architects thus have to deal with two fundamentally different kinds of information. Technical functions can often be described in forms that can be made digital; aesthetic and artistic values are much more difficult to computerize. This conflict is one important starting point for the discussions in this paper.

# STUDY DESIGN

1. *The term originates from Nathan Glazer.*

As Donald Schön vividly describes, designers belong to a ″minor″ profession[1]. The ″major″ professions – lawyers, doctors, and others – base their authority on science. They rest on a solid base of knowledge, rooted in techniques and theories developed by scientific research in universities over the centuries. This knowledge has for centuries been the core of the academic institutions, and has given the major professions common – or at least fairly undisputed – goals to strive for.

The minor professions have yet to achieve this status. For them, the scientific efforts must to a great extent deal with the foundations on which research rests. The search must be for a common and consistent terminology; to find scientific traditions to follow; to investigate, test, and evaluate methods to rely upon.

Obviously, not all research within the design professions needs this scientific foundation. There are no clear borders between research and evaluation, or between research and development of materials, methods, techniques, tools or work forms (Lundequist, 1995:1).

This chapter aims at describing the design of the study, and putting it ″in its place″ in terms of scientific tradition and choice of method. It is however a brief description, which will be extended in further work.

This paper presents *Part 1* of a study dealing with the tools, methods, and professional roles of the landscape architect. It concentrates on giving a historic and contemporary description. The main source of information in the work is literature studies, complemented by a small series of interviews. Three landscape architects have been part of a beginning series of case studies, with the purpose of shedding light on different approaches to IT use.

The planned *Part 2* will enlarge the series of interview, to broaden the perspective to as many fields of practice and experiences as possible. It will concentrate on contemporary and future possibilities and problems concerning computer-aided techniques.

Chapter 1, *Purpose and Study Design*, describes the reasons for and the methodological background of the study: scientific theory tradition, scientific method, and finally theories and propositions.

Chapter 2, *Historic Background*, has two sections. The first presents some highlights of the fast and exciting history of computers and software, with some examples from use in architecture, building and construction. The second part consists of an historic exposé of the use of maps, drawings, and images in landscape architecture.

Chapter 3, *The Landscape Architect – Tools, Methods and Professional Role*, constitutes the bulk of the work produced. It aims at giving a contemporary description of the problems studied.

Chapter 4, *Result, Conclusions and Further Studies*, tries to sum up the different views presented mainly in Chapter 3, and shows some possible subjects for further studies.

## Scientific Theory Tradition

When raising one's focus from the daily work of the practicing designer, in an effort to truly reflect on its problems and limitations, possibilities and future, there is a whole new world to conquer first. This world is far from the mainly technical methods taught at school and in further training. The old and safe tools – sketches, drawings, technical studies – are not applicable any more. As a budding researcher, the first chore one has to carry out is to get oriented in scientific theory, learn about paradigms and traditions and famous forefathers in philosophy and science. One has to grasp the concepts of epistemology and ontology, theory and empiric evaluation, qualitative and quantitative research, induction and deduction, hypotheses and propositions. It is not an easy task to evaluate all this information, to put all the notions at their proper "level".

This paper contains a brief summary of my efforts to explore parts of this world. It will be described in more detail in future work.

As I see it, I need a smorgasbord of theories to back me up in this study. I simply cannot find one single movement that sufficiently supports my personal views on how research should be conducted. What then can I distill from the different theories?

❊ *Systems theory* is needed because the landscape architect can be viewed as a part of a system. He or she cannot make decisions about tools and methods without consideration to other parties. Building a system model can help guide the line of questioning.

❊ *Hermeneutics* is the base of the interpretations of statements made by the interviewees. The interpretations should be made in a floating series of steps; i) analyzing the original statements and observations, ii) finding underlying meanings, iii) finding aspects of ideology, politics, social reproduction, iv) "self-analysis" of the text of this study, claims of authority, selectivity.
❊ In doing case studies, *ethnomethodology* is used. Although the interviews are based on a loose set of questions, the main objective is to find thoughts, explanations, rules et cetera expressed by the interviewees. This data is needed in order to build theories concerning how tools affect the professional role.
❊ *Symbolic interactionism* has been an important source of inspiration. Some key words of this movement are pragmatism, understanding, exploration, social action, cognitive symbols, and closeness to empiric data. These objectives have served as a guide.
❊ Performing case study is one way of collecting data for *grounded theory*. From interview statements, theories can be generated. However, the tenuous coding of classic grounded theory has not been used. The study does not pretend to be totally objective and free from bias. Statements are classified in a more intuitive, or abductive, fashion, using my pre-understanding of the issue.

From all of these perspectives, a synthesis has been made that hopefully is appropriate to the problem of the study.

## Scientific Method

After digesting some scientific theory, the methodological aspects of research must be given attention. In short, this work aims at finding methods for data collection, and which kinds of data to use; deciding on how to analyze the data acquired; and finally how to test the validity and reliability of the results.

Data Collection Method

First of all, practical methods for collecting and analyzing data must be found. Concerning the problem of data analyzing, the most important theoretical movements listed above. As for data collection, it was clear that case studies would be most appropriate. Many authors, for instance Jerker Lundequist, supported this decision.[1]

The main part of the investigation was thus conducted as a series of case studies. The "cases" are easy to define – they simply con-

*1. Research on design and product development aims at producing knowledge about the social, economical, technical and psychological terms of these activities; this type of research is often carried out as limited case studies, aiming at concept development. (Lundequist, 1995:1, p. 12)* sist of a small number of landscape architects. This group has been used as the most important source of empirical data for the study. Their views on the situation for the landscape architect in the past, today and in the future has been analyzed.

The decision to use case study methodology was not hard to make. I saw no other way of getting to know the thoughts of a number of colleagues. Questionnaires in surveys cannot be designed to harvest the complex kind of experiences, attitudes and values that I was after, nor can they communicate directly back to me. Experiments are quite obviously out of the question. Neither could I find the contemporary kind of data I was looking for in any kind of archive.

In the literature, there are numerous references to the usefulness of case study research. One of the strongest spokesmen is Donald Schön. His excellent book *The Reflective Practitioner* is in itself based on several cases. Schön uses them to show different approaches to reflection-in-action – the quality he propagates for in every professional. As mentioned earlier, Schön also invites followers to examine how this reflection is developed.[1]

*1. We know very little about the ways in which individuals develop the feel for media, language, and repertoire which shapes their reflection-in-action. This is an intriguing and promising topic for future research. (Schön, 1991, pp. 271-272)*

With this support, I felt rather confident in choosing to scrutinize how a number of individuals reflect on their actions.

Qualitative or Quantitative Method?

The study is based on *qualitative methods*. There are several reasons for this choice:

❊ The use of IT among landscape architect is an unexplored field. With the help of a qualitative approach, the characters of the issue could be examined (Wallén, 1996, p. 73). Qualitative method simply seeks to describe the qualities of a phenomenon, which is exactly the goal of this study (Eneroth, 1984, p. 347).
❊ Being a longtime computer user, I feared that my prejudices could too much influence questions put in a quantitative survey. Using qualitative methods could lessen this risk, according to Alvesson and Sköldberg.[2]

*2. An […] important characteristic for the qualitative methods is that they start out from the perspective of the study subject, while quantitative studies typically to a higher degree start out from the ideas of the researcher concerning which dimensions and categories should be in the center (Alvesson & Sköldberg, 1994, p. 10)*

A conscious use of reflective analysis, dealing with the interpretations of facts and my personal convictions, could also strengthen the results.

❊ The goal of the study is *understanding* an issue rather than *measuring* effects or trends. When qualitative methods are used, new

and unexpected ways of explaining can enlighten the issue (Wallén, 1996, p.73).
❊ Grounded theory, with its emphasis on theory *generation*, also advocates the use of qualitative data when studying complex phenomenon and processes (Alvesson & Sköldberg, 1994, p. 73).

Quantitative methods simply have too many prerequisites that conflict with the goals of this study, as well as with my personal values. First, quantitative method departs from a logical-deductive view on knowledge – reality is *tested* against a concept or theory made in advance. It is also based on an *atomistic* comprehension of reality – the notion that everything can be understood by dividing it into smaller parts, and then put it back together again. Furthermore, it claims that subject and object are separable, that the scientist can free himself from the reality he is examining (Eneroth, 1984, p. 11).

In reality, this extreme form of quantitative research is rare. Most modern studies accept the fact that science does not stand free from the subject of study. Nevertheless, all three of the factors mentioned disqualify quantitative method from this study. Since the issue is unexplored, there are no clear theories to start with. Some assumptions are made, based on personal experience, but not enough to make testable hypotheses from. The landscape architect is clearly a part of a system, impossible to study separately. Lastly, I am indeed a part of the object of the study – to the extent that I will use my own experiences as one data source.

However, the decision of method is not an easy one to make. For a newcomer in the scientific field, it is easy to get confused. The main part of the literature in social science does not concern itself with the kind of topic dealt with in this study. Finally, I decided to be pragmatic about this issue. Research problems are always to some degree depending on the epistemological and theoretical starting point of the researcher, which means that method and problems are mutually affecting each other. (Alvesson & Sköldberg, 1994, p. 11) I simply felt that I had to choose the method I was most comfortable with, and where I could have some degree of faith that I would reach at least some unexpected conclusions.

Obviously, there are a lot of difficulties and disadvantages in using qualitative methods.

❊ Quantitative methods (”statistics”) tend to be more effective than qualitative methods (”reasoning”) in bringing the message out to a more general knowledge.
❊ The pre-understanding of the researcher, and his influence on the studied population, makes it hard to perform objective investigations and evaluations. The results tend to conform to the expected.
❊ The reliability of the results can be hard to test. Social events are difficult to duplicate for another researcher.

The second problem is the same as for quantitative methods listed previously. The solution is to openly account for my subjective choices and experiences, for the reader to evaluate. The quote summarizes the debate between the two methods.[1]

*1. [T]he qualitative method seeks a concept that will cover a given part of reality, while the quantitative method seeks a reality on which to test a given concept. (Eneroth, 1984, p. 49)*

In this study, it was finally a simple choice to use the former method.

Inductive, Deductive or Abductive Method?

One important issue in the debate between methodological movements is whether research should be based on *inductive*[2] or *deductive*[3] reasoning (Wallén, 1996, p. 47). Is theory generated as a result of investigations and understanding, or is it the point of departure for the following search for empirical data to support it?

*2. Induction: in logic, the process of reasoning or drawing a conclusion from particular facts or individual cases.*
*3. Deduction: reasoning from a known principle to an unknown, from the general to the specific, or from a premise to a logical conclusion.*
*(Webster's Dictionary, 1969)*

Qualitative studies are generally inductive. The critical point of this method is of course that theories generated cannot encompass anything more than can be found in the empirical data. Since data collection is based on presumptions, so will the theories be.

In deductive studies, theories and hypotheses have a more independent position. A general rule is the start, and cases or facts are presented that can be explained by the rule (Alvesson & Sköldberg, 1994, p. 41). Consequently, deductions tend to be shallow, simply demonstrating that a rule is followed in a specific case, and not *explain* anything.

There is also a third model of viewing scientific work, namely *abduction*. This is similar to induction in the sense that it departs from empiric data. However, it is not a simple ”condensation” of facts into theory. Instead it is a dynamic process, where the area of empirical application is successively developed, and the underlying theory is adjusted and refined. In this sense, *understanding* becomes central. (Alvesson & Sköldberg, 1994, p. 42)

Abduction is not a new method, invented to solve the problems connected with induction and deduction. It dates back to

Aristotle, but has been further developed in recent years. It may even be so, Alvesson & Sköldberg reason, that it is the ”primary” way of dealing with scientific problems; perhaps induction and deduction are *phases* of abduction, artificially derived from it.

Abductive research must move in circles – or perhaps in a zig-zag motion. The works starts with the pre-understanding of the researcher, who sees empirical patterns, or superficial structures. The researcher then uses empirical data of a case to find deep structures. These structures, or theories, are tested on new cases, which lead to refinement of the theories, and so on.

The theories thus tested are by no means objective. They are the subjective result of the perspective of the researcher. Facts are always ”loaded” with the values of the person using them.

Method Validity

Case studies should be exposed to the same attention to validity as other research designs. There are four commonly used test methods (Yin 1991, pp. 33-37):

❊ *Construct validity*: establishing correct operational measures for the concepts being studied. This is especially problematic in case study research. Three tactics for dealing with problem are using multiple sources of evidence; establishing a chain of evidence; and having the draft case study report reviewed by key informants. In this study, I use the first and last of these methods.
❊ *Internal validity* (for explanatory or causal studies only, and not for descriptive or exploratory studies): establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious (false) relationships. The problem is not applicable to this study.
❊ *External validity*: establishing the domain to which a study's findings can be generalized. Important here is to remember that case studies rely on analytical generalization, and not statistical generalization as in survey research. Theories must nevertheless be tested – in multiple-case design normally through replication in several cases. I will try to make this generalization in respect to other, neighboring professions.
❊ *Reliability*: demonstrating that the operations of a study – such as the data collection procedures can be repeated, with the same results. Noteworthy is that reliability can only be tested in the same cases – not by replicating the work with other cases. This can only be achieved if the study is well documented in terms of procedures as well as empiric data, as I have tried to do.

What then about the drawbacks of case study research? Most of them are, according to Yin, traditional prejudices. These exist mainly because too many "sloppy" case studies have been presented, he claims. If they instead are carried out, using rigorous methods and protocol writing, the status of the strategy will rise.

The problem of validity – which is held against case study research – can be countered by using the test methods above. Even more important is to remember the fact that *case studies can be generalized only in regard to the theoretical propositions stated in the study – not to actual populations or universes*! (Yin, 1994, p. 10) This applies to scientific experiments as well, according to Yin.

Data Sources

The empirical data used in a case study can come from six different sources: documents, archival records, interviews, direct observation, participant-observation, and physical artifacts[1] (Yin, 1994, p. 378). In the actual case study phase of this project, interviews have been used – statements of a group of landscape architects have been collected in a series of meetings. These were supplemented by the collecting of physical artifacts[1] and by literature studies.

This use of multiple sources is one of the strongest benefits of using the case study strategy. By having different kinds of empirical data backing up the theoretical propositions, the problems of construct validity can be addressed (Yin, 1994, p. 92). The results can either *converge*, and thus "triangulate" as to which findings or conclusions are the most convincing and accurate; or be *non*-converging, each source leading to a different conclusion.

*1. In this work, perhaps* digital *artificts is a more correct term ;-)*

Data Source I: Interviews

There are several forms of interviews. Yin lists three main types (1994, p. 84):

❊ *Open-ended* interviews. The respondents are asked for facts as well as opinions and explanations to the problems of the study. Even suggestions for propositions that change the base of the inquiry can be asked for.
❊ *Focused interviews*. The respondents are interviewed for a short time period. The interview normally follows a set of questions from a protocol.
❊ *Structured interview*, where the questions follow the lines of a formal *survey*.

In this study, the use of open-ended interviews was chosen, mainly because the need for input into the propositions formulated in the beginning of the study. The systems model used to categorize the questions was deliberately open and ”diffuse”. The outcome of the interviews was to a great extent influenced by the interviewees. This was again inspired by Yin.[1]

*1. The more that a respondent assists in this [open] manner, the more that the role may be considered one of an "informant" rather than a respondent. Key informants are often critical to the success of a case study. Such persons not only provide the case study investigator with insights into a matter but also can suggest sources of corroboratory evidence – and initiate the access to such sources. (Yin, 1994, p. 84)*

As mentioned, multiple-case study design demands careful selection of the cases, with consideration to the different kinds of replication. In this first part of the study, members of the small group were selected among landscape architects known to have a special interest in using different kinds of computer support. The group is biased in the sense that the members are attracted to the technology, and narrow in the sense that it represents only private practices. This was of course a made with a purpose, namely to show as many positive examples as possible within the small study, and within a field close to my own professional experiences. Being a beginner in the field of qualitative sociology, it was comforting to start doing interviews with my ”peers”.

As this first part of the study is concentrated on background research, only three people have been interviewed. In the next part of the investigation, the group will be enlarged considerably, in order to give a broad view of the many aspects of the studied problem. The interviewees will then consist of landscape architects from different professional fields, and with different experiences of and attitudes towards using information technology.

The interviews were made in 1998, at work, and in the working hours of the interviewees. They were open-ended, giving each interview an individual profile. However, all cases covered the same set of questions - or rather issues - which was prepared beforehand. (The interview manual is shown in Appendix A.) The interviewees were not given the questions in advance. The only information they had received was that the interview would focus on their views on how computer use affected their professional work.

The steps taken in registering and analyzing the interviews are described in Appendix B. In this first part however, analysis was not as thorough as the appendix suggests. Instead a more intuitive interpretation was made, based on my pre-understanding of the statements. My ambition is to reach further into hermeneutic analysis as the work continues, and more interviews are made.

The interviewees are kept anonymous in the study. When cited, they are referred to as IS 1, IS 2, and IS 3 (Interview Subject 1-3). In some of the quotations from the interviews questions are included, preceded by a "Q". The answers are preceded by an "A".

The three interviewees are by no means representative of the landscape architect profession. Two of them were chosen based on personal knowledge, the third by recommendation from one of the others. They are all highly skilled IT users, male, and between 35 and 49 years old.

IS 1

Interview subject 1 (IS 1) is a Swedish landscape architect with 14 years experience, employed at a large technical and architectural consultant practice, with offices nationwide. His office employs around 40 people, of whom 8 are landscape architects.

Work tasks are varied, covering small-scale design, road design and environmental assessment studies. IS 1 is a visualization expert, occasionally helping colleagues in other offices to illustrate design projects.

IS 2

Interview subject 2 (IS 2) is an English landscape architect, sharing his time between teaching and running his own business as an IT consultant. He has a solid background in computer programming as well as landscape design on all levels. He started working in 1985, and has experience from small as well as large consultant firms.

As an IT consultant, he is often called in to assist in visualization, environmental assessment and terrain modeling.

IS 3

Interview subject 1 (IS 3) is English, working in a large company, purely in the field of landscape architecture. A substantial part of the business is conducted abroad. The firm has a high profile, marketing itself with quality and high-status projects.

The career of IS 3 started in the early 1990's, and has moved from a small landscape architect office, via a large engineering firm to the present occupation. As practicing manager, he is responsible for preparation and implementation of the IT strategy.

Data Source II: Literature

Literature dealing with different kinds of IT use in planning and architecture is abundant. It is impossible to cover the whole field within a study of this size. I have tried to cover the aspects I have found most important, and get views from different parts of the world. The emphasis of the literature studies has been on different aspects of CAD and GIS.

Apart from literature in this major area of the study, the scope of reading has covered the history of garden and landscape planning, and of the general evolvement of information technology. Inspiration from these sources has been important as a background to the main subject. It was for instance almost a revelation for me to discover the deep historical roots of the methods and techniques we currently use.

## Theories and Propositions

The design of this study clearly puts it in the field of *evaluative research*. The main purpose is to explore and describe the landscape architects' use of tools and methods. Schön would describe this as *reflective research*, aiming at raising the awareness of the repertoire of the profession – to aid the reflection-in-action used in the design process.

In order to clarify the issues, a systems theory approach was made to describe the landscape architect. In this way, a structure for interview questions – and for the report itself – could be outlined.

A model was constructed, with the overall aim to picture the *flow of information* in a process where a landscape architect is involved. It starts with gathering of information, and ends up in a result of the process. In between we find the technology and methods used, how data is structured, what role the landscape architect plays, and how he or she communicates with others in the process (Figure 2).

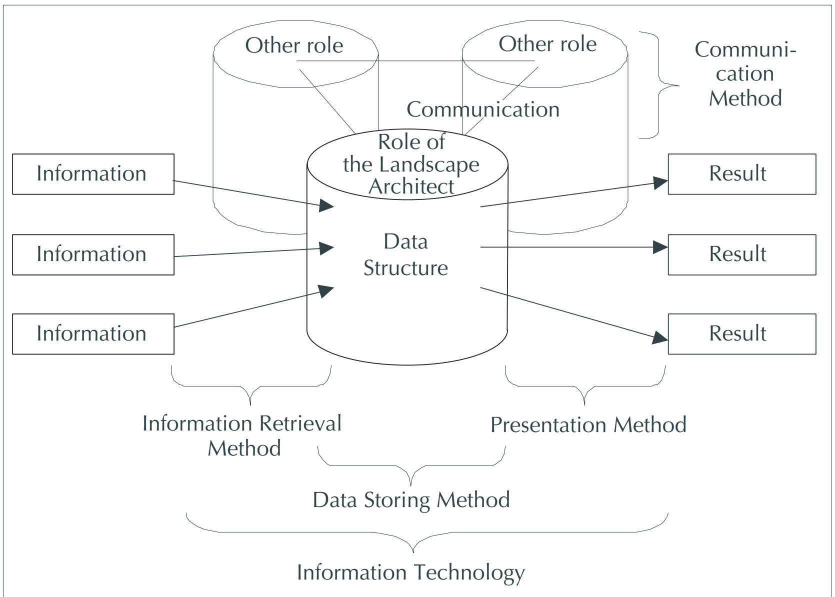



*Figure 2. The landscape architect as a part of an information technology system*

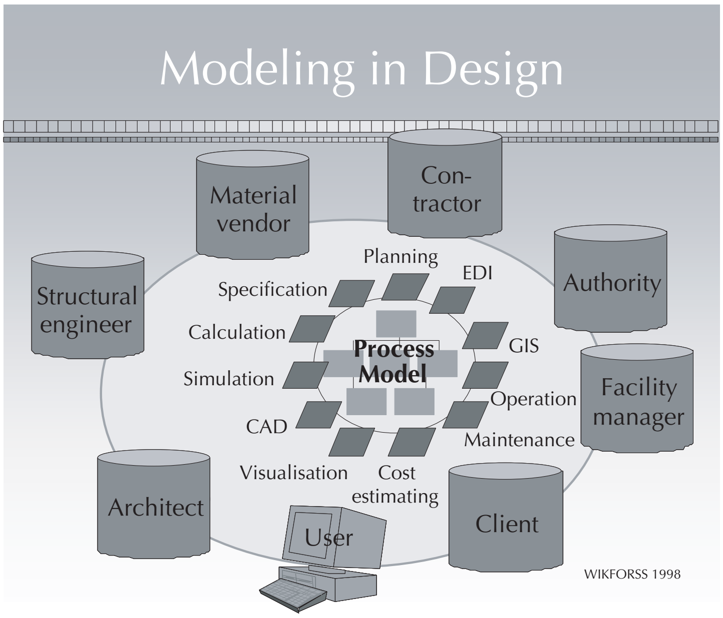



*Figure 3. Modeling in design – process model by Örjan Wikforss.*

This communication – and co-operation – is essential in every project. Örjan Wikforss illustrates some of the parties and techniques involved in Figure 3. Figure 2 can thus be considerad a subset of Figure 3.

The lowest bracket in Figure 3 designates that information technology is used in all the arrows and lines connecting the parts of the system. The parts of the model can be described as follows:

❄ *Information*. What kind of information is being handled in the processes in which the landscape architect is involved? What sources are used? What is the purpose of using the information?
❄ *Technology*. Which technologies does the landscape architect use in the process? Which tools are handled? How does the choice of tools affect the process of decision-making?
❄ *Data structure*. In which different ways does the landscape architect organize his work in terms of structuring the data used in the process? Is data stored in digital form, or are more traditional methods preferred? Are project handled ad hoc, based on experience, or are more structured ways of controlling data used – perhaps formalized quality assessment and software for workflow control?
❄ *Role*. Which are the roles the landscape architect can play in different types of projects? Are they affected be the use of information technology?
❄ *Communication*. With which parties does the landscape architect communicate? Which communication tools are used, and how are they changing? To what extent do other parties affect the work of the landscape architect?
❄ *Method*. Which methods does the landscape architect use when performing the different roles? How are these methods brought into the repertoire of possible ways to deal with a problem? Are methods learned by traditional ways of education? Are there other ways of finding methodological models?

❊ *Result*. What are the characteristics of the result of the processes? In which ways does the result reflect the tools and methods used? How do the recipients – clients, contractors, colleagues, and the public – view the different types of work made by the landscape architect? Are there differences in interpretation of the same kind of work, produced with traditional methods and with computer aid, respectively?

This description, with its large set of questions, was obviously not encompassed in all the interviews. It did however make it possible to keep them ”on track” most of the time, thereby providing the data needed for the evaluation.

The model can easily be accused of being too simple. However, Max Weber and his idea of ”ideal types” give support of this way of building models. Briefly, this means that the ”categories” of the studied object are ”purified” and sorted into characteristic (or ideal) types.

There are of course many other factors affecting the professional landscape architect: the availability of tools and techniques, attitudes on the personal level and in the environment, time, economical resources et cetera. These will be discussed in later sections of this report.

Theories

When conducting case study research, theory development is essential (Yin, 1994, p. 27). The role of the theory is different, however, from the ”grand formal theories” used in social science. Yin views the theory as a ”blueprint” for the study, based on theoretical propositions.

Theories for the study do not have to be ”invented”. Existing theories can be found in literature dealing with the problem at hand. In other cases, descriptive theories may be appropriate. The theory then focuses on the study's purpose, range of topics that will completely describe it, and which of these that are the most important. A third type of theory must be used when the topic is previously untouched by research and literature. In these cases, the theory simply states the topic of the study, the purpose of the exploration, and the criteria by which the exploration will be regarded as successful (Yin, 1994, pp. 28-29).

The main theory of this study simply suggests that:

❊ *The choice of tools affects the methods, roles and result of the work of the landscape architect.*

Propositions

In order to clarify the issue at stake, it is important to state some propositions. Study design is, in the words of Yin, mainly a logical problem (1994, p.20). By using logical reasoning, one can clearly see the weak points of a study.

Derived from the questions and starting points expressed in Chapter 1, the following propositions for the entire study can be formulated:

- The tools and methods made possible by information technology gives the landscape architect opportunities to concentrate on the *design process*. The use of IT minimizes routine tasks such as administration and cost estimation.
- By using information technology in a conscious and systematic way, the landscape architect can strengthen his or her professional role. The tasks can be shifted to earlier stages of the design process – from "making it green" when everyone else is finished, to an actual involvement in principal decision-making.
- The professional role of the landscape architect has moved from being a "gardener" to being a part of a variety of processes in the society. The use of IT can give possibilities to *move into new fields* – unheard of today or established by others.
- The most important factors influencing the use of tools and methods are found in the *environment* of the landscape architect. Changing processes and new demands result in new tools, which are put into use when the organizations find them appropriate.

The first three propositions were deliberately formulated in a very positive manner. You can find similar statements in brochures for computer software of almost any kind. My objective was simply to put these goals to a test.

## Summary of Study Design

According to Yin, the following five components of a case study design are especially important (1994, p. 20):

- A study's questions
- Its propositions, if any
- Its unit(s) of analysis
- The logic linking the data to the propositions
- The criteria for interpreting the findings.

Questions

❊ How does the use of information technology affect the tools, methods, and professional roles of the landscape architect?
❊ How was the work of the landscape architect being done in the past, how is it done today, and what are the expectations for the future?

Propositions

❊ IT makes it possible to concentrate on the design process, and minimizes the routine tasks.
❊ IT can strengthen the professional role.
❊ IT can open possibilities to move into new professional fields.
❊ The environment determines which tools and methods that are used.

Unit of Analysis

The unit of analysis in the study is professional landscape architects as a collective. Within this group, individual landscape architects are examined as embedded cases. No efforts have been made to investigate the views of organizations of any kind.

Logic Linking Data to the Propositions

By using hermeneutic analysis on the interview data, statements expressed in the interviews were connected to the theory. This was achieved by using grounded theory. The interviews were transcribed and moved into computer software for qualitative analysis – coding, grouping, pattern finding and so on.

By using the system model as a base for the interpretation, the interviews could be structured into parts that could be analyzed. The computer software accommodated linking of data to these parts, and different opinions of the interviewees could be compared to each other, to the literature, and to my own experiences.

*In this first part, interpreting the result of the interviews and the literature studies have been simplified by the fact that mainly positive attitudes have been sampled. However, the method will be the same in the second part. Again, the components of the system model will be used to systematize the work.*

*Since the study is qualitative, the criteria for interpreting are per definition subjective. Interview statements have been compared to my personal values, and other opinions expressed in the literature, and thereafter moved into the structure of the report text. The rigorous steps of truly hermeneutic analysis have not been taken – instead a more intuitive method has been used.*

# Chapter 2
# Historic Background

As a background to the investigation into present and future work of the landscape architect, a historical study has been made.

The first part covers the general history of computers and software. This historic description has a general approach to computing. To give perspective, some specific aspects of computer use in architecture, building, and construction is added. In Chapter 3, this perspective is widened to encompass also the work of the landscape architect.

The second part describes a part of the historical development of the results the landscape architect produce, using manual methods. Computer-aided techniques and methods are dealt with in the following chapter.

## Computer and Software History

This summary of the computer and software history will briefly describe some of the steps leading up to Bill Gates vision of "a computer on every desktop", and Scott McNealy´s (of Sun Microsystems) "the network is the computer". Both statements are today rapidly becoming true, leading to consequences hard to imagine.

Apart from the tremendous intellectual and engineering efforts behind the hardware development, there are other interesting aspects behind the history of the computer. The road to success for companies like IBM, Microsoft and Apple did not lie in the access of superior technology. Far more important have been system vision, marketing, and simply being in the right place at the right moment in time.

The Technical Research Institute of Finland (VTT), has likened the development of computerization in building and construction with the land-rise in the Nordic archipelago[1]. The different parts of the industry are still working on separate islands, communicating with primitive tools like DXF[2]. Techniques that are more

*1. This slow land-rise is a result of the latest ice-age – the land is still moving upwards after being pressed down by the massive ice cover.*

*2. Drawing eXchange Format*

competent are presently being developed, such as STEP (discussed later in Chapter 3). When the communication problems eventually become solved, the land will rise to the "Coastline of the 2000 Building Product Model" (Figure 1).

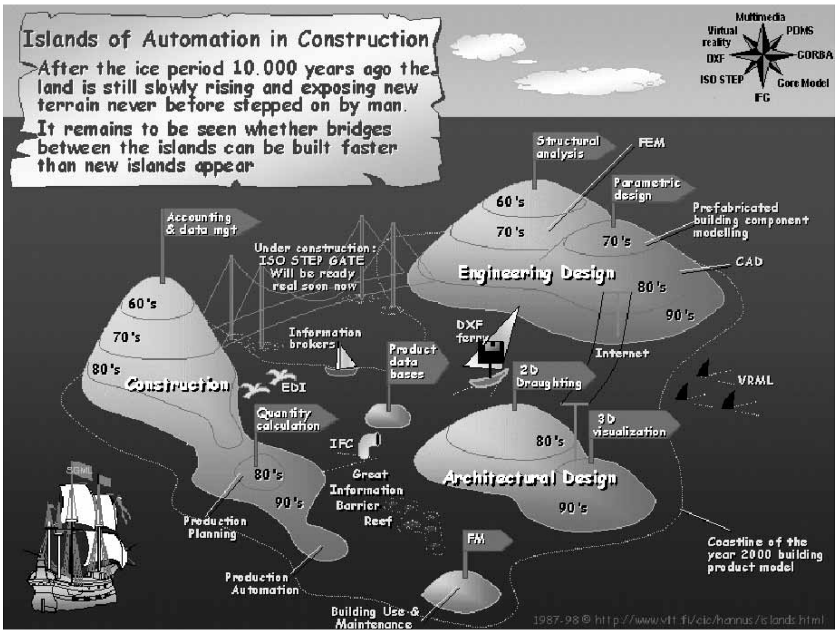



*Figure 1. Island of Automation in Construction*

## The Early Years

The major part of the computer history has its origin in the United States. The starting points were the enormous task of census in the late nineteenth century, and the development of office automation. Herman Hollerith had engineered a punched card system for the census that was very successful. At the same time, large-scale data processing began to enter the private sector, starting off in the insurance business. Although the United States was later than Europe in its economical development, the Americans were swift at developing and accepting techniques.

Office Utilities

The new techniques could be advanced, such as the Hollerith system. Far more common was more modest machines and gadgets; typewriters, adding machines, record-keeping systems, but also a vast variety of pens, paper clips, staplers, cash sorters, and so on. More or less useful office utensils flooded the market.

The American companies were unburdened by old-fashioned offices and working methods. At the turn of the century they started to become mechanized and systematized. Office managers and employees were eager to use modern gadgets and tools. A new type of consultant speeded up the development.[1]

The first widely used machine was the typewriter. The most successful manufacturer was Remington – not because they produced the best version, but because they realized the importance of sales and after-sales service. The machines often needed repair, and by using local branches Remington could satisfy their customers in this respect.

Another important aspect was that machine typing required new skills by the users. Thus typewriting schools flourished in the United States, educating a new work force of office clerks. Apart from the availability of a cheap and sufficiently reliable machine, a system of sales, repairs and education had thus emerged. Within the office, the information technology by the turn of the century consisted of typewriters for documentation, new and ingenious filing systems for storage, and adding machines for processing information.

*1. Systematizers set about restructuring the office introducing typewriters and adding machines, designing multipart business forms and loose-leaf filing systems, replacing old-fashioned accounting ledgers with machine billing systems, and so on. The office systematizer was the ancestor of today's information-technology consultant. (Campbell-Kelly and Aspray, 1996, pp. 27-28)*

Business Systems

The importance of viewing the machine as a part of a system was further developed by Burroughs, successful manufacturer of adding and accounting machines. Along with selling the machine, Burroughs brought a knowledge of business systems. This philosophy later enabled the company to successfully enter the computer market (Campbell-Kelly and Aspray, 1996, p. 39).

The National Cash Register Company, NCR, further developed sales techniques. Besides its aggressive marketing, taught in internal sales training schools ("cash registers are sold, not bought"), NCR was pioneer in the establishment of a small "inventions department" (Campbell-Kelly and Aspray, 1996, p. 40). The entire market copied the efforts by NCR. It was soon perfected by a company that was to shape the future of office automation: IBM. The "Big Blue" started off as C-T-R, a company that had purchased the rights to the Hollerith punched-card system.[2]

*2. There were three reasons for the ultimate success of ibm: the development of a sales organization based on that of NCR; the "rent-and-refill" nature of the punched-card machine business; and technical innovation. All of these were intimately bound up with the appointment of Thomas J. Watson Sr. as C-T-R's general manager in 1911 and its president in 1914. (Campbell-Kelly and Aspray, 1996, p. 47)*

IBM

Thomas Watson had started his career as a successful salesman with NCR, advanced to general manager, but was eventually fired by the dictatorial founder John H. Patterson. He managed to expand the markets of C-T-R, and in 1924 renamed the company International Business Machines. The IBM developed an incredibly strong company culture, with dynamic salesmen and impeccable sense of business and office systems. The system of renting out its machines, and its monopoly on the critical punched card, gave the company a steady income, even through the depression. Its inventions were always keeping it in top of the technological race.

The Mainframe Computer

This economical strength made it possible for IBM to enter the computer age with confidence. During the war, the first computers were designed, funded by the military. The people behind the ENIAC and the EDVAC, used mainly for calculating missile trajectories, went into private business when the war was over. After a long funding struggle, where among others IBM were given the opportunity to buy the company, they presented the UNIVAC in 1951. Under the wings of Remington RAND Corporation, the computer was first installed at the Census Bureau

IBM was not far behind. In the end of 1952, their model 701 was made public. It was not ready for sale – commercial production of the model 702 started first in 1955. The deliveries of the UNIVAC were equally slow.

These huge and expensive machines were not for the mass market. Smaller machines were developed; many of them were cheaply rented to universities and colleges. This masterful example of marketing resulted in a generation of programmers and computer scientists brought up on IBM 650s.

In the beginning of the 1960's, IBM was still primarily a punched-card machine supplier. A decade later, computers dominated the sales completely. The successful transformation of the company started with the model 1401, which was the first computer system. The IBM marketing managers had still a strong position. They recognized the need for supplying solutions to business problems, rather than raw computing power. This insight brought the company way ahead of its competitors. The computers were delivered, accompanied by customized software, services, spare parts, and superior printers.

The success encouraged IBM to take another large step. The old technology and programming was thrown overboard, and a major project took of, aiming at a new, compatible and upgradeable line of computer models. In 1964, the System/360 product line was launched. This introduction marked the beginning of the modern computer era.

## The System-Centric Era

Information technology has over the years grown in a series of waves, with different technologies, user groups and other characteristics. With the purpose of discussing this history, and with an effort to look in to the future, David C. Moschella makes the following summary (Moshella, 1997, p. ix)

| | **System-Centric 1964-1981** | **PC-Centric 1981-1994** | **Network-Centric 1994-2005** | **Content-Centric 2005-2015** |
|---|---|---|---|---|
| **Key Audience** | Corporate | Professional | Consumer | Individual |
| **Key Technology** | Transistor | Microprocessor | Communication bandwidth | Software |
| **Governing Principle** | Grosch's Law[1] | Moore's Law[2] | Metcalfe's Law[3] | Law of transformation[4] |
| **Vendor Offerings** | Proprietary systems | Standard products | Value-added services | Custom services |
| **Channel** | Direct | Indirect | Online | Customer pull |
| **Network Focus** | Data center | Internal LANs | Public networks | Transparency |
| **User Focus** | Efficiency | Productivity | Customer service | Virtualization |
| **Supplier Structure** | Vertical integration | Horizontal computer value chain | Unified computer & communications chain | Embedded |
| **Supplier Leadership** | U.S. systems | U.S. components | National carriers | Content providers |
| **Number of Users at End of Period** | 10 million | 100 million | 1 billion | Universal |
| **End of Period Market Size** | $20 billion | $460 billion | $3 trillion | Too embedded to be measurable |

*1. Computer power increases as the square of the cost.*
*2. Semiconductor performance doubles every two years.*
*3. While the cost of a network expands linearly with increases in network size, the value of a network increases exponentially.*
*4. The extent of an industry's transformation (entering the mature IT age) will be equal to the square of the percentage of that industry's value-add which is accounted for by pure information (bits) as opposed to atom processing activity.*

IBM Domination

The system-centric era, with its large mainframe computers, was completely dominated by IBM. Based on the huge profits from card-punching machines, IBM's solid technology, deep understanding of customer's needs, splendid marketing, and tough (or ruthless) tactics against competitors, the company reached a stunning 70% market share. The System/360 was successful enough to make the industry vertically oriented – third-party companies provided services, peripherals, software and financing around the central system (Moschella, 1997, p. 7). To customers, this model was comfortable but expensive. They were tightly locked to their suppliers, for long periods of time.

Software Development

Modern software development started in the 1950s, with the invention of the high-level programming languages FORTRAN and COBOL. The former was an IBM project, aimed mainly for scientific use; the latter was developed on a government initiative, for use in commercial data processing. Still, software was considered a non-salable item, which was bundled with hardware sales. Programs were often exchanged within cooperative user groups (Campbell-Kelly and Aspray, 1996, p. 192-193).

Customers rarely had the abilities to produce their own programs. Instead, software-contracting firms started to emerge in the beginning of the 1960s. Some of them became large – the largest ones tied to the U.S. government in different projects. Some of these occupied thousands of programmers, and became an important factor in the U.S. supremacy in software manufacturing for decades to come.

The software market boomed for some years, but soon a crisis became apparent. The hardware capacity rose quickly, and the programmers had difficulty keeping the pace. The programs became larger and more complicated, up to a level were the problems simply became too hard to handle. The largest failure was made by IBM, whose huge project for a new operating system – the OS/360 – never could be completed. The aims of the projects were too high, and after spending half a billion dollars, the system was released in 1967, late by a year. Still it had large errors that were hard to fix. The failure eventually led to a major drop in market confidence in mainframe computers, and of course in IBM itself.

The crisis led to two new movements in computer programming. The first was to make programming more structured, making it a true engineering discipline. The other approach was to make thing easier for programmers and customers alike, by offer-ing software packages for standard tasks. This solution, obvious as it seems today, was made possible by the IBM decision in 1968 to "unbundle" its software from the computers they delivered.

Mainframes in Building and Construction

The mainframe systems developed were mainly used for business and finance. When these computer systems started to mature, in the middle of the 1960s, the building construction industry had not yet reached the point where everyday calculations and drawing were done in a computer environment. There were of course exceptions, especially among large corporations and in some universities. The efforts were in the beginning isolated efforts, dealing with specific problems. The construction industry focused on accounting and data management; engineering design began to develop structural analysis and parametric design of components. The architectural efforts dragged behind, starting to use drafting in a larger scale well into the 1980s.

## The PC-Centric Era

The explosive growth of the PC industry in the last two decades is well known. A worldwide sale of $2 billion in 1980 had ten years later grown to $83 billion. Yet another five years later, in 1995, sales reached $160 billion.

Time-Sharing

Before the introduction of the PC however, one major improvement in systems architecture was achieved. The mainframe computers needed specialists to run it, with users sending in their program to be run in batch processes. The solution to this awkward process was time-sharing. Developed in the beginning of the 1960s, time-sharing allowed users to sit at terminals, simultaneously accessing the computer. The idea was in 1964 broadened into the "computer utility" concept (Campbell-Kelly and Aspray, 1996, p. 215). The large computer should be a common utility, from which users could draw computing power. Grosch's Law showed the sense in this reasoning. It was clearly more economical to have many users share one large computer than providing them with individual machines.

Despite these obvious advantages, the computer utility market had only a short period of glory. Due to the problems writing software for the complicated processes, the market soon turned its back to the idea. Today it remains only in very specialized segments, such as science, engineering and business calculations (Campbell-Kelly and Aspray, 1996, p. 219).

Unix and C

Another important step from mainframe architecture was the Unix operating system, developed at Bell Labs during 1969-74. Small but effective, Unix gave single users powerful facilities on standard hardware. A new programming language – C – was developed in the process. The combination of Unix and C proved to be a strong alternative to the centralized mainframes. Many were appealed by the idea of giving the control to the user, instead of relying on a mysterious and secluded computer department.

Since then, Unix has evolved into a number of dialects, owned by hardware manufacturers. It dominates the market in some segments, such as high-level engineering and visualization. Companies such as HP, DEC, Sun and Silicon Graphics produce small but powerful computers, known as workstations. The C programming language has matured in steps – C++ is today one of the most commonly used worldwide.

Minicomputers

Mainframe computers were also threatened by the introduction of minicomputers. Dramatically falling prizes, due to the introduction of integrated circuits, quickly made the original idea of time-sharing ineffective. The concept was modified and scaled down, with a small number of users sharing a small and relatively cheap computer.

The minicomputer was first developed in the university environment, inspired by the miniaturization that started to change the industry completely. Besides computers, the market was soon flooded with calculators, digital watches, and video games.

Most prominent among the new producers was Digital Equipment Corporation (DEC). Founded in 1958, the company introduced the PDP-8 minicomputer in 1965. It was a monumental success, gives the users unprecedented computing power at a relatively low cost. For the first time, the computer became a "personal" commodity, with users developing software, and even games. A computer hobbyist culture started to evolve.

Minicomputers in Architecture

The foundation of the minicomputer was the rapid pace of semiconductor innovation. In the late 1960s and the early 1970s, integrated circuits with ever-larger capacity and lower price revolutionized the industry. At this time, computing in architecture started to develop. The work took place in the universities – computer hardware was at this time far too expensive to invest in for architectural firms. The first widely known system was called Sketchpad. Presented in 1963, the system had been designed by Ivan Sutherland at MIT. It utilized a screen-pointing device, with which lines, arcs and circles could be drawn. Repeated elements could be defined once, and thereafter inserted and moved. The ideas were quickly developed, and the software soon became remarkably advanced.

A few years later, another architectural application was developed in England. This system was object-oriented, using a standardized set of building elements – walls, windows, floor slabs etc. The user would chose components from this library, thereby constructing floor plans.

Despite these advanced functions, adoption in the market was very slow. The computer was early used by structural engineers and other consultants, but architects were harder to convince. The technique was hard to learn, and not very rewarding. The systems had little to offer in the areas of design and appearance, where most architects had their main interest. For use in drafting, the computers were simply too expensive for all but the largest American and Japanese firms, alongside with some governmental organizations.

Minicomputers in Swedish Building and Construction

There are some exceptions to this rule. In Sweden, landscape architects Söderblom & Palm AB used 3-dimensional ground models for calculating masses in a large housing projects in the late 1960s. The computer programming was made in cooperation with an architect's office, Lettströms. The software was developed and used by other companies during the 1970s. (Florgård, 1999)

Swedish building constructors started using the computer for calculations in the early 1970s. A system called BERIT[1] was developed, and among others used by J&W, a large technical consultant practice. The cooperative real-estate company HSB was another user, at times having 30% of the designs made in BERIT (Danielsson and Wikforss, 1998). The primitive user interface, where all data was fed into the computer by the use of coordinates and punched-cards, was naturally a high threshold for designers.

*1. An acronym for the Swedish words for calculate and draft ("beräkna och rita")*

It was not until the end of the 1970s that computer use in architecture started to spread. By this time, minicomputers were available and software had advanced somewhat from pure drafting. In 1981, 65% of the American architects used computing in some form (Radford and Stevens, 1987). In Sweden, White Arkitekter, FFNS Arkitekter and VBB started using CAD systems with a more modern design in the late 1970s. Utilizing mini computer systems, software such as RUCAPS, GDS and Intergraph produced CAD drawings and planning maps (Danielsson and Wikforss, 1998).

In the early 1980s, the problems of communicating between different systems had become evident. Standardization efforts – IGES, STEP, BEC, and DXF – were started. Another approach was to have complex software, capable of dealing with every aspect of design, construction and building. In Finland – and in a few Swedish offices – the MEDUSA system was used for this purpose. A Swedish system for calculations, connected to MEDUSA, was named MCAD.

Byggnadsstyrelsen – the former Swedish agency for managing governmental real estate property – organized an early test of the benefits of CAD in building projects. In the city of Bollnäs, a new building was designed using MEDUSA. The consultants stored their work in a common "data-pool", consisting of layers in a database. Data was transferred between some of parties involved with 4,800-baud modems. Apart from delivering drawings, the system generated different kinds of component lists.

The project was monitored by researchers, and evaluated in two reports. The conclusions and suggestions were remarkably advanced, and are as valid today, 15 years later. (Figures 1 and 2)

Although Sweden had a well-established system for classification of building components, these efforts did not have a large impact on the market. Architects found them restricting, since early decisions had to be made concerning technical solutions. The economical crisis in the late 1980s – which led to an almost complete stop in building construction – also lessened the effects of these radical ideas. (Danielsson and Wikforss, 1998)

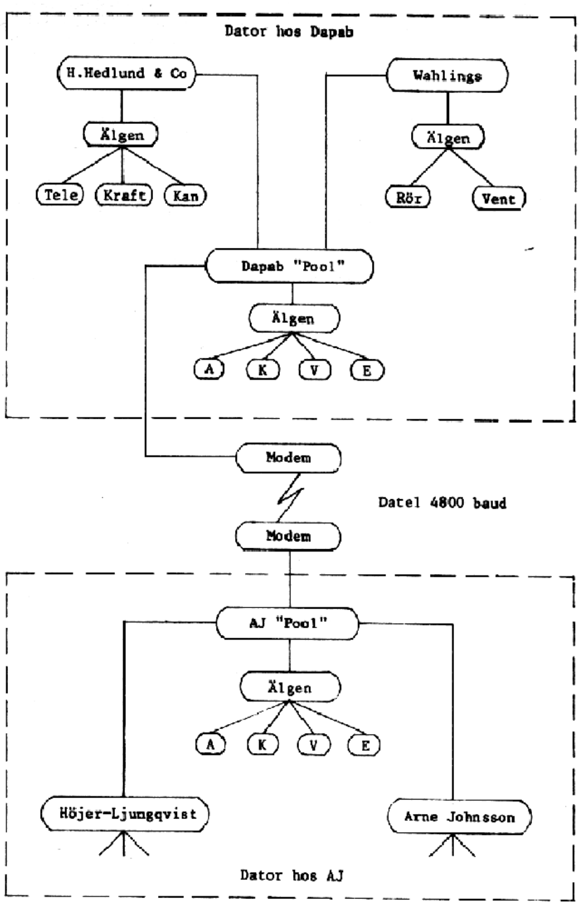



*Figure 2. Coordination with MEDUSA BYGG and Installations-MEDUSA was made through transfer layers (a so called pool). (Byggnadsstyrelsens rapporter 163, 1985)*

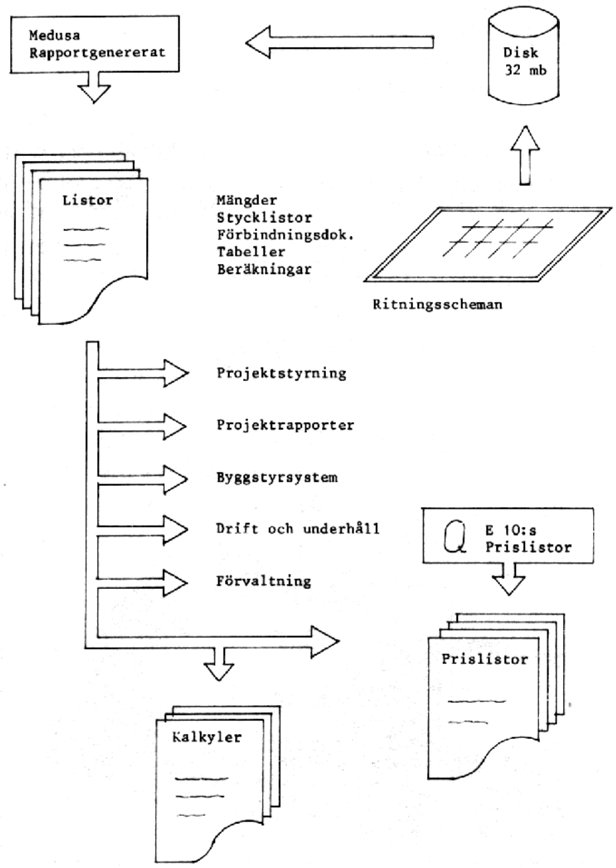



*Figure 3. The report generator automatically produces desired information from the database. (Byggnads-styrelsens rapporter 163, 1985)*

The Personal Computer

The combination of cheap electronics and a computer hobbyist culture eventually resulted in the possibility to build your own "personal computer". The "computer liberation movement" of the American West Coast was the center of this process, using the first microprocessor-based computer – the Altair 8800. This hobbyist kit, however small and primitive, aroused large attention in these circles. People started producing accessories to the machine – memory boards, data recorders, and so on – as well as software for using it.

Microsoft and Apple

One of these software pioneers would eventually out shadow the rest of them – Bill Gates, co-founder of Microsoft. Like many others, he started from a personal interest in computer programming. The community of hobbyist programmers triggered a fast development. The Altair received hard competition from many other manufacturers – Commodore and Tandy being the best known of these.

Bill Gates and Paul Allen produced the BASIC programming language for the Altair, Steve Jobs and Stephen Wozniac started manufacturing the Apple personal computer. Apart from being skilled technicians, they were early-matured entrepreneurs, realizing the need for strong partners and effective marketing.

Hardware alone did not make the personal computer useful enough for it to reach beyond the relatively small group of enthusiasts. Software development started on a larger scale for computer games and educational purposes. The sales of PCs rose quickly when more business-oriented applications were released: the spreadsheet, the word processor and the database. The Visi-Calc spreadsheet for the Apple II computer, released in 1979, was the largest seller. In the beginning of the 1980s, word processors with WYSIWYG[1] capabilities were introduced, along with low-cost printers. Suddenly the PC had become a useful tool also for the businessman.

*1. What You See Is What You Get – the document layout as printed is shown directly on screen.*

The IBM PC

At this point in time, IBM started to move. They were well aware of the evolvement of the personal computer, and realized its potential. Turning their old methods completely around, the company outsourced all components they did not already produce in-house, and started selling through regular retail channels.

These bold decisions have affected the PC market ever since. The heart of the hardware – the processor – was bought from Intel. To develop the operating system, the bid went to Microsoft. Gates and Allen bought a system from a Seattle firm, improved it, and presented it as MS-DOS. The mold of all PCs to come – the IBM Personal Computer – was thus presented in 1981.

Market demand immediately exploded. IBM's entering the PC market gave it the legitimacy it needed. Their machine quickly became a de facto standard. Most of the software packages were converted to the DOS environment, which made it even more popular. As the market for microprocessors and other components was open for all, the IBM recipe was soon copied by a number of hardware vendors. A large sub-industry also emerged, manufacturing peripherals such as memory boards, disk drives, and printers. As the number of user grew, dedicated PC magazines and newspapers emerged. The growth of the market was so stunning, that in 1983, the Time magazine nominated as their Man of the Year not a person but a machine: the PC.

Only one important competitor managed to stay free from the IBM standard. Apple Computer, led by its founder Steve Jobs, took a completely different approach. They strictly controlled the hardware specifications, allowing no "clone" computers to be manufactured. Instead, they competed by making better operating systems and software.

The PC boom had fundamental impact on the IT industry. As shown in the table by Moschella on page 39, many aspects shifted orientation completely. For the common user, the greatest change was the possibility to use cheap standard products, for improvement of the personal productivity, and increasingly important, for personal pleasure. The initiative could be shifted, from the company IT department to the individual IT user.

1. *Wagner, W.F. 1985.* Result of a Record Survey: How Firms with Computers Are Faring and What the Nonusers Are Waiting For. *Architectural Record, June. Cited in Radford and Stevens, 1987.*

## The PC in Architecture

The introduction of the PC made the use of computing in architecture and construction increase rapidly. In a 1985 survey[1], 62 percept of the computer users had purchased their systems in the two years prior to the survey. This did not distinguish architecture from other business – like everone else, architect used ordinary office management software. Computer-aided design had not yet begun.[2] Figure 4 shows the result of the Wagner survey.

2. *It would seem that architects had not yet truly taken up the challenge of computing and incorporated it as a standard tool in the architectural design process. (Radford and Stevens, 1987, p. 12)*

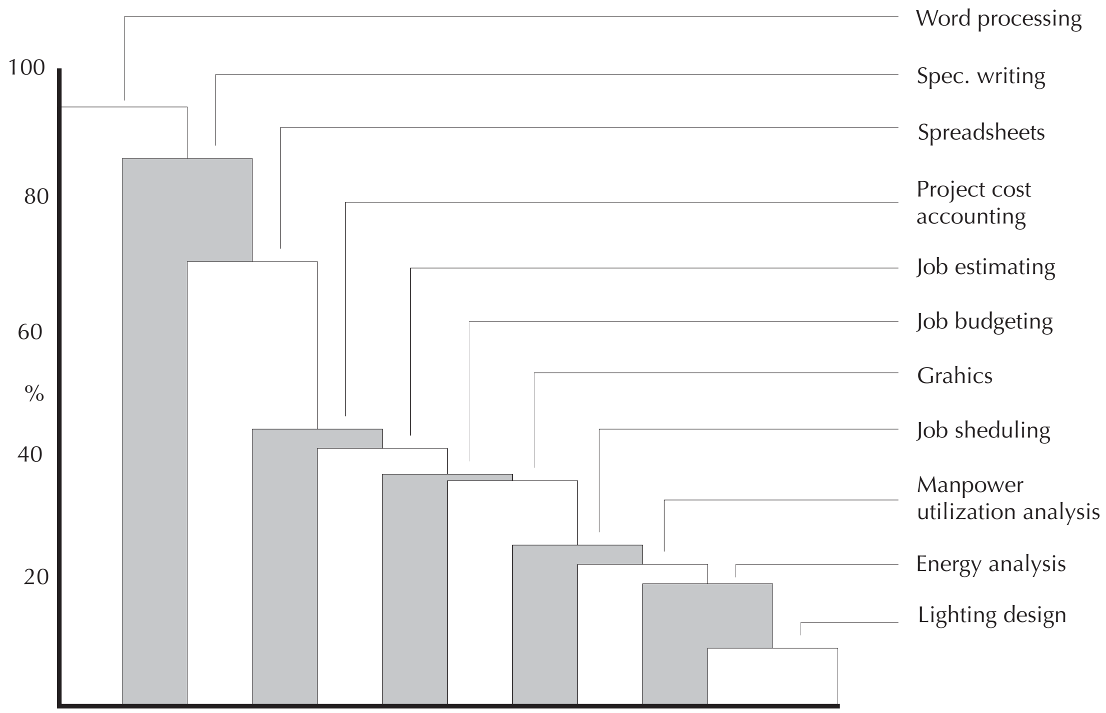



*Figure 4. Percentage of computer-using respondents replying that they use computers in the displayed application areas (Wagner, 1985). Diagram by Radford and Stevens (1987, p. 11)*

The development among Swedish architects shows a similar pattern, lagging behind a few years. In the beginning of the 1990s, about 75% of the building consultants used CAD to some extent (Lundqvist, 1991). Among architects, the figure was estimated to about 40%. CAD use was more frequent in large companies and organizations.

By the end of the decade, IT use had grown even more. Most of the practices use computer support to some extent, even though the efforts and interest still varies greatly. As a summary of the computer tools used in architecture today, the following matrix can be used (Figure 5):

| | Design | Drafting | Specifications | Project management | Business | Estimating | Business development | Interiors | Administrative | Personal | Contracts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Word processing | | | ● | ● | ● | ● | ● | | ● | ● | ● |
| Spreadsheets | ● | | | | ● | | | | | ● | ● |
| Flatfile database | ● | ● | | | | | | ● | | ● | |
| Relational database | | ● | | ● | ● | ● | | | | | |
| Slide preparation | ● | | | | | | ● | | | | |
| Project scheduling | | ● | ● | ● | ● | ● | | ● | | | ● |
| Contact management | ● | | | ● | | ● | ● | | | ● | |
| Calendar | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Multimedia | ● | | | | | | ● | | | | |
| E-mail | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Messaging | | | | ● | | | | | | ● | |
| Internet browsing | | | ● | | | ● | | | | ● | |
| Illustration software | ● | | | | ● | | ● | ● | | | |
| Two-dimensional CAD | ● | ● | ● | ● | | ● | | ● | | | |
| Three-dimensional CAD | ● | ● | ● | ● | | ● | | ● | | | |
| Visualization | ● | | | | | | ● | ● | | | |
| Animation | ● | | | | | | ● | ● | | | |
| Virtualreality | ● | | | | | | ● | ● | | | |
| Desktop publishing | ● | ● | | | ● | | ● | ● | | ● | |

*Figure 5. Software/task matrix. From Stevens, 1996.*

The Software Explosion

The most important aspect for the user was the new software that trailed the PC. When relieved from the straitjacket of the mainframe era, software industry started to bloom. The competition soon became fierce, and the efforts necessary to succeed became larger and larger. Huge marketing efforts were needed to compete on the market. The small-scale style of the hobbyist years faded away.[1]

*1. Only to make a grand comeback with the introduction of the Internet and shareware an odd dozen years later!*

On the arena for mainframe computers, the crisis for programmers and software developers was overridden. Data-processing computers became well established in large corporations and in the government. These large-scale operations, using batch-processing or real-time applications, are vastly different from the processes run in a PC. The difference in culture – and naturally in hardware performance – made it hard for the existing software packages to enter the PC arena.

Instead, new players came along. The market was flooded with software. As stated earlier, the competition soon made it hard for the small actors to compete. Microsoft, with its steady and large income from the MS-DOS license deal with IBM – and all other PC vendors to come – used its economical strength to eventually become by far the largest software company. Microsoft could afford to produce applications that failed, and simply use the experience when designing new ones.

The Graphical User Interface

MS-DOS had one major drawback: the primitive way in which the user communicated with the operating system. The command line interface worked fine for computer technicians, but was awkward and unrewarding for the everyday user. Furthermore, software designers had the freedom to develop a unique style for every application. Moving between them proved difficult for the users.

A graphical user interface, handled by a mouse, was first outlined in the early 1960s, with every component of the Windows and Macintosh operating systems today. The first manufacturer to develop a commercial product was Xerox, designed by an extremely inventive research lab in Palo Alto, California. However, the Xerox Star computer, released in 1981, was not a success. The machine was simply too expensive for most office tasks.

Nevertheless, the idea of the graphical user interface spread, first in workstations aimed at the technical and engineering market. To the mass market, it was realized in the shape of the Apple Macintosh.

The Apple Macintosh

In 1983, Apple had just mimicked the failure of Xerox, releasing the advanced but expensive Lisa model. The Macintosh, brilliantly designed to be a household appliance, was presented in 1984. Despite spectacular marketing, it didn't reach its goal. Ordinary people were not interested in investing so much money in a computer. For business purposes, the machine did not have enough capacity for its price. In addition, many were skeptical towards this IBM competitor, with its aura of youth, rebellion, and creativity. The opposite was true for people in publishing and media, who quickly found their favorite tool in the Macintosh. The user-friendly interface also made it popular in education.

Microsoft Windows

Most successful in designing software for the Macintosh was Microsoft. The applications they produced were later converted to run on IBM-compatible PCs. The cooperation with Apple gave Microsoft important insight into the design of graphical user interfaces (Campbell-Kelly and Aspray, 1996, p. 276). The first version of Windows was released in 1985, copying most of the features of the Macintosh. Designed as an add-on to MS-DOS, it didn't cut off the possibility to use old software.

However, even on the best Intel microprocessor of the time – the Intel 286 – it was so slow it was almost impossible to use. As the processors gained performance, the operating system could be modernized. The third version of Windows, launched in 1990, was a major improvement. Along with the success of the office applications Word and Excel, Windows 3.0 brought Microsoft to an unrivaled lead position. Not even the large efforts of IBM, resulting in the OS/2 operating system, could compete.

The Windows operating system has been steadily upgraded. Version 3.11 was the first to include network capabilities in small work-groups – a function that had been built into the Macintosh from the very start. Windows 95 was mainly an aesthetic improvement, even if it sported some of the easy installment of peripherals that again for many years had been a standard Macintosh feature. Windows 98 made the system faster, and somewhat less likely to crash.

Architectural Software

The evolution of PC software for architectural purposes began in the early 1980s. One of the first to emerge on the market was Autodesk, with the CAD software AutoCAD. Shipping started in 1982, and the program soon dominated the market for PC CAD systems. Five years later, 100,000 copies had been sold; in 1994 one million. Once again, the open philosophy of the PC sector triumphed – Autodesk encouraged others to make applications to extend the functionality of the CAD software. In Sweden, ArCad and CadPoint were quick to grab this opportunity. Today, AutoCAD with applications have around 80% of the Swedish CAD market (Danielsson and Wikforss, 1998).

Apart from CAD, a long range of software can today be used in design and planning.

Twenty years after the mainframe computers took its hold over large corporations and government, the PC and the software development had thus completely changed the picture. The industry changed from being vertical, with a few large companies delivering all sorts of software and hardware, to a market characterized by specialization and fierce competition on every level. IBM was still a large player, but the development was dominated by "Wintel" – the Windows operating system by Microsoft, run on processors manufactured by Intel.

## The Network-Centric Era

To satisfy customers with higher demands for stability and security, Microsoft presented a new and completely re-written operating system – Windows NT. Since its release in 1993, it has been another success, taking large market shares from the Unix developers and the Novell network operating system.

Local Area Networks

Before Windows NT, Novell had completely dominated the building of local area networks. In the PC market, the trio of Microsoft, Intel and Novell were setting the pace. The 1980s was the decade of the LAN, and Novell was the major player in this field. They provided the operating system; vendors like Cisco, 3Com and Bay Networks built the hardware to connect the computers in networks.

The ability to connect to local area networks was a major improvement for most PC users. However, it did not mark the beginning of the network-centric era. Instead, it was the explosive growth of the Internet, set off by the HyperText Mark-up Language (HTML) in conjunction with the introduction of the Mosaic web browser in 1993.

The concentration of efforts for enhancement of communication, business, information gathering and other Internet activities, has again shaken the IT industry in its foundations. Old giants like

IBM are struggling to keep initiative in at least some areas; new actors have quickly risen. Again, Microsoft has placed itself in the center of attention. At first failing to build an Internet for itself – the Microsoft Network – the company has made a remarkably successful effort to become a major provider of Internet applications and content.

Rivaled in importance only by the newcomer Netscape, and the large workstation manufacturer Sun with its Java programming language, Microsoft now struggles with the U.S. government. The latest version of its web browser – and the Windows 98 operating system – symbolically tears down the borders between the computer and the network. Both of them use a common interface for the computer, the local network, and the Internet – a natural step in the network-centric era, but a major obstacle for other software vendors. As this is written, a preliminary ruling states this design as unacceptable to U.S. monopoly regulations. Meanwhile, Microsoft has not hesitated to sell the new products.

The Internet

The Internet reached enormous attention in the beginning of the 1990s. The idea of connecting remote computers was of course older, dating back thirty years. The U.S. Advanced Research Projects Agency made the first practical efforts in building a network. A division within ARPA, the Information Processing Techniques Office (IPTO) had many visionary and ambitious projects, with special attention on human-computer interaction. Time-sharing was a major interest, connecting many users to large computers. Connecting the computers with each other was a natural step to take, and constituted the beginning of the Arpanet.

Techniques for sending and routing information in small packages were developed, along with a dedicated computer to handle the traffic at each node of the network. In 1970, the first network was running. The scientific community quickly appreciated the technology, but the U.S. military was in the beginning very restrictive about admitting new members to the network. In 1982 it was eventually split up into two parts, the military developing its own Milnet.

E-mail

The real breakthrough of the Internet was the invention of a new means of communiciation: e-mail[1]. With the attraction of e-mail, the network grew rapidly. By 1975, there were over a thousand registered e-mail users. The Usenet started, formed by colleges and universities that had been refused to join the Arpanet. Its news system was an invention that became very popular. By

*1. It was not, however, the economics of resource sharing, the ability to use remote computers, or even the pleasure of playing computer games that caused the explosion of interest in networking; indeed, most users never made use of any of these facilities. Instead it was the opportunity for communicating through electronic mail that attracted users. (Campbell-Kelly and Aspray, 1996, p. 294)*

1991, Usenet had grown to 35,000 nodes, with millions using the news network. The benefits of e-mailing also spread in business, mainly for use as coordination of group activities.

TCP/IP

As the numbers of users grew, it was necessary to formalize the communication methods. The Transmission Control Protocol/ Internet Protocol (TCP/IP) was established by IPTO in 1973, and soon became a de facto standard. In 1980, the Internet had a couple of hundred hosts; in 1984 one thousand; in 1988 over 50,000; in 1989 150,000; 1992 1 million; 1994 3.8 million. The amount of information had become impossible to grasp.

The World Wide Web

The first attempt to help users retrieve information was the Gopher system, which became very popular among scientists. Far more appealing was the World Wide Web, based on the use of HTML. Originated in the CERN laboratory in Geneva, it fulfilled the old idea of hypertext documents. With its multimedia capability, and the seamless integration of documents of different origin, it rapidly caught the attention of a broad market. "Surfing the net" became popular in the late 1980s, with content providers such as CompuServe and America Online serving the needs of households and small business.

The transformation of the IT industry to the network-centric era has shifted the main interest from microprocessor speed to communications bandwidth. The ever-growing number of users has in one sense become a threat to all users of the Internet – the size of the traffic has made connections slower and slower. The original Internet was built almost entirely on government funds, mainly for use in the academic and military societies. Today, commercial interests dominate the Internet. In order to enhance communication between them, universities in the U.S. have started to construct an Internet II. At the other end of the spectrum, most home users have slow modem connections to the Internet. A major battle has begun over the possibility to deliver bandwidth to the consumers. Telecommunication vendors, electric power suppliers, and owners of communication satellites are on the arena today – more will probably enter.

Wide Area Networks, Intranets, Extranets

The focus today lies not on local area networks and intranets but their extensions to the community surrounding the individual companies – wide area networks connecting corporations; extranets inviting regular customers and business associates; and of course the Internet which connects all these levels. These techniques are rapidly growing also in architecture and building construction. In Sweden, many projects gravitate around a web site, where the actors download work they have produced, and upload information they need. Copying services receive drawings online, and can quickly print on demand. This and other effect of the network-centric era are further discussed in Chapter 3.

Vendors of network operating systems have presently a hard time arguing that their technology still is fundamental. Techniques such as VPN – virtual private networks – give users access to secure connections to their company, on the otherwise wide-open Internet.

The mature phase of the network-centric era will show a shifting focus on the use of IT. The emphasis on improving internal efficiencies will diminish, and instead the main efforts will be put into external communication. The Intranets will be expanded to become Extranets, connecting directly to suppliers and customers. As the current security problems are solved, electronic commerce will be one of the main uses of the Internet.

New Internet Devices

This radical change will greatly affect hardware vendors and software companies alike. The PC is still the dominating Internet access device, but in just a few years this situation will change. As a prediction, by the year 2002, non-PC devices such as TV set-top boxes, telephones, personal digital assistants and videogame consoles will account for 50% of the shipment (Gens, 1998). Microsoft is of course in there fighting the opposition, with a specialized operating system, new file formats for streaming sound and images and so on. New constellations of vendors are constantly popping up, as the actors try to spread their risks, while simultaneously staying ahead in the race.

Fortunes are created overnight, as "hyped" companies present their revolutionary ideas. The IT stock market is still booming, as this is written in late 1999. Will the new millennium cool things down, or will the market continue to embrace the new gadgets and technologies as they are introduced – WAP, ASDL, satellite cellular phones and what have you?

## The Content-Centric Era

The fundamental changes this will cause on the society are of course impossible to predict in detail today. Information technology will permeate all aspects of living, from private living to business and government. The network will finally be the computer. To the common computer user, the network-centric era will have even greater impact than the PC revolution. The computer will not only be a tool for productivity at work and leisure at home, but also and mainly a means to communicate, gather information and purchase all sorts of items.

Eventually, the problems of lacking bandwidth will be solved, and the Internet will reach practically all people in the developed countries. As the technology becomes invisible and embedded, the focus on hardware, network construction, and other technical issues will gradually shift towards uses and needs, to software, to services and to information content.

For the landscape architect, this evolution will gradually change everyday practice. Less time will be spent on the hunt for data, and more time for the creative parts of the work – analysis, design, presentation and communication. Being an "information refiner", the landscape architect can also be a content provider on the Internet. New business will emanate, where the special skills of the landscape architect will be part of a seamless network. Customers can judge performance by the level of previous and ongoing projects, all published on the Net. Marketing will also find new methods – as you already can view the car of your liking, perhaps you will be able to get an instant remodeling of your garden, before you decide in hiring a landscape architect.

The change will not be here overnight, but rather a slow and uneven shift towards a truly efficient flow of data, information, and perhaps even of knowledge. If Moshella's "law of transformation" is correct, the change for the landscape architect will however be fundamental. Ten years from now, we will have dramatically new means of visualizing, product modeling, and communication. The practical effects are of course hard to imagine today. This is not the place to make predictions – if this study is continued, some of the answers will be here by the time the next report is written :-)

# History of Landscape Drawings and Images

Information technology has given the landscape architect a number of new means of expressing ideas and designs. Some of these mimic old methods; others have new possibilities. The purpose of this part is to show the historic foundation of the new techniques.

There are a number of ways to address the problem of describing the history of architectural design, presentation and drafting. First of all, the subject must be limited in order to keep the task possible to fulfill. In this case, the wide field of design – and design theory – is only hinted at. Instead, the main effort lies on presentation techniques. Drafting is indeed important, but has not (yet) undergone such dramatic changes as has the means and methods of presenting design ideas.

Secondly, a structure of the description must be defined. The following pages are organized into themes, covering different types of images. The story is thus not strictly chronological, but rather thematic. Different kinds of images, from different time period, are grouped together and compared.

Sketching and design marks the core of work of an architect. No matter what field of expertise, the method of solving problems graphically is common for the architect professionals. Images are used to analyze situations, to explore alternatives, and eventually to present solutions.

The most fundamental use is the drawing, closely tied to the design process. The architect solves problems not by theoretical reasoning or writing memos, but by making analysis and synthesis with a pencil in hand. The mental process is directly linked to the motion of the hand; the brain uses the pencil to express and evaluate ideas in drawings before they are – or even can be – expressed in words. This creative process continues, using trial and error, until no further refinements can be made.

For the classic designing architect, this process is a deeply personal act. As the sketches are refined, the aesthetic effect of the drawing itself becomes an important result. This is one part of the explanation why many architects have found computer support hard to accept and use.[1]

*1. Given this close relationship between drawing and design, it is hardly surprising that there is some concern over rejecting the habit of 500 years and abruptly replacing pen and pencil with keyboard, digitizer, and mouse […]. (Radford and Stevens, 1987, p. 130)*

The short historical exposé in this chapter is by no means covering all of the six aspects of the system model described in Chapter 1. Instead, it concentrates on the most typical *results* the landscape architect produces: drawings and images, and how they are used[1]. They are classified into the following categories:

❊ maps
❊ land-use plans
❊ plan drawings
❊ perspective and axonometric drawings
❊ photographs.

Again, this classification is not complete. As the professional field of the landscape architect widens, new means of expressing the result of a process are developed. For instance is the land-use plan a very wide term – the examples shown are mainly large-scale landscape projects. Landscape architects are today increasing their presence in urban planning and design. There are however few examples from these fields. The majority is from areas where landscape architects by tradition have been the most active.

The examples have been selected in order to give a sense for the most common techniques used by landscape architects and others. The sources are from literature covering garden history, map history, landscape planning, landscape architecture and so on. Some sources are more intuitive – simply from books found to be relevant to the study.

## The Map

Starting this historical overview in the large scale, it can easily be stated that planning of the physical environment involves a long range of issues – geology, hydrology, flora and fauna, pollution, human population, infrastructure, business development, economic growth, social services, and history, just to mention a few. For the landscape architect, areas of special interest include landscape analysis and land-use planning. Analyzing, describing and illustrating the landscape has always been major tasks for the landscape architect.

The prime method of describing the landscape is in a map[2]. Primitive maps have existed since the earliest times of man. The ancient Egyptians used them, among other purposes, to aid tax collectors. The Greeks, who evolved mapmaking into a science,

*1. In many cases, a 3-dimensional model of a design is a superior way of conveying ideas. However, historical models to study are scarce and thus hard to compare with modern techniques.*

*2. The border between maps and plan drawings is diffuse. The term* map *is originally an abbreviation of the Latin expression* mappa mundi (map of the world)*, where map means* napkin; signal cloth; map. *Webster´s definition of a map is "a drawing or other representation of the surface of the earth".*

*In this sense, a plan drawing is of course a map. In everyday language, the map simply shows a larger part of the earth than the plan drawing. Also, the map is normally produced for an overall orientation, whereas the plan drawing shows details of a specific object.*

*In Swedish, map is "karta", originating from the Latin "charta", for* written paper.

improved their methods. Two thousand years ago, they made accurate measurements of the circumference of the earth and produced atlases describing the known world – where of course most of the continents were missing. In about 190 BC Hipparchus established the measurement of latitude and longitude and dividing the world into 360 degrees. He also made the first known detailed chart of the heavens, where he fixed the position of at least 850 stars.[1] (What use is a map, 1989)

*1. Hipparchus had other interests as well, such as dividing the world into climatic zones.*

The mapmaking skill of the Greeks was continued in the Roman Empire, where maps were used widely. When reaching the limits of the known, the mapmakers created fantasy landmasses, populated by strange creatures. More restrained was the second century Ptolemy of Alexandria. He published extensive tables of coordinates of places – many fairly correct, others very misplaced. His view of the world, with Africa connected to Asia, the Indian Ocean a vast lake, and a great Terra Australis incognita, remained the accepted description into the seventeenth century.

The maps thus remained primitive for a very long time. The European introduction of the compass in the twelfth century made a new method possible. By practical experience gained on voyages, sailors could produce practical maps for ocean traveling.

There are many uses of maps – for going places; for running a country; for attack and defense; for exploitation of natural resources; for fun and leisure; for general information purposes; for the world of business.[2]

*2. Maps serve the wielders of power as well as the suppliers of power. An astute [shrewd; smart; of good judgment] politician like Lord Burghley was aware of geographical factors when he used maps to store information about the Elizabethan gentry. Others, with religious, political or legal aims, put maps to propaganda use, claiming souls or territory, enticing the footloose to a colonial utopia, or presenting a legal case in a favourable light. (What use is a map, 1989, p. 15)*

Due to the primitive cartographic methods, old maps were often quite inaccurate. This could of course lead to problems in navigation, but for political reasons, the maps could very well be exaggerated or even utopic. The methods were improved rapidly in the seventeenth and eighteenth century, when the Netherlands dominated cartography and hydrography (Allen, 1997). New advances in science – especially trigonometry and astronomy – alongside with the invention of new technology made it possible to produce maps of unprecedented accuracy.

In the middle of the eighteenth century, the sextant, chronometer, and theodolite became standard equipment. In the following century, the new technology made possible a large-scale charting of continental coasts. The continents of Africa and Australia were explored and described. In Europe, very accurate and detailed maps were produced. (Allen, 1997). The printing technique also developed. In the mid 1800s, copper plates were replaced by lithography, where the map images were drawn on stone. Clarity was enhanced, and a larger number of copies could be printed. Lithography is still in use, but is today increasingly replaced by photographic or digital printing methods.

Old maps often had several themes – apart from showing land and water, cities and political borders, they could display topology, population of people and wildlife, flora and natural resources. The planar maps were often accompanied by sections and views (Figure 6).

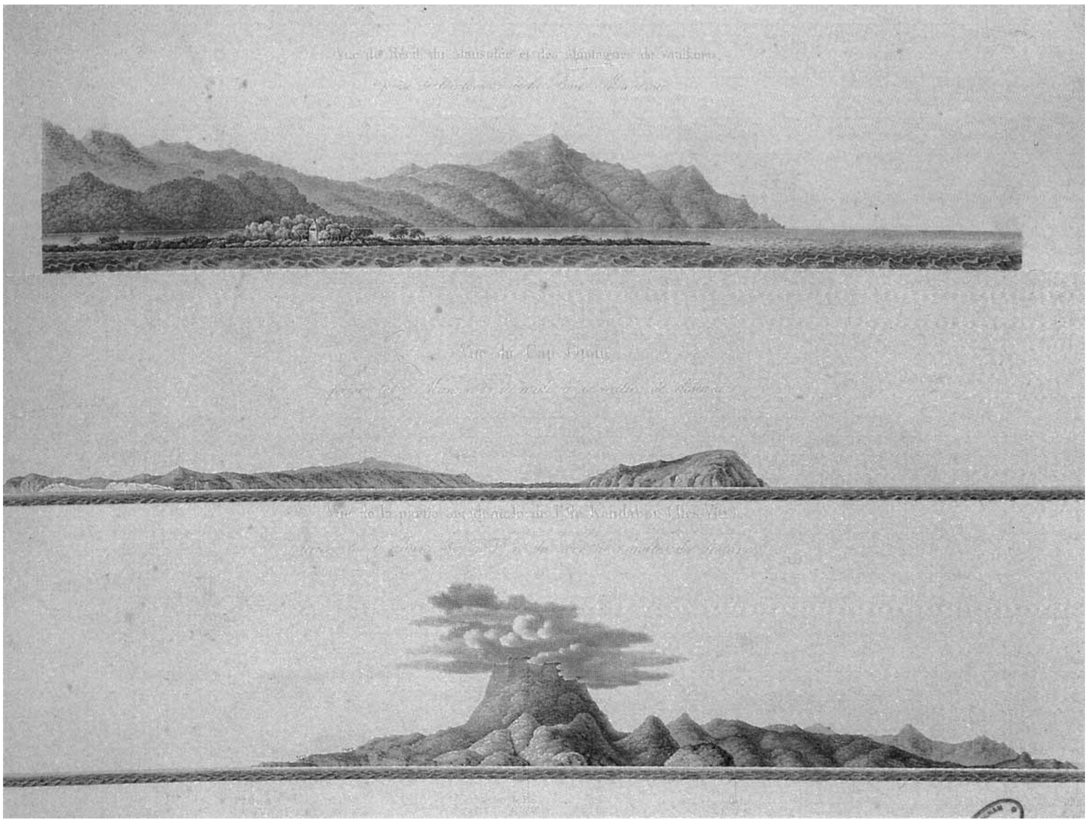


*Figure 6. Landmarks in New Zealand, illustrated by Jules Dumont D'Urville in 1828 (Allen, 1997)*

1. *The development of a railway network, a postal system and the telegraph went hand in hand with the growth of popular newspapers, the public library system and better public health and led to the formation of a society which required books that both informed and entertained. The introduction to many of the general atlases published toward the end of the [nineteenth] century expressed the hope that they would fulfill this function – and most of them certainly do so. (Allen, 1997, p. 143)*

All the new skills led to a large production of comprehensive atlases. The imperialistic states wanted to manifest their wealth; the self-confidence and belief in progress needed to be consolidated.[1]

Maps in Planning

By the end of the nineteenth century, the improved methods in cartography and survey were also starting to be used in planning. Surveying techniques had already for a hundred years put its mark in the Untied States, where the rectangular subdivisions on the vast inland areas still are characteristic. When the techniques were improved, they were applied to more advanced forms of site survey. Detailed maps – showing topography, vegetation, and streams – were used to find suitable areas for different kinds of development. (Fabos, 1985)

Modern Mapmaking

The twentieth century witnessed a rapid growth of cartographic data. The surveying methods were further improved – with Sweden in the lead – which resulted in the production of extremely accurate maps. High-quality aerial photography in combination with stereoscopic instruments was used to build up national survey maps all over the world.

During the last few decades, surveying methods have become digital. Surveying instruments use laser technology to enhance quality and productivity. Aerial photographs are digital, either by origin or by scanning. Maps are produced either as raster images, or by using vector data.

Geographic Databases

Today, most of the developed countries have extensive national geographic databases. Sweden is still one most advanced in this field. The entire country is covered by land-use maps in scale 1:10,000 or 1:20,000, showing detailed information about property, administrative borders, topography, communication, buildings, land-use restrictions and so on. The information can be delivered in several forms and scales, adjusted to the user's needs.

## The Land-Use Plan

Land-use planning is as old as map-making. Large landowners have always planned the exploitation of the natural resources they control. This activity has however been so closely related to the everyday events that it seldom was expressed in maps or drawings. More evidence exists from urban environments. In the Western world, famous examples range back to the city planning of the old Greek culture, continued in the Renaissance Italy. The ideas of the "ideal city" were further developed in the nineteenth century, then dealing with the problems of the industrialized society. Twentieth century utopians such as Le Corbusier, Frank Lloyd Wright and Paolo Soleri consequently had their solutions to city design.

Landscape Preservation

This kind of explicit planning, driven by political, social, or other values, is a more recent activity in the urban setting. Abhorred by the negative effects of private ownership of the land, and a society that welcomed all forms of enterprise, the nineteenth century saw the birth of two important movements. Park planners began to propagate for "bringing back a bit of nature" into the cities. However, this was not enough – nature itself had to be protected against the economical activities of man. Legendary landscape architect Frederick Law Olmstead was, besides being the most famous park designer, a leader of the preservation movement. The most obvious result from this movement was the creation of national parks throughout the United States, Yellowstone Park being the first. This success was soon copied all over the world, and became one important task for land-use planners.

Public Recreation

Closely related to the national parks was the interest of planning for public recreation. In the end of the nineteenth century, special areas for recreation were being developed for the first time, with large-scale establishment beginning in the 1920s (Fabos, 1985, p. 68). In the United States, this was mainly an effort on the state level. One objective was to lessen the risk of the national parks receiving too many visitors.

Housing Development

The scope of issues that were subject to land-use planning gradually increased. In the 1950s and 1960s, many large-scale planning projects were initiated. In Sweden, the well-fare society obliged to build 1 million apartments in 10 years – a promise that had major impact on many city landscapes. In the United States, insensitive, large-scale redevelopment projects were carried out in all major cities, replacing housing for the poor with luxury complexes and office buildings (Fabos, 1985).

These efforts were criticized even before they were accomplished. Many planners rejected the top-down perspective and large scale of the projects. Instead, inspiration was sought from advances in science, such as ecology and environmental monitoring; changes in technology, e.g. transport and computers; and changing societal values. Planning needed to be more flexible, sensitive, and made in dialogue with the interests affected by it.

More information needed to be processed, in order to minimize negative effects from projects that were realized. Planners had to be more sensitive to the values of different groups in society, acting as a mediator among the opposing views. Great hopes were again put in the possibilities of planning.

Julius Fabos was such an optimist. He believed that land-use planning, by using new technology and "information networks", would be able to handle more complex issues than before, and at the same time enhance the local foundation. These increased capabilities would also strengthen the democracy, as the public more easily would get questions answered and conflicts analyzed. The very scope of the planners would also increase[1].

*1. [The planners] also will have the ability to simulate the consequences of actions not only in the context of their primary, local impact, but also their impact on contribution on the region, the state, the nation, and beyond. (Fabos, 1985, p. xxii)*

This modernization of planning and landscape analysis is personified in Ian McHarg. His influential book *Design with Nature* (McHarg, 1971) describes the first widespread method of systematic collecting of data for use in weighting of factors affecting planning issues. The foreword, by Lewis Mumford, is rather discouraging for computer users:

*Ian McHarg, while trained professionally as a town planner and a landscape architect, might better be described as an inspired ecologist: his is a mind that not merely looks at all nature and human activity from the external vantage point of ecology, but who likewise sees this world from within, as a participant and an actor, bringing to the cold, dry, colorless world of science the special contribution that differentiates the higher mammals, above all human beings, from all other animate things: vivid color and passion, emotions, feelings, sensitivities, erotic and esthetic delights – all that makes the human mind at its fullest so immensely superior to a computer, or to under-dimensioned minds that have adapted themselves to a computers limitations. (McHarg, 1971, p. vii)*

Mumfords negative opinion on computer support is naturally colored by the immature technique of the time. Today, he would perhaps be a bit more sympathetic. If you believe that computers can be guided by human emotions and values, then McHarg's method is perfectly applicable for use in GIS.

In short, the method is based on an effort to identify and value social as well as natural processes in terms of social values. The values can be expressed in economic terms, but also in terms of relative weight – an important historic building would by most people be considered more valuable than a regular private home. In the same way, natural conditions – climate, soil, vegetation et cetera – can be compared and ranked. All these different types of factors can be related to each other in a creative comparison, and the most "efficient" solution found.[2]

*2. The alternative is always to be sought – an alignment that avoids areas of high social costs and incurs the least penalties in construction costs and creates new values. The basis of the method is constant for all case studies – that nature is interacting process, a seamless web, that it is responsive to laws, that it constitutes a value system with intrinsic opportunities and constraints to human use. (McHarg, 1971, p. 34)*

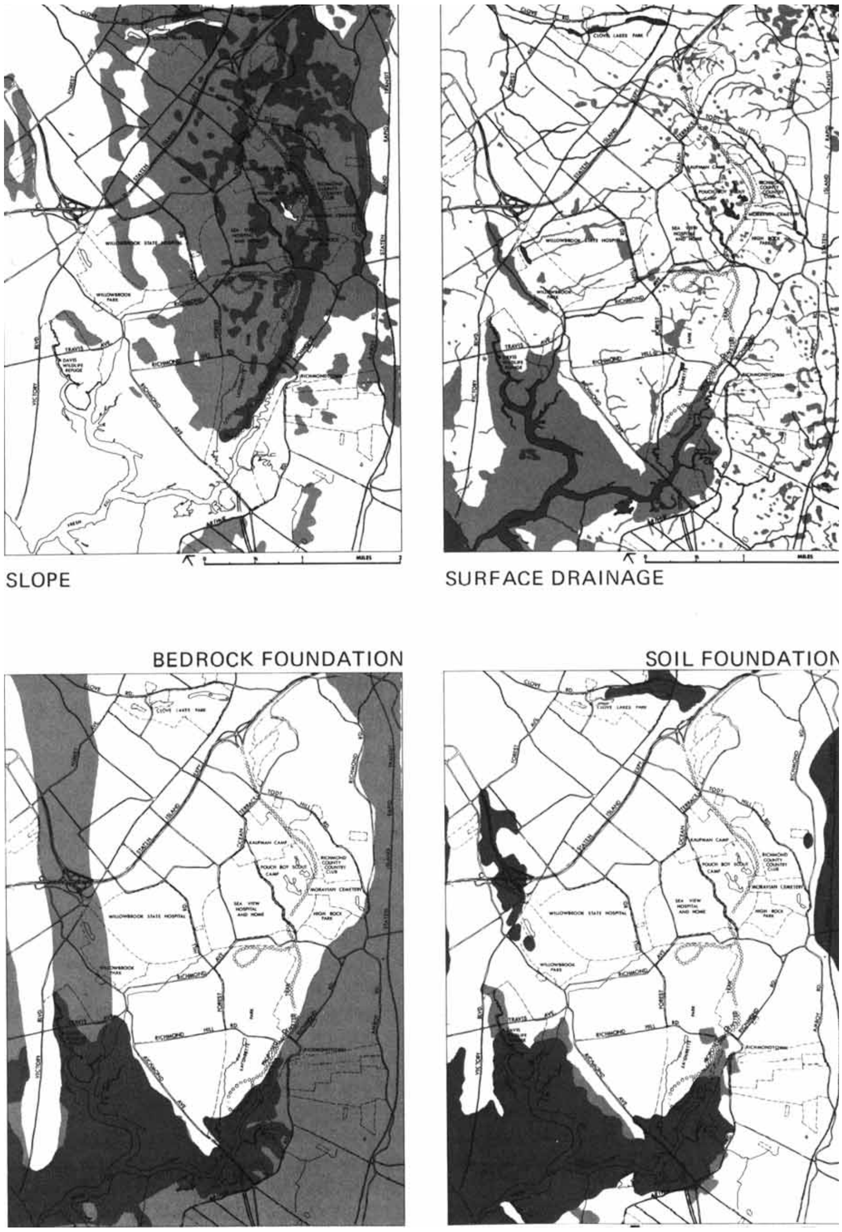



*Figure 7. Four out of 16 maps presenting factors affecting the Richmond Parkway. (McHarg, 1971).*

McHarg and his associates produced the maps needed to present these evaluations manually (Figure 7). Today, the work would surely be done using GIS. The method states that the transparent maps are overlaid each other, giving visual aid to finding areas with certain conditions. With the use of GIS, queries can be made to the data collected. The weighting of factors can be manipulated in a flexible way.

*1. By [superimposing factors] we can observe the maximum concurrence of either high or low social values and seek that corridor which transects the areas of least social value in all the categories. (McHarg, 1971, p. 34)*

The comparison between different types of values cannot, according to McHarg, be made using the same "unit", resulting in an absolute truth. The different factors can be laid on top of each other in different combinations, but the result can never be described in terms of money, or any other value.[1]

Obviously, Mumford is right in the sense that the computer cannot make the final evaluations. They are not even for the planner to decide, no matter how righteous he or she might be. The comparing of different kinds of values is ethical and political, and must thus be for the public, and for the elected politicians, to debate and decide on.

McHarg's method is still standard procedure in physical planning. Many countries have formalized the process, demanding environmental assessment studies whenever changes to the environment are planned.

## The Plan Drawing

The oldest paintings aimed at accurately describing buildings and gardens are from Egypt. One example of the Egyptians strange mixture of projections was found in the tomb of a high court official of Amenhetop III. The painting is partly in plan, partly in projection, with some elements twisted around in place (Figure 8). The plan can be interpreted into a perspective, more easily readable for a modern viewer (Figure 9).

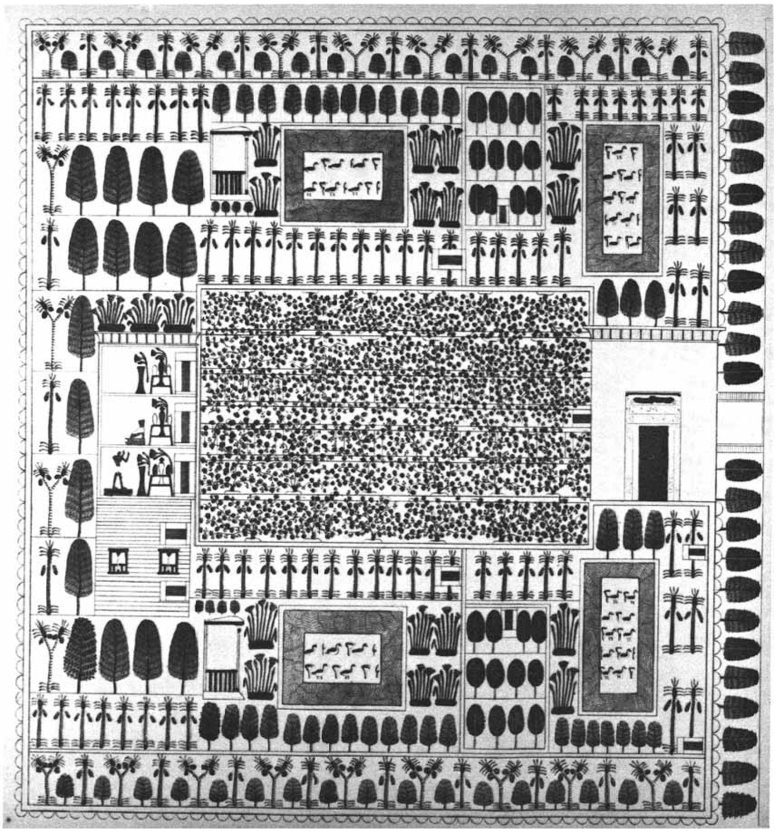


*Figure 8. Wall painting depicting house and grounds of an official at the court of Amenhotep III (Newton, 1971. Originally in Rosellini,* Monumenti dell'Egitto e della Nubia, II*)*

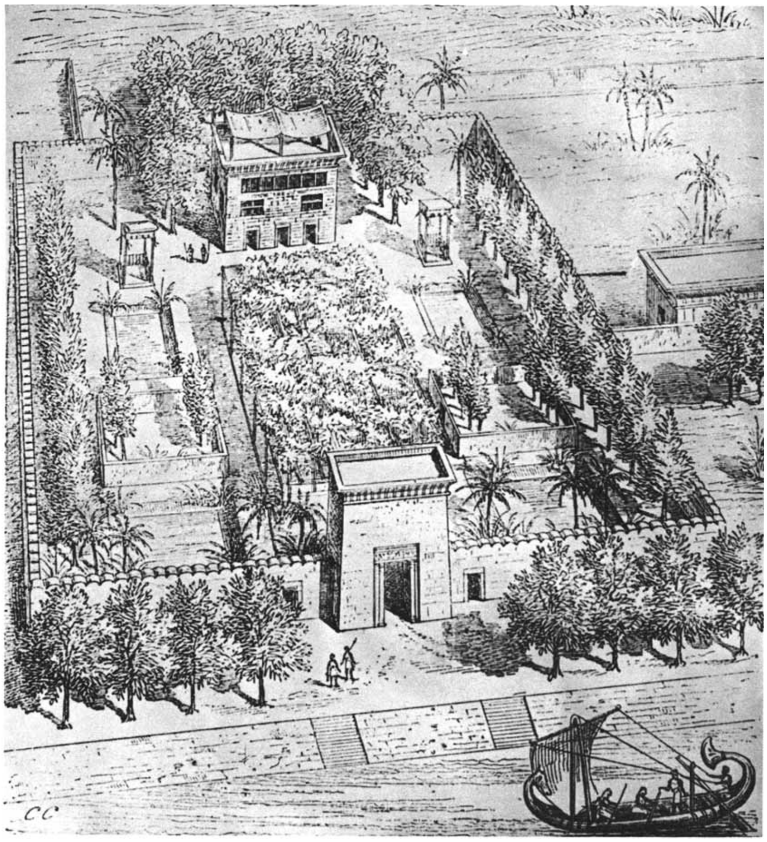


*Figure 9. Perspective interpretation of the mural (Newton, 1971. Originally in Perrot and Chipiez,* History of Art, II*)*

In the beginning was the word. The architect – the "master builder" – stayed on site throughout the construction phase. He had no reasons to express his design in technical drawings. The orders were given orally to the workers. As the constructions became increasingly complex, this organization was changed. The designer recorded his ideas on plans, showing general layout, as well as constructive details.

In the seventeenth century, architects and landscape architects drew and painted large and beautiful plans showing garden designs and layouts.[1] These beautiful drawings combined technical clarity with an ability to express the spirit of the garden to be built. Mosser and Teyssot find parallels in other cultural expressions of the time; the literature, often filled with Utopian fantasies; the flair for exotic countries and strange plants from far places.

*1. From this derived a fashion for "cartography of gardens and orchards'. The technique employed was that of traditional cartographic relief drawing using shading, but it was combined with an aesthetic approach which gave it a quality of its own. (Mosser and Teyssot, 1991, p. 12)*

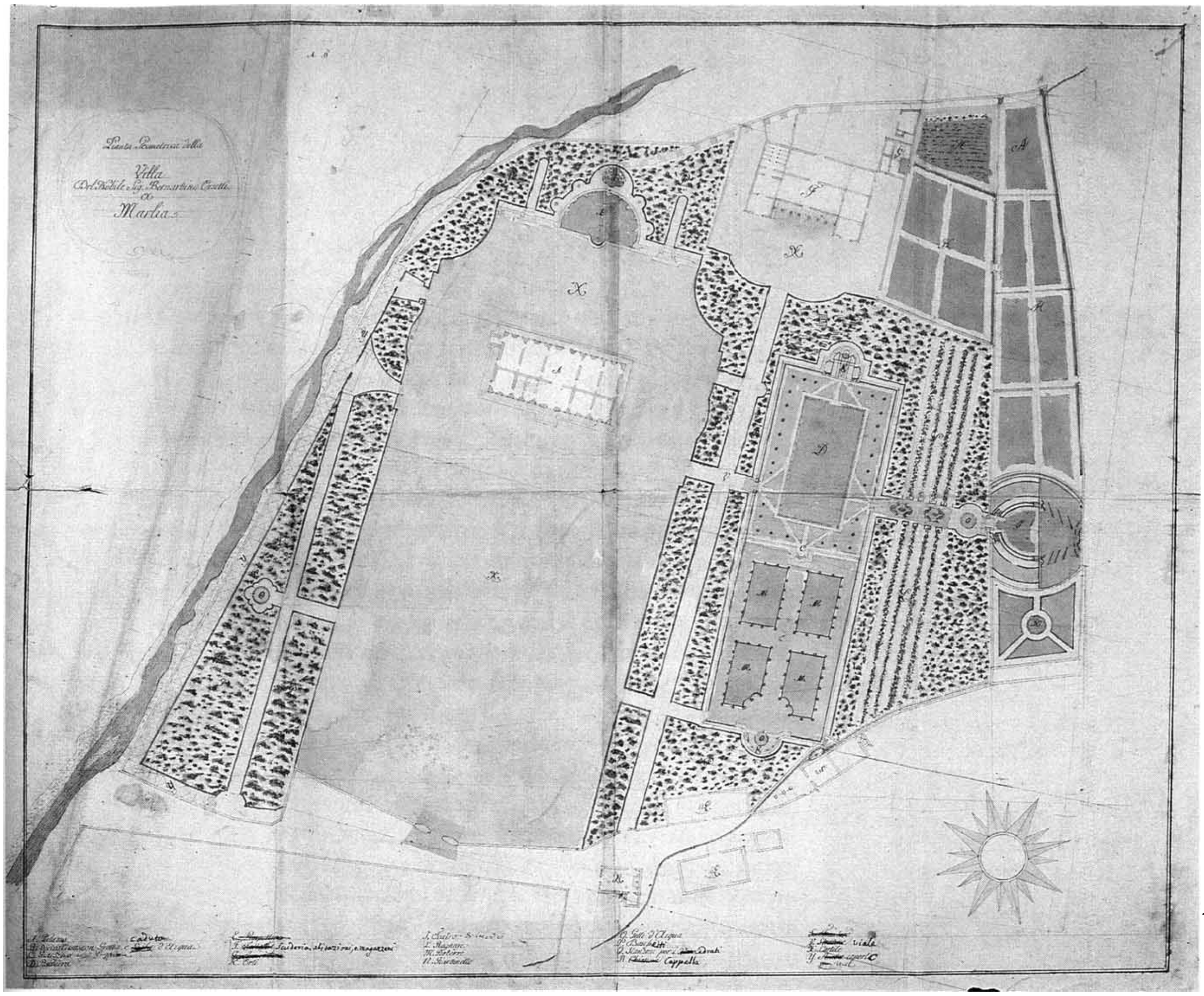


*Figure 10. Plan of Villa Orsetti (Mosser and Teyssot, 1991. Originally from the Lucca State Archives)*

One example of a eighteenth century plan drawing is from the Villa Orsetti (Figure 10). However simple, it is a clear and readable presentation of the garden, drawn with ink and watercolor.

In addition, constructive details were becoming more important, and expressed in drawings to guide craftsmen and workers. These skills were systematized interpretation of the eighteenth century France, were garden design became almost scientific in its methodic approach. Spaces were analyzed in search for geometric principles, sometimes with the aim to find the "divine proportions" (Mosser and Teyssot, 1991, p. 140).[1] The design principles were recorded in systematic manuals for garden theory and practice, complete with detailed construction proposals (Figure 11).

1 . *These designers would have loved* CAD*!*

At this time, garden design and engineering went hand in hand. Using state-of-the art instruments – compasses, ruler, set square, bevel, and astrolobe – the designers led the construction works in the large gardens (Mosser and Teyssot, 1991, p. 139). Advances in surveying – pushed forward by the military, and for property taxation – was quickly adopted in gardening.

The drawing in the figure below is engraved – actual work drawings used on site were mostly made with pencil or ink.

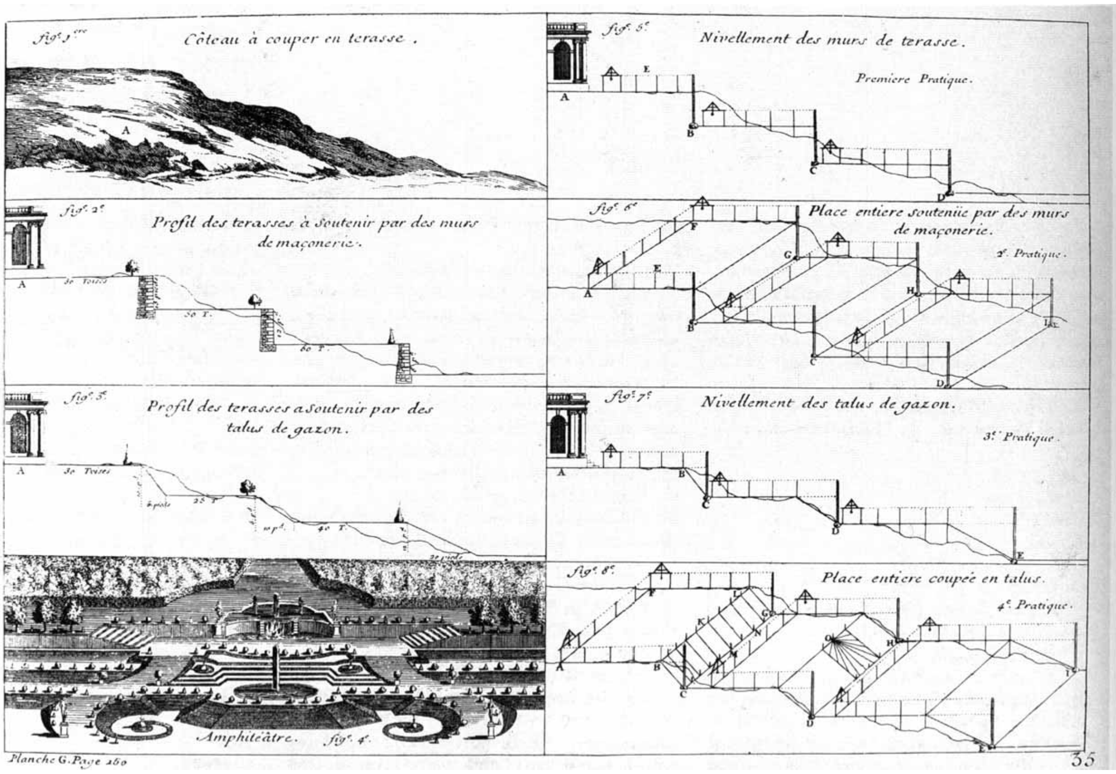



*Figure 11. Method of leveling land for the laying out of terraces (Mosser and Teyssot, 1991. Originally from A.-J. Dezailler d'Argentville,* La Théorie et la pratique du jardinage, *Paris 1713)*

In the 1920s, many of the classical Italian villas were measured and drawn by international visitors. In the illustration plan over the Villa Gamberia shown below, the use of shadows to produce depth is masterly used. The inserted smaller detail drawing, with its shadowed edges, is a pretty example of a "tromp l'œil" – in a more primitive form a very popular effect in modern desktop publishing (Figure 12). The section uses an almost photographic ink technique (Figure 13).

Dealing with the same subject, J.C. Shepard also in the 1920s painted a large number of watercolor illustrations for *Italian Gardens of the Renaissance* (Shepard and Jellicoe, 1986). Mostly printed in black and white, they still by the use of splendid technique combine the softness and accuracy that watercolor painting can achieve (Figure 14).

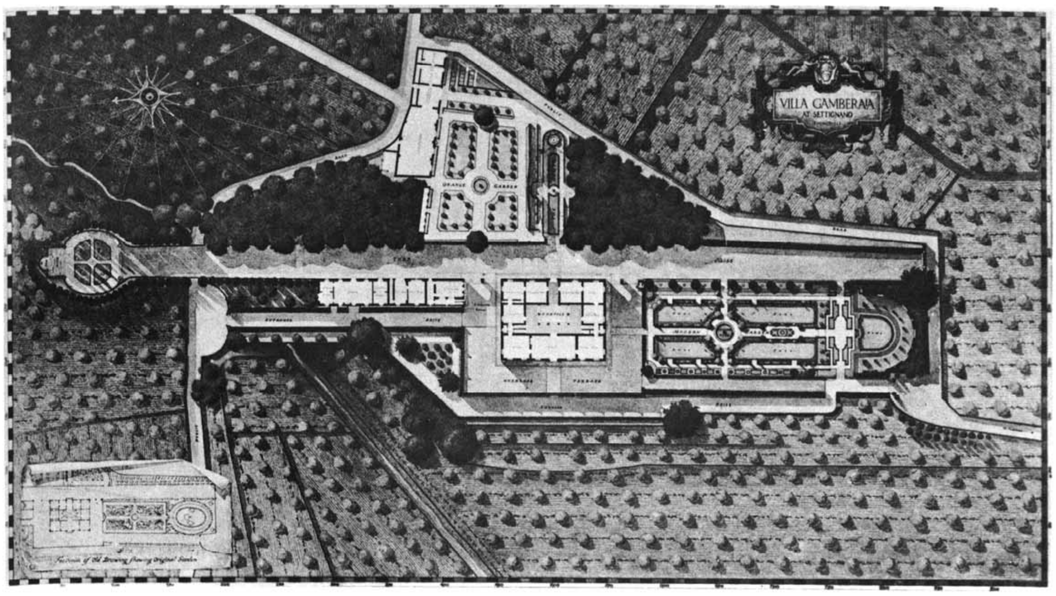



*Figure 12. Plan of the Villa Gamberaia (Newton, 1971. Originally by Ralph E. Griswald)*


*Figure 13. Section of the Villa Gamberaia, drawn to accompany the plan*

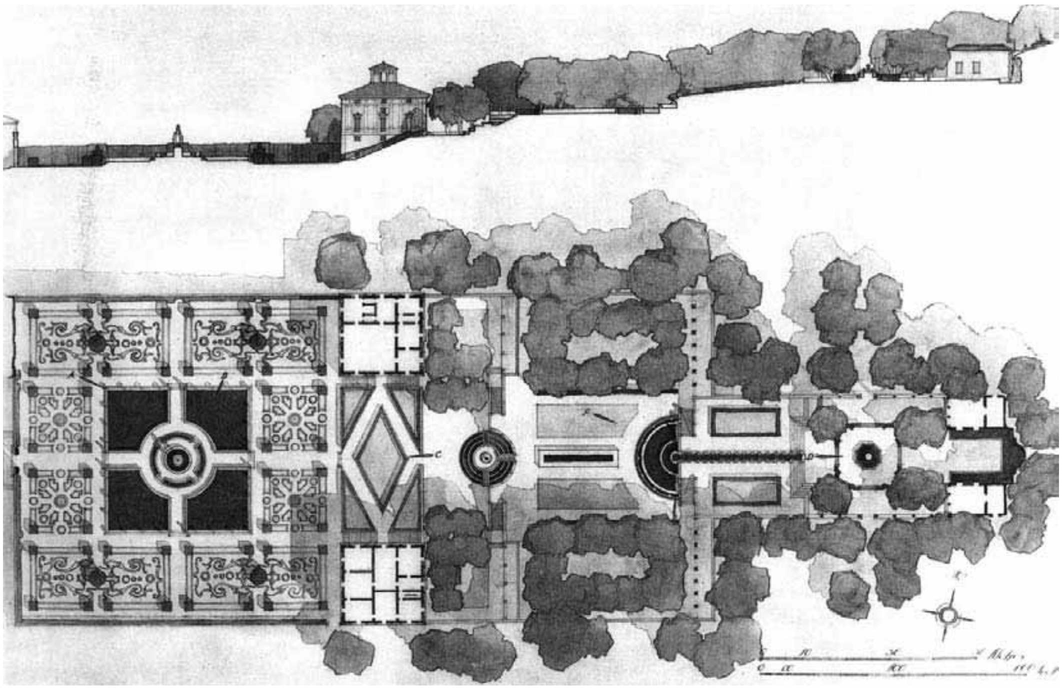


*Figure 14. Villa Lante, painted by J.C. Shepard 1923 (Shepard and Jellicoe, 1986)*

At the same time, a completely different presentation technique was becoming in use – an ink line drawing, with great simplification, and symbols more decorative than illustrative. The Art-Nouveau style illustration below is appropriately[1] showing a proposal for the *Jugendpark* in Berlin (Figure 15).

*1 . In Sweden, the Art-Nouveau style is designated "Jugend".*

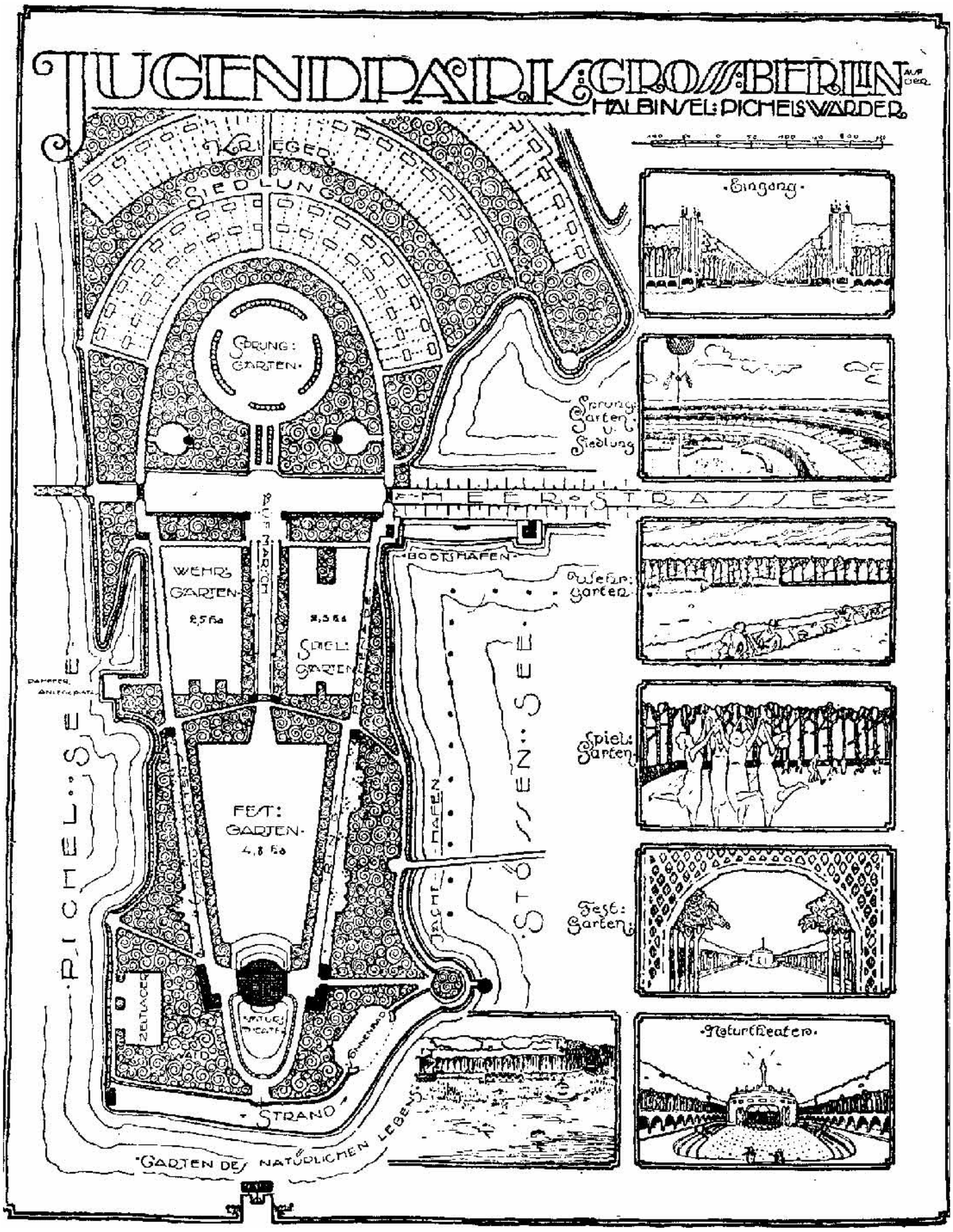



*Figure 15. L. Migger, M. Wagner, design for a youth park in Berlin, 1916 (Mosser and Teyssot, 1991)*

An even more modern and simplistic way of illustrating is used in *The History of Garden Design* (Mosser and Teyssot, 1991). By varying the density of an ink raster, a simple 3-dimensional effect is produced (Figure 16).

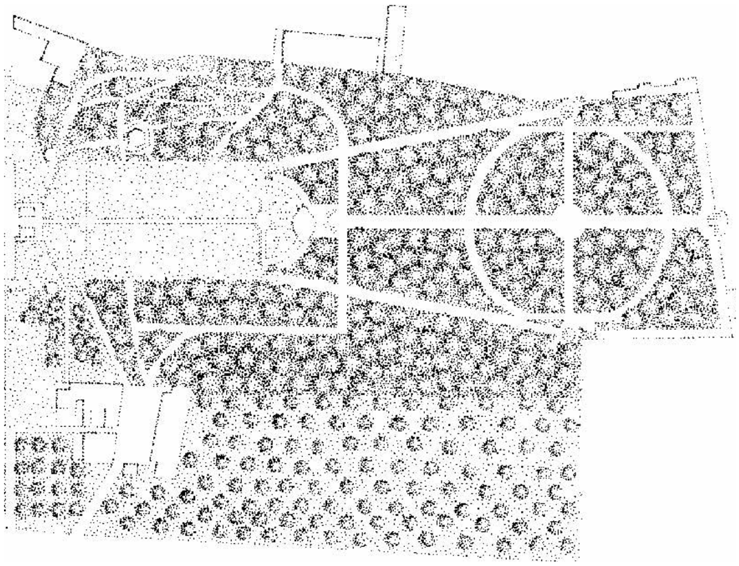


*Figure 16. Part of presentation of the Garden of Pratolino (Mosser and Teyssot, 1991)*

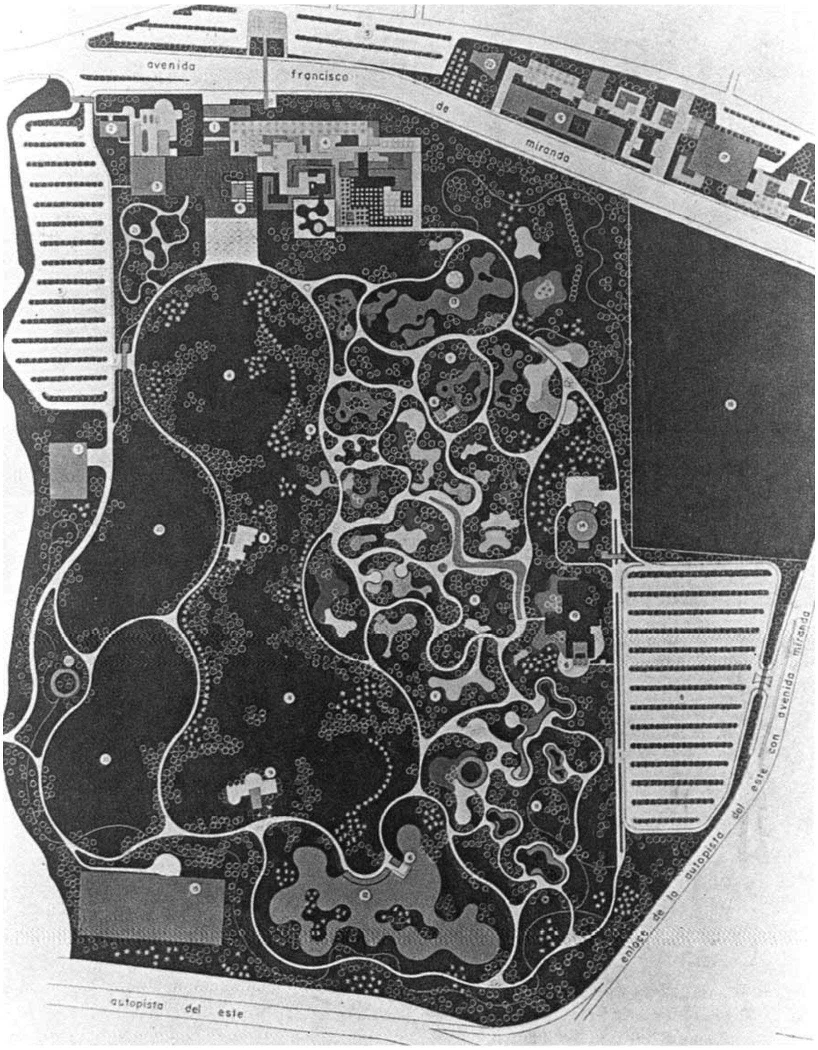



*Figure 17. General plan of the Parque del Este in Caracas, Venezuela, designed by Roberto Burle Marx, 1957 (Mosser and Teyssot, 1991)*

The ties between art and landscape design have perhaps never been more evident than in the works of Roberto Burle Marx. The colorful paintings, with its plastic forms and intricate patterns, are realized by skillful use of flowering plants and custom-made concrete tiles (Figure 17).

As this overview moves into modern time, the range of possible techniques expands even further. Plan drawings become more and more symbolic, sometimes iconic, and slowly leaves the goal of conveying a naturalistic view of a proposed design. In line with illustrations made by building architects, the drawings become hard, with sharp contrasts and black shadows. Hard pencils and ink pens are used (Figure 18).

This new style evolves, especially in the United States, into the dominant method for landscape architects to present ideas in two dimensions. Several handbooks teach the techniques to use, such as Wester (1990) and Reid (1987). Drawings are often pure black and white, with strong lines, heavy shadows, bold and casual lettering (Figure 19).

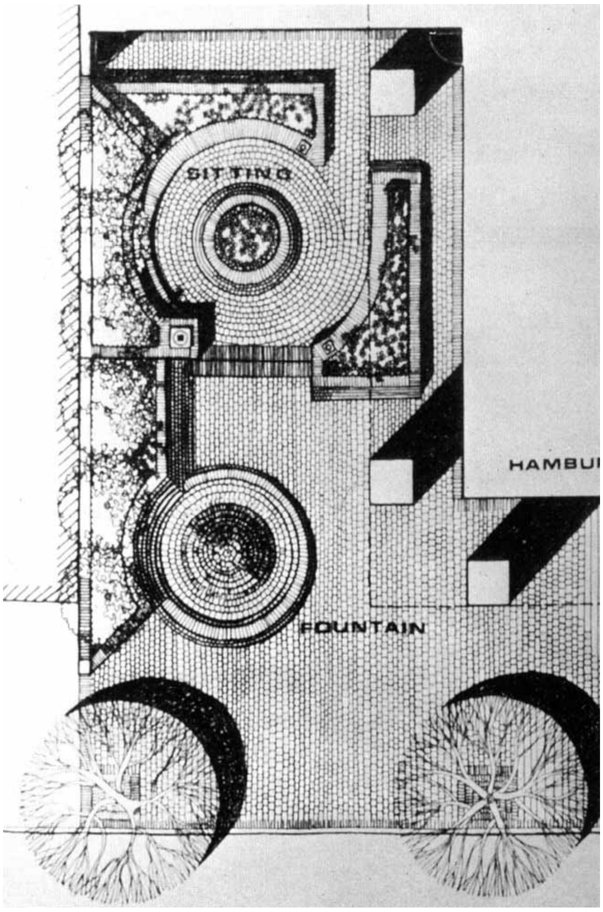



*Figure 18. Wilshire Plaza, designed by Allen Fong (Lyall, 1991)*

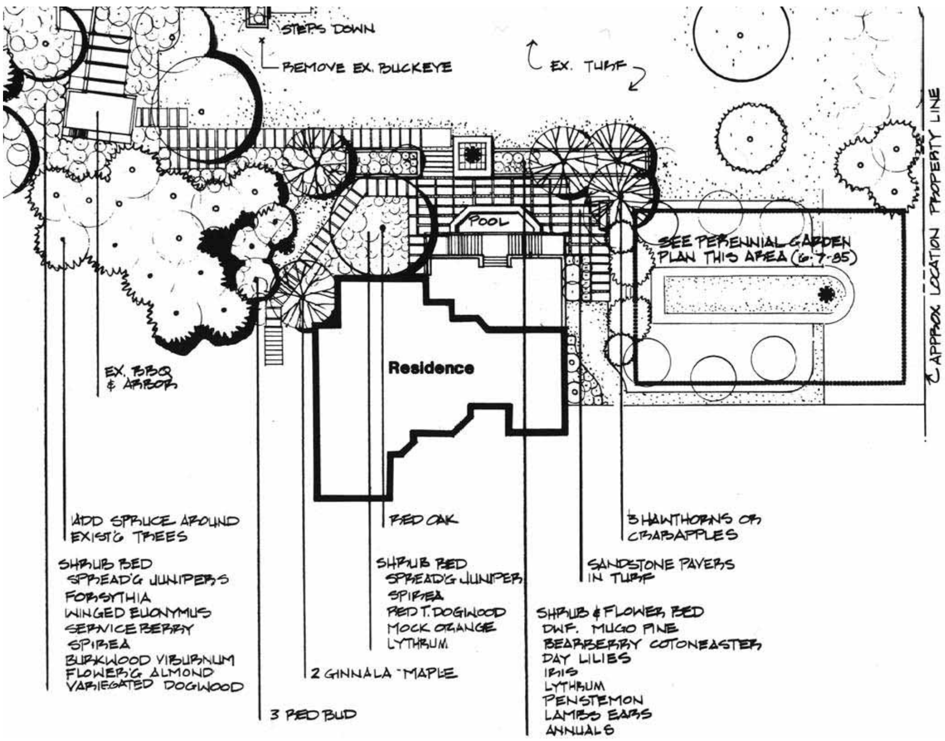



*Figure 19. Part of landscape plan of private residence in Denver, Colorado. Plan by EDAW Inc. 1985. (Reid, 1987)*

In Sweden, the style is somewhat more discrete (Figure 20). The often-close cooperation with building architects is evident when the site planning is presented on floor plans (Figure 21).

With a solid knowledge of the classical style of presentation, Geoffrey Jellicoe succeeds in giving a modern, informal "squibbling" technique a touch of history (Figure 22).

Often, a soft and irregular technique is used for representing vegetation, and a strict manner applied to hard surfaces and built objects. This combination is used worldwide (Figure 23).

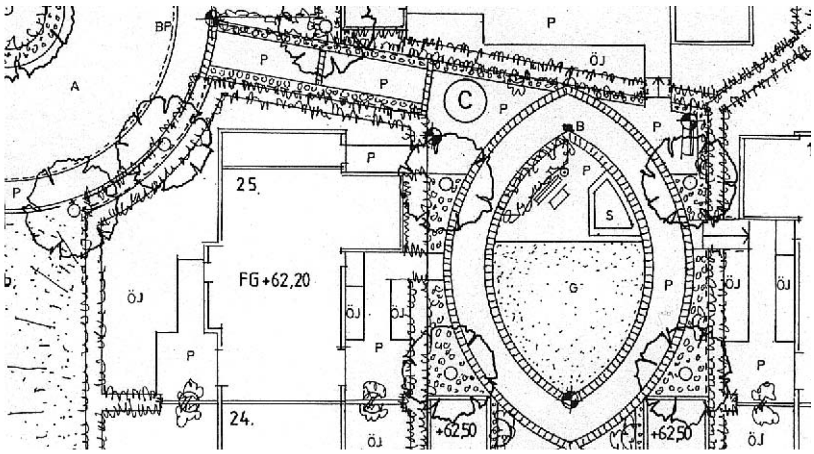



*Figure 20. Illustrative plan, courtesy of Landskapsgruppen Syd, Helsingborg*

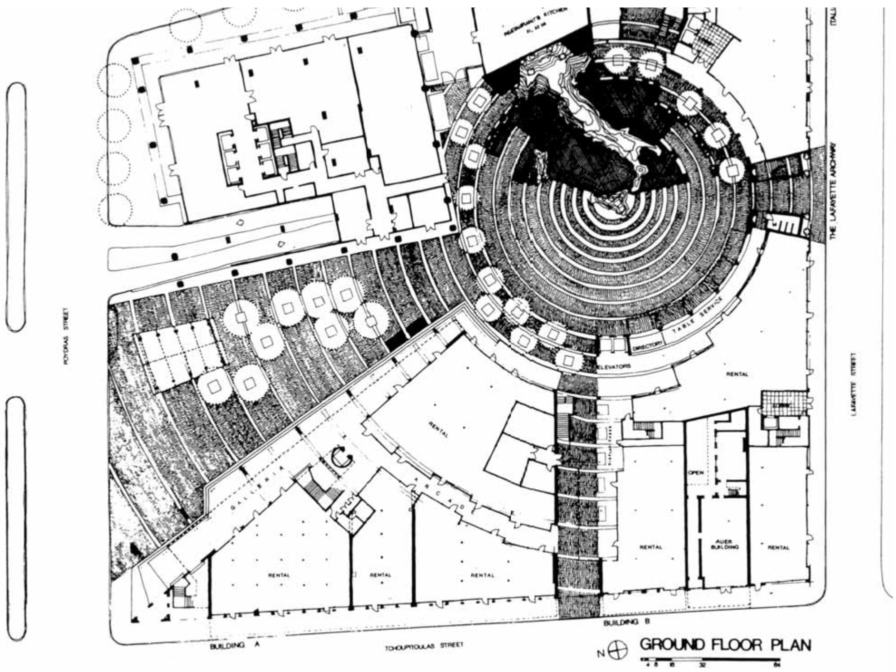



*Figure 21. Piazza d'Italia, New Orleans, designed by Moore Perez Associates and Ron Filson (Lyall, 1991)*

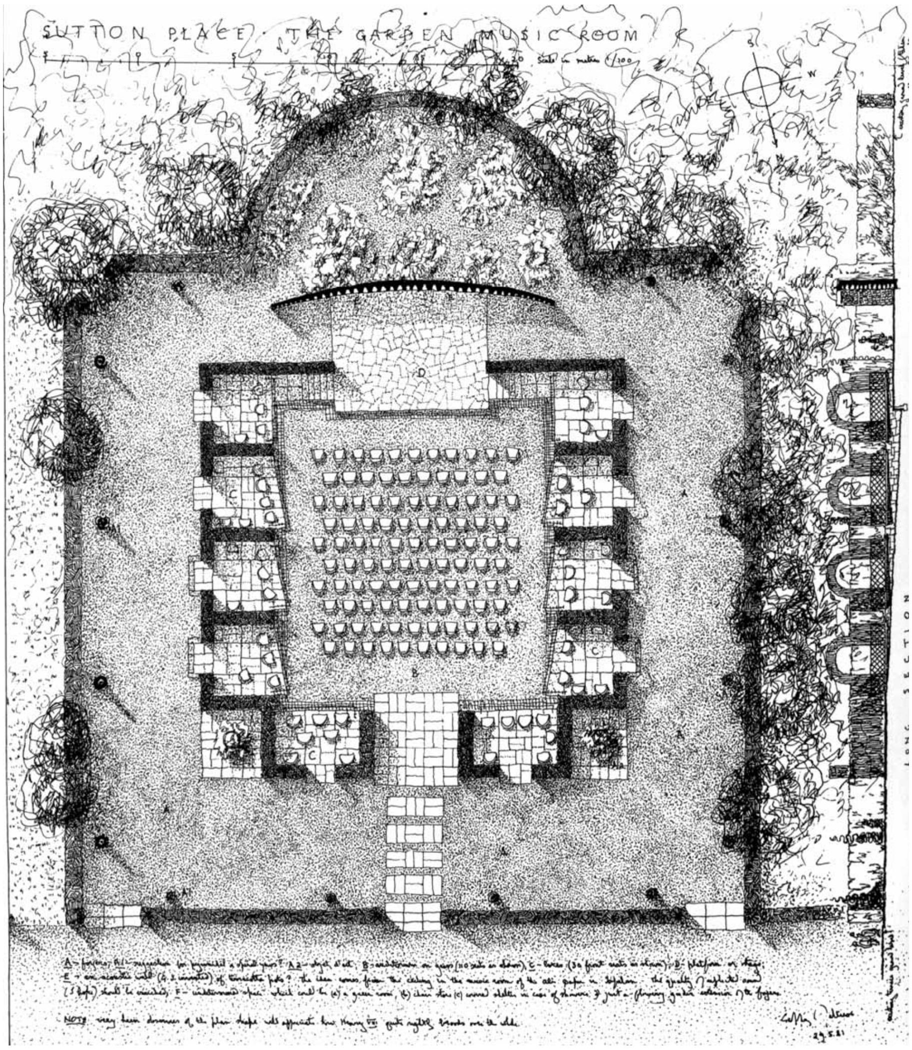



*Figure 22. Sutton Place, Surrey. Open-air theatre design by Geoffrey Jelleicoe, 1982 (Lyall, 1991)*

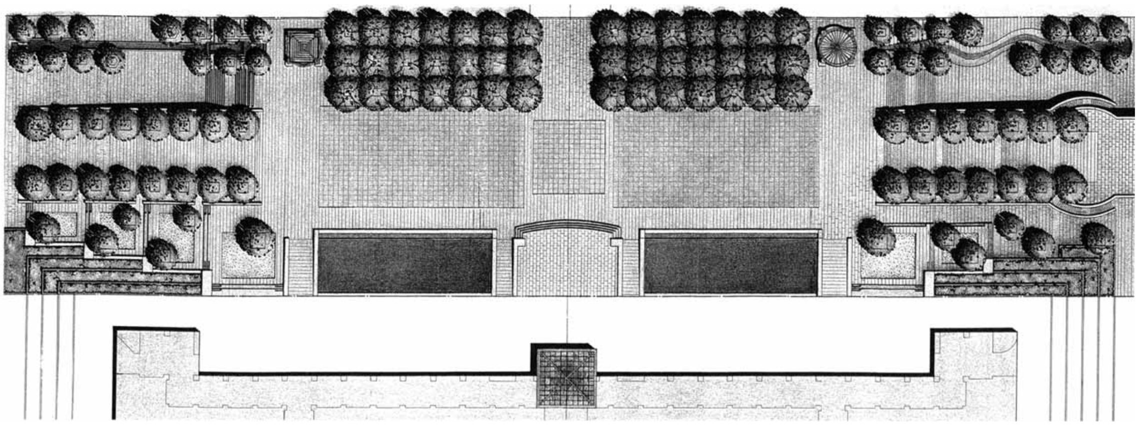


*Figure 23. Grand Mall Park, Nishi-ku, Yokahama City. Design by Tokyo Landscape Architects, 1989 (Lyall, 1991)*

The example below uses a similar technique, using elaborate manual ink lines to present more naturalistic representations of plants. A section accompanies the plan, to even more increase readability (Figure 24).

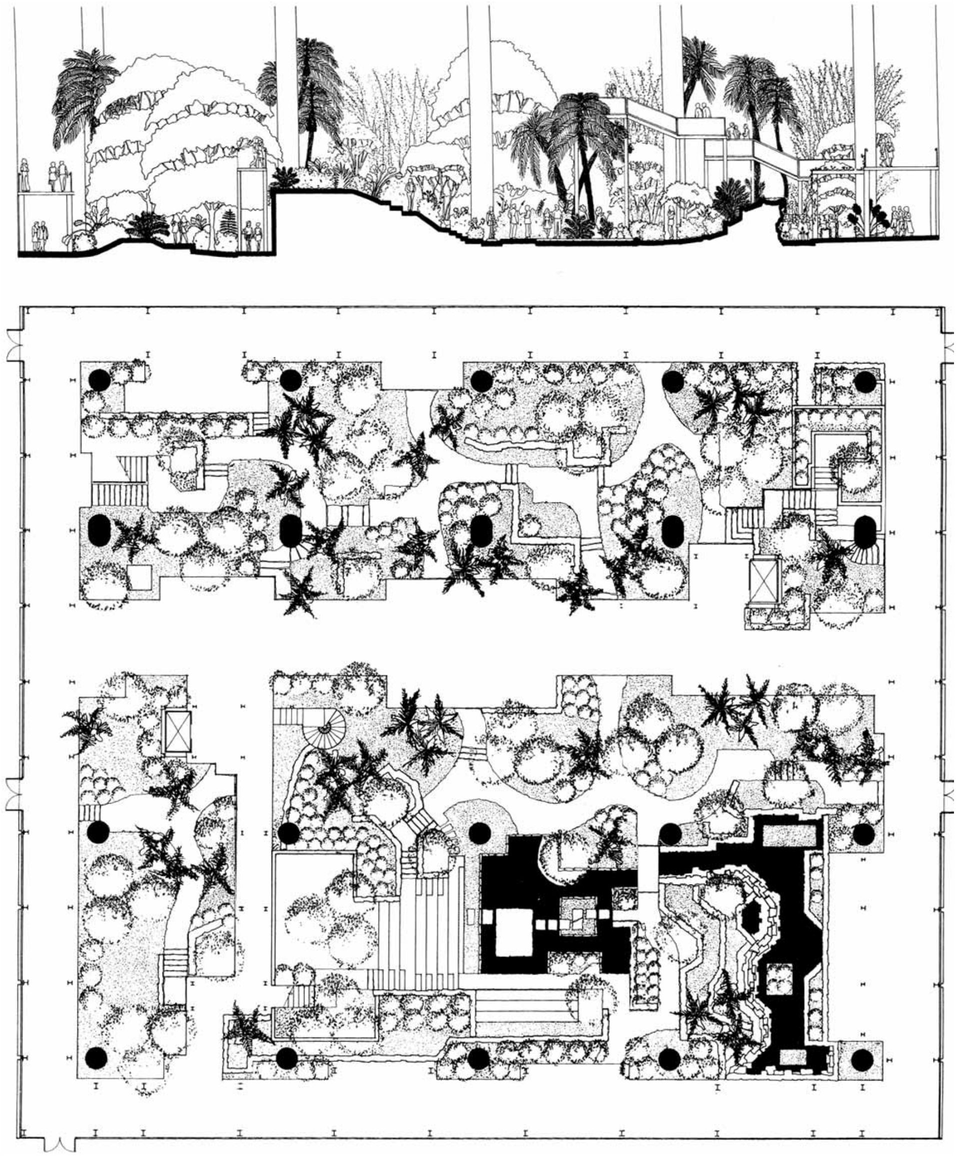


*Figure 24. Winter Garden, Niagara Falls. Design by M. Paul Friedberg, 1977 (Lyall (1991)*

In the 1980s, a new style of presentation drawing appears. Using thin lines and a mechanical touch, inspired by the availability of CAD systems, the pictures begin to clearly move away from the naturalistic. A new ideal is being expressed among some of the leading architects and landscape architect alike – elegant, sophisticated, deconstructed.

The example below still uses manual techniques – ink and rub-on screen film (Figure 25).

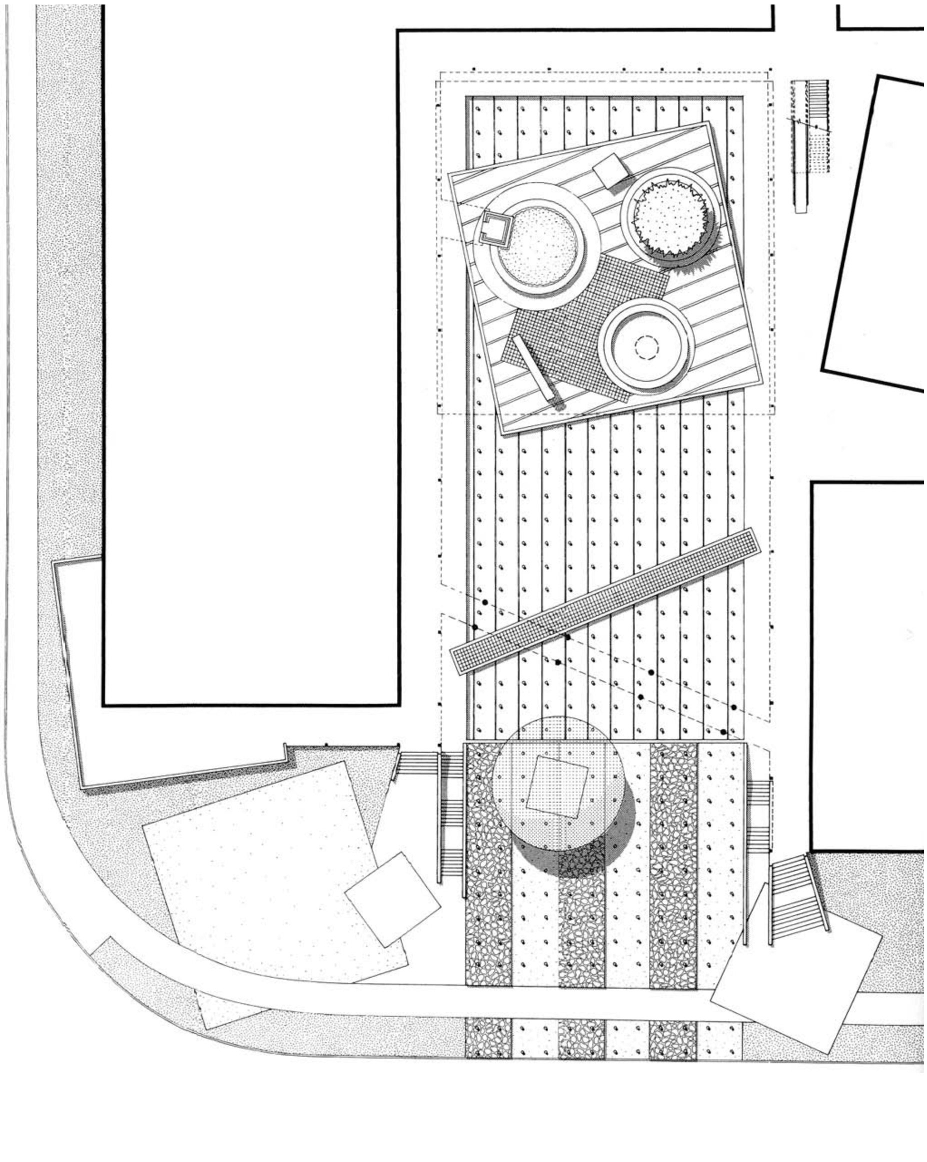


*Figure 25. Rio Shopping Center, Atlanta. Design by Martha Schwartz, 1988 (Lyall, 1991)*

Alongside with this high-tech fashion lives the careful manual technique, where color pencils are used to produce classically beautiful pictures. In the plan below, inserted details clarify points of interest (Figure 26).

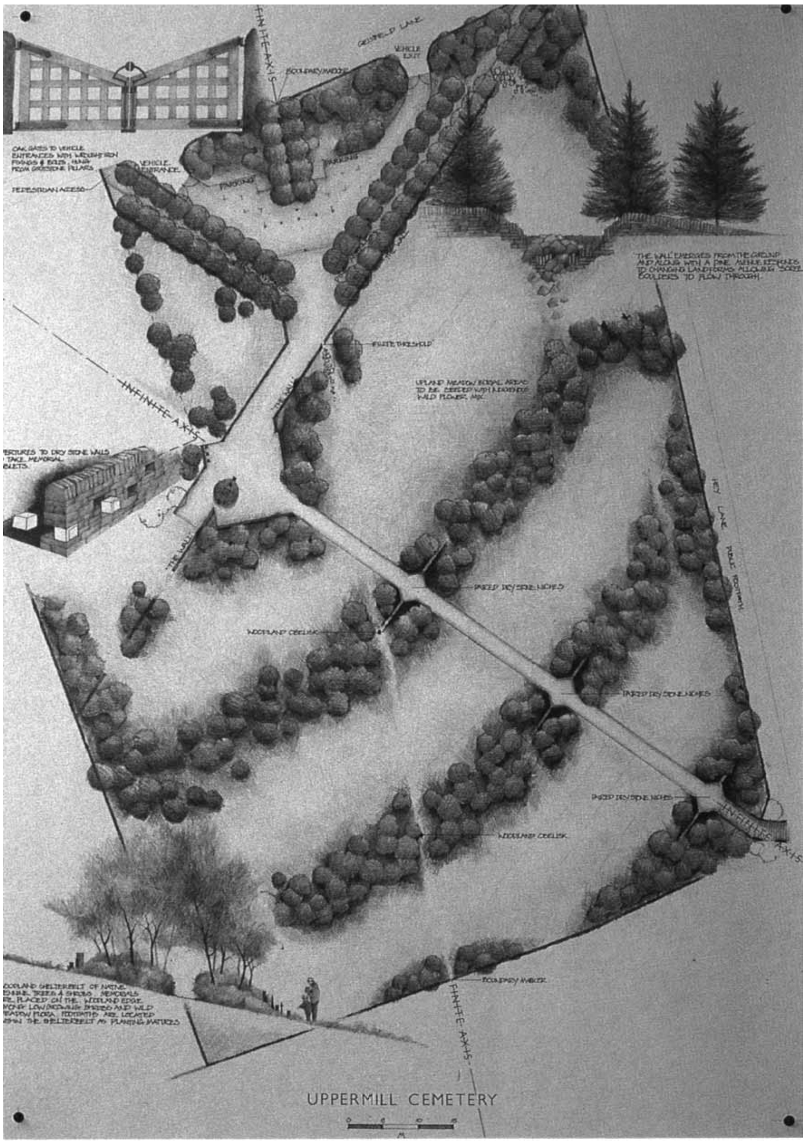



*Figure 26. Uppermill Cemetary by Camlin Lonsdale. Plan drawing by Robert Camlin (Holden, 1996)*

Katryn Gustafson shows another modern example of an old, “natural” representation. Her plan has a great likeness with that of St-Leu-Tavery shown earlier, drawn 150 years before Gustafson’s. The terrain forms are softly shaded to produce a three-dimensional effect (Figure 27).

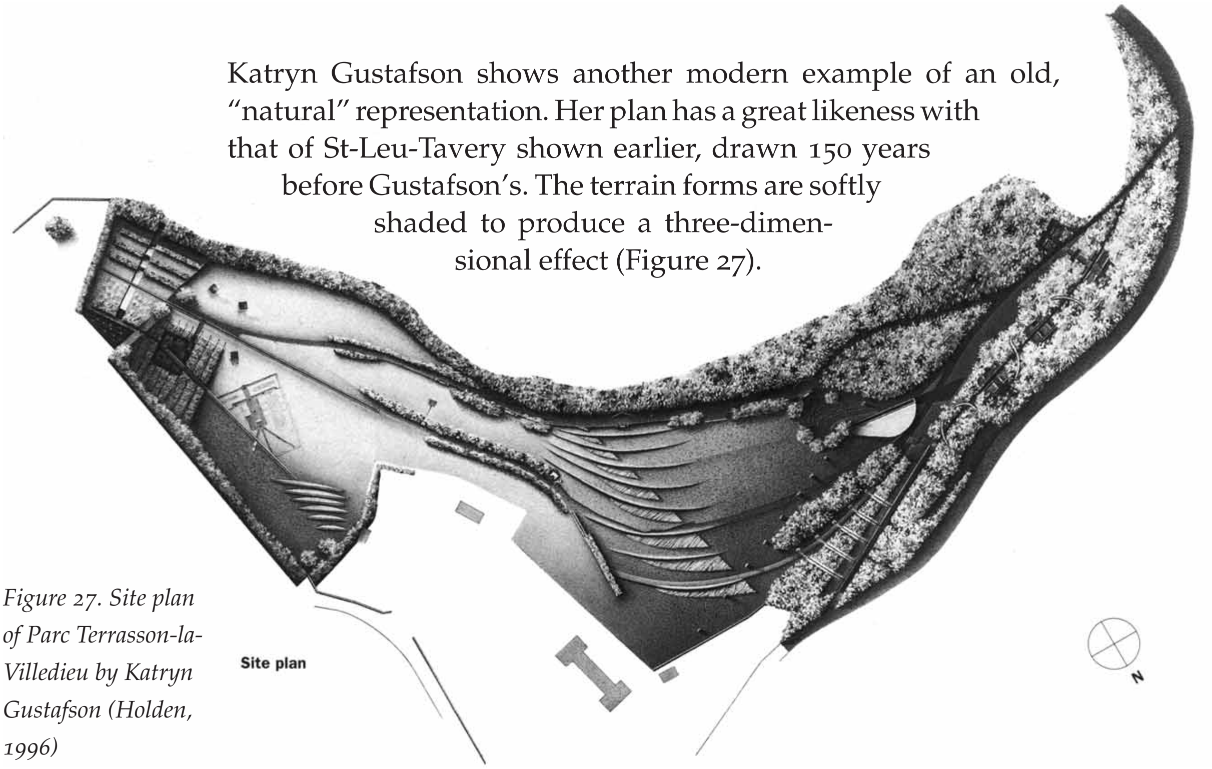



*Figure 27. Site plan of Parc Terrasson-la-Villedieu by Katryn Gustafson (Holden, 1996)*

Technical Drafting

The drafting technique for technical drawings has not changed much since the eighteenth century. Only small adjustments have been made, leading up to the contemporary techniques. Technical pens have been introduced, giving the drafter a tool with high precision in line quality. Drawing aids for lettering, drafting of symbols, curves, and so on accompanied the pens. Eventually, the drafting started to be done with computer support.

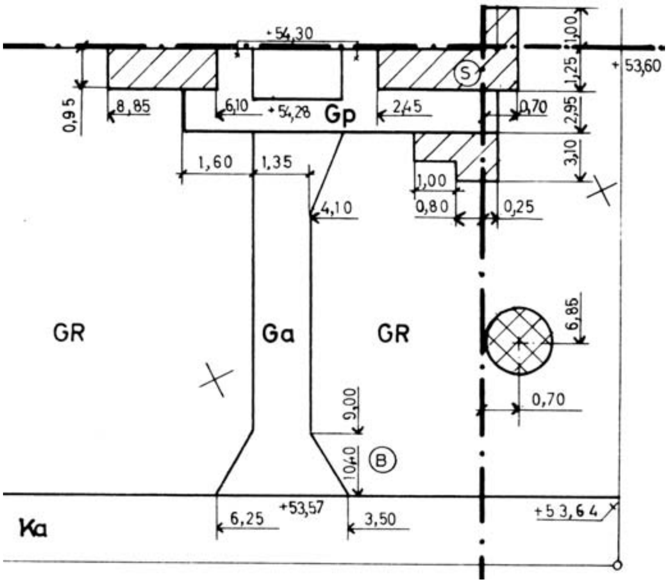
The traditions differ somewhat between nations. There is today two major ways of illustrating the technical construction of sites and built objects – one somewhat cold and technical, one more artistic and illustrative. The latter is still preferred by most landscape architects, especially for representing vegetation.

Drafting Standards

In Sweden, drafting standardization for building and construction began in the middle of the 1950s. The first result was publicated in 1959, and was followed by a large number of drafting recommendations. During the following decade, these were formalized into Swedish Standard. The result was a comprehensive documentation of the modern drafting style: *Redovisning 72* (“Presentation 72”).

This was the first major effort to establish a national standard for drafting technique, covering all disciplines in building and construction. The work was – with few changes – later adopted as the first international ISO standards in the field (Florgård, 1999). Although many landscape architects still tended to lean towards the traditional, more elaborated and aesthetic manner of drafting, the standard did have a large impact in technical drafting – hardwork plans etc. (Figure 28).

The Swedish National Board for Building Standardisation (Byggstandardiseringen BST) modernized the documentation recommendations in the 1980s, resulting in *Bygghandlingar 90*. Part 1-6 covered the building process in general, and different documentation aspects of building and technical installations.




Part 7, dealing with landscape and site documentation, was the first attempt to unite the documentation techniques for site development with large-scale road and railroad projects (Dahlin, Eckerberg and Suneson, 1996). Line types and symbols were as far as possible harmonized with neighboring areas – mapping, geologic technique, electrical installations, and other technical aspects of site design. (Figure 29).

*Figure 28. Plan from Bygghandlingar 90 Del 7, Redovisning av Mark*

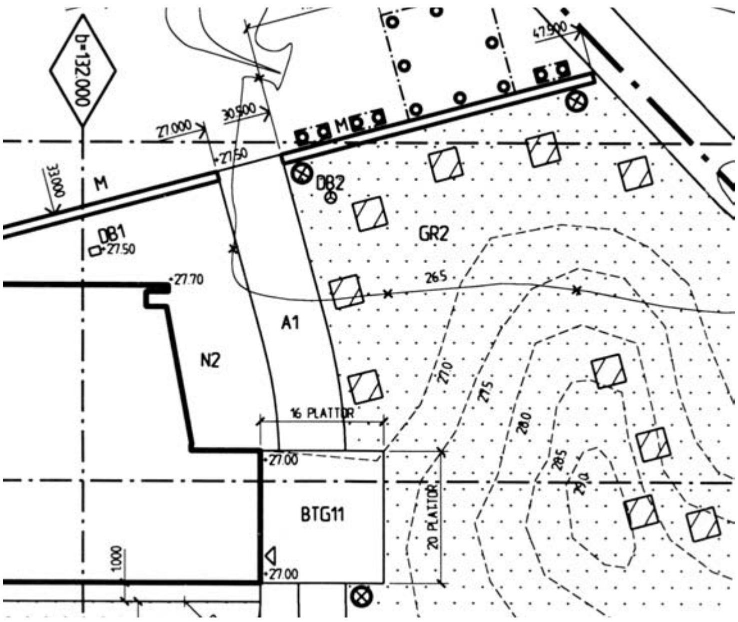



*Figure 29. Plan from Redovisning 72*

## The Perspective and Axonometric Drawing

Inaccurate maps have obvious disadvantages. The problem of inaccuracy is much less evident for other means of describing the physical environment – often, it is quite the opposite. When realism is not sufficient, imagination can do the trick. Paintings and engravings describing large estates where considered important proof of the grandeur of a nobleman, a king or even a country.

Drawings as Propaganda

In Sweden, the multi-talented Erik Dahlberg initiated the gigantic project *Suecia Antiqua et Modierna*. Never quite finished, Dahlberg and other artists traveled around Sweden between 1663 and 1720, documenting buildings, historical monuments and other points of interest – "a topography over the entire country of Sweden and its subordinate provinces, illustrated with copperplates". The task of engraving all the plates was obviously laborious, consuming time and large amount of money. Concentrating on buildings, it still gives a fascinating insight into Sweden of the time – its landscapes as well as its propagandistic skills. One example of this work is shown in Figure 30.

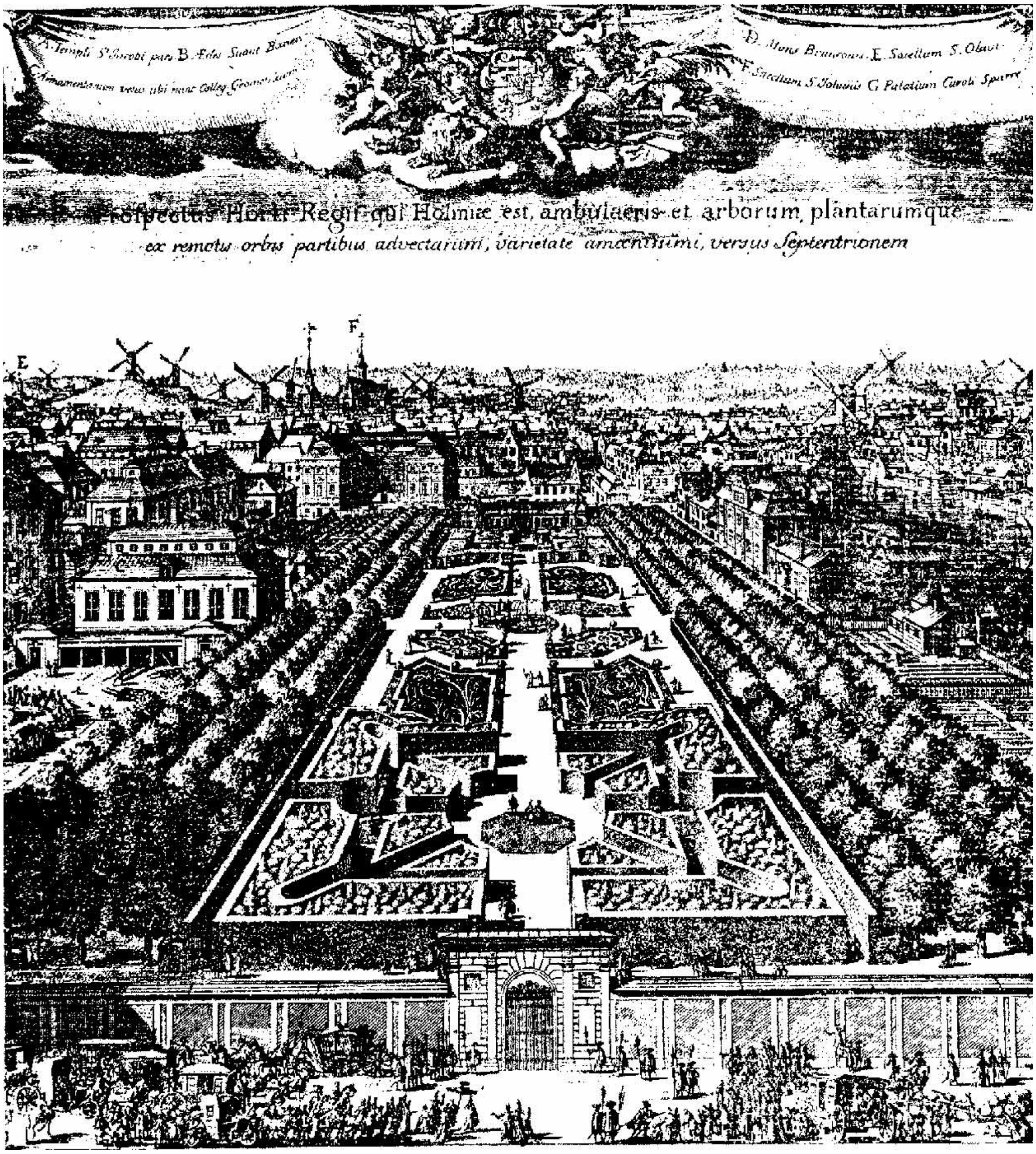



*Figure 30. "Prospect over Kungsträdgården in Stockholm, with marvelously beautiful nature by its promenades and the surrounding plentiful trees and herbs, brought there from distant parts of the world." (Dahlberg, p. 42)*

Illustrations of landscapes, built or natural, have of course a much older history than this. The evidence is harder to collect, the more distant time periods that are studied. First-hand illustrations by their designers, aimed at presenting a single garden, can be hard to find. Instead, we have to find the evidence on "tapestries, miniatures, paintings, memoirs illustrated with drawings, sketches and plans, engravings in treatises, architects' notebooks etc" (Mosser and Teyssot, 1991, p. 11). These sources can at least give hints on what presentation techniques that were used at the time.

Landscape Perception

The images used to illustrate nature, landscapes and gardens are not just mere representations of what the artist sees – in fact, they strongly influence the way people in their socialization process actually come to perceive and value these concepts. Our perception of new places is often strongly influenced by prior "virtual visits" by means of paintings, photographs, movies and television. Once in place, we try to produce the same images with our own camera.[1]

Landscape painting have thus not only been used to shape actual gardens and landscapes, they have also shaped our view of how gardens and landscape should look; they are indeed a part of our cultures' history of seeing.

*1. There is a specific set of pictures that, whether we have studied them or not, have helped to mold our conception of the landscape and have thereby played a crucial role in the objectification, or pictorialization, of nature: landscape paintings (and photographs of them). It is widely agreed that these pictures have had a great influence on the history of landscape architecture. (Crandell, 1993, p. 1)*

One or Many Viewspoints

The dominant method of representing nature and gardens in our culture is the linear perspective, developed during the Renaissance. As shown earlier, the Egyptian painters used a variety of views in a single image. They simply found it simpler – and more effective – to show every object from the angle where it is easiest to recognize, and shows as much information as possible.[2]

Little is known regarding the technique used in these ancient times for presentation used in the construction and building processes. Models were surely used, but plans and other types of drawings have been hard to find. The great Greek culture, the Roman Empire, the Moor culture, the Middle Ages – all of these grand periods has left no traces of the design process behind the construction of gardens and landscapes. Only a few illustrations remain, showing ideal gardens, where little can be said about their actual appearance.

*2. The Egyptian artists "drew from memory, according to strict rules which ensures that everything that had to go into the picture would stand out in perfect clarity. Their method, in fact, resembled that of the map-maker rather than that of the painter". (Crandell, 1993, p. 7. Quotation from John Barrel,* The Idea of landscape and the Sense of the Place.*)*

From the Renaissance period, the evidence is more extensive, still however mostly showing actual built appearance rather than the design process. In the end of the fifteenth century, wood engravings were used to illustrate the gardens (Figure 31).

The ink paintings and engravings of this time show a remarkable knowledge of perspective construction and use of light and shadow to produce depth in the pictures. Pictures that were more technical were beginning to be produced, with a greater effort to show actual design (Figure 32)

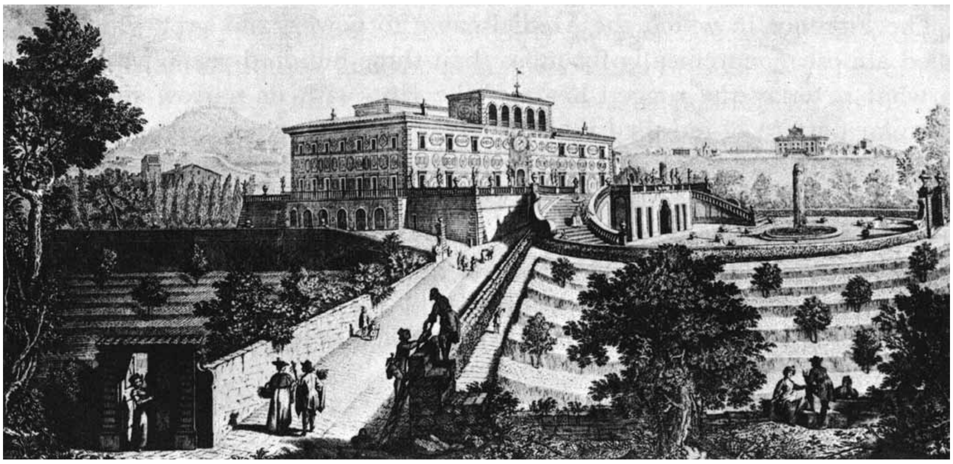


*Figure 31. The Villa Palmieri around 1460 (Newton, 1971. Originally in Zocchi,* Vedute delle Ville*)*

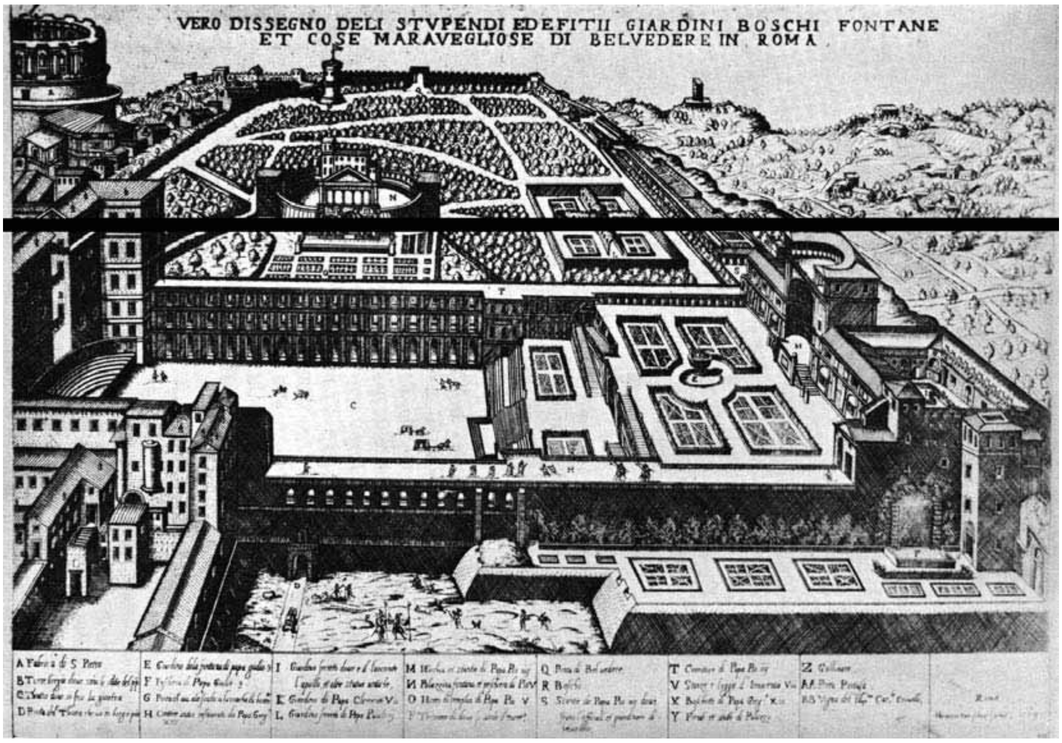



*Figure 32. Sixteenth century engraving of the Belvedere, summerhouse of the Pope (Newton, 1971. Originally from the Fogg Museum, Harvard)*

The resemblance of the presentation technique used by Erik Dahlberg is striking. The engraving posed obvious limitations to the pictures. A more elaborate and artistic technique was however to come. The conflict between technical drawing for construction purposes, and illustrations for presentation, was early known by the garden designers.[1] Figure 33 shows a more advanced variety of the bird-eye-view.

These images were a sort of a compromise between maps and landscape paintings. They remained popular until the end of the seventeenth century. Some of the work produced was exceptionally modern in its appearance. This is especially true for the sketches made prior to final illustrations or during construction. The drawing in Figure 34 is made around 1558-61.

*1. From the beginning of the Renaissance, therefore, the technique most frequently adopted for the representation of gardens was that of the bird's-eye-view, by means of which the layout and the details of the garden could be shown in a far more realistic form. (Mosser and Teyssot, 1991, p. 12)*

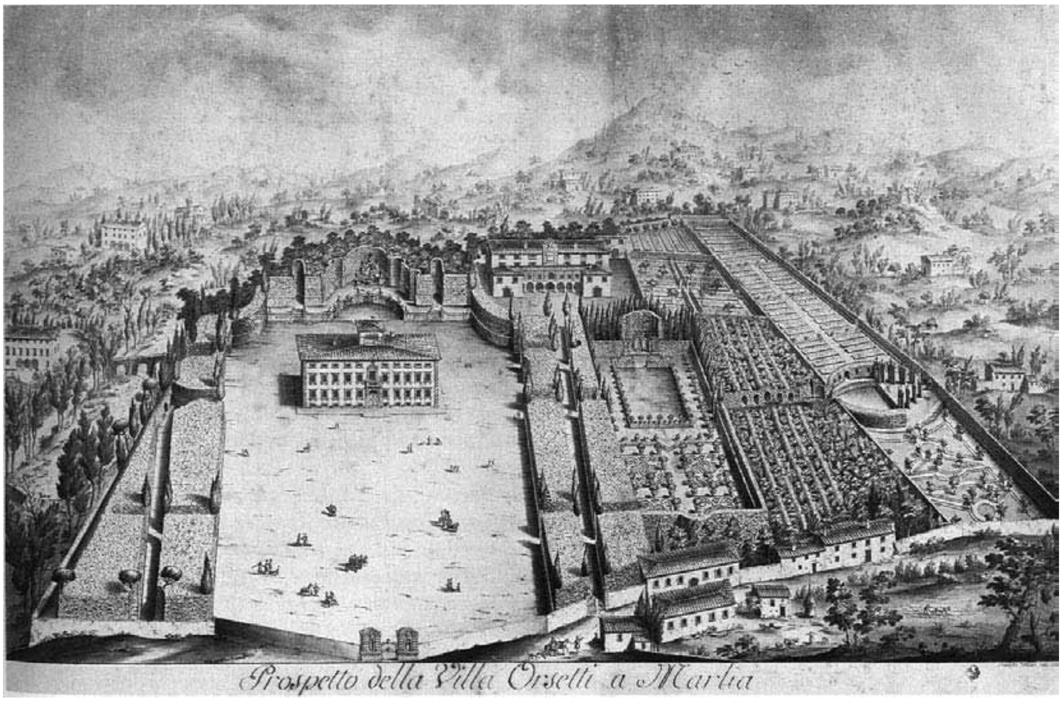



*Figure 33. View of Villa Orsetti. Engraving, 1775 (Mosser and Teyssot, 1991)*

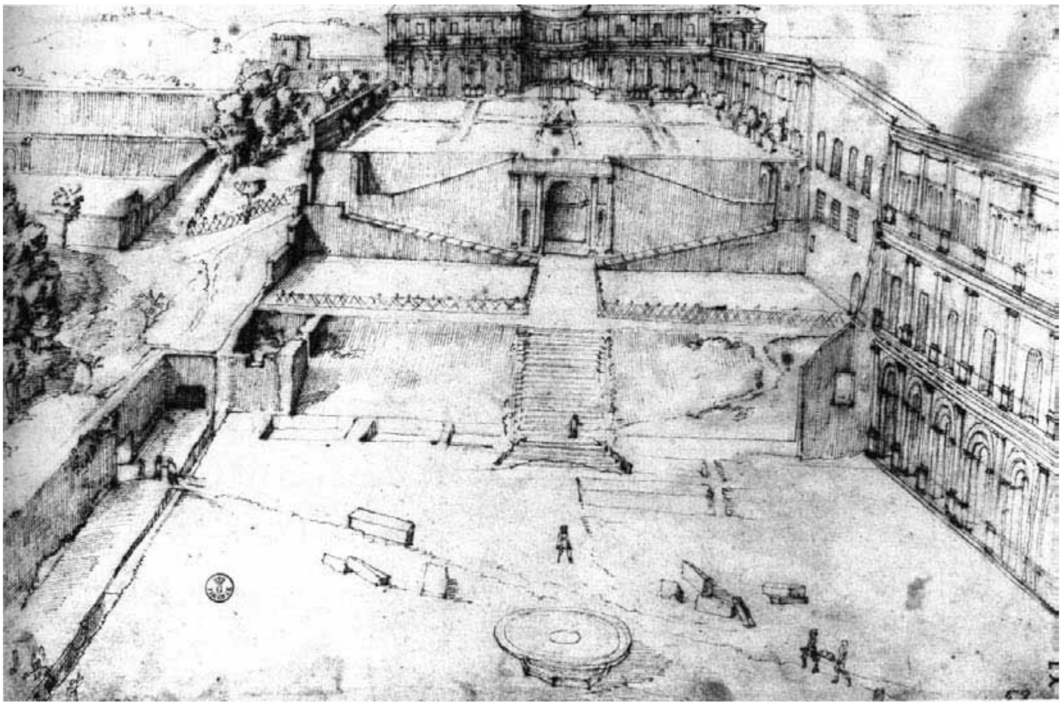


*Figure 34. Belvedere Court. Drawing by G.A. Dosio (Mosser and Teyssot, 1991. Originally Uffizi, Florence)*

Traditional landscape painting in England often used the same raised and distant view. Artists often portrayed ideal and imagined landscape, but were sometimes actually using the painting to illustrate a proposed design of an actual landscape garden. In the second half of the eighteenth century, great intellectual and artistic effort was put into the shaping of "beauty" in landscaping (Crandell, 1993, p. 127).

Several books discussed the concept, and landscape designers such as Capability Brown and Humphrey Repton produced pictures that had great influence on the shaping of the landscape gardens.[1] Repton's "Red Books" had images of sites before and after alterations, and were accompanied by text describing the measures to be made (Figure 35 and 36). Still, the distant single view was used.

*1. In the work of Humphrey Repton, [Capability] Brown's successor, we come to a full circle: a landscape designer paints a picture of an actual place based on all the pictorial conventions that originally led to the creation of the landscape garden. (Crandell, 1993, p. 132)*

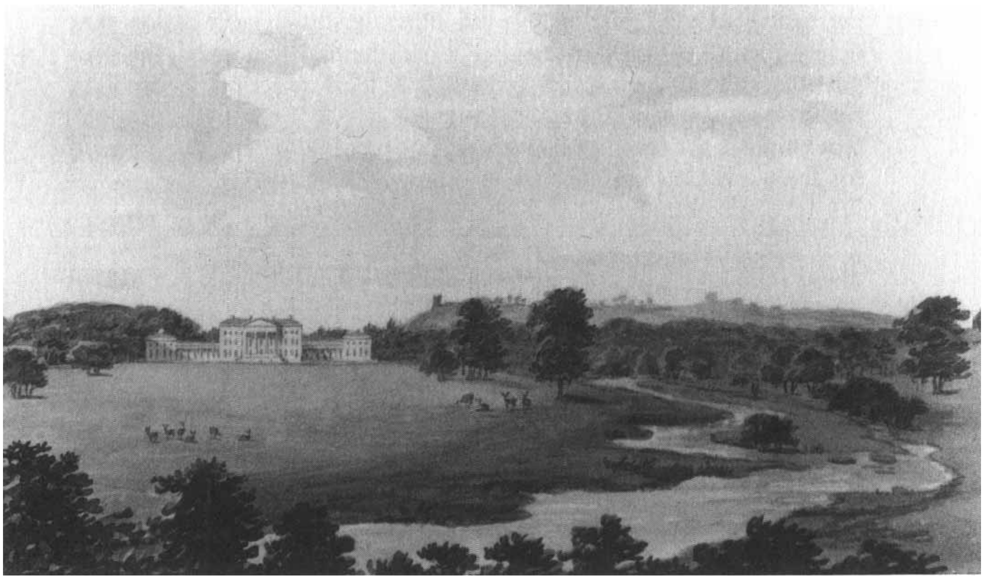


*Figure 35. Number 5 Attingham Park in Shropshire. From Humphrey Repton,* The Red Book of Humphrey Repton, *vol. 3 (Mosser and Teyssot, 1991)*

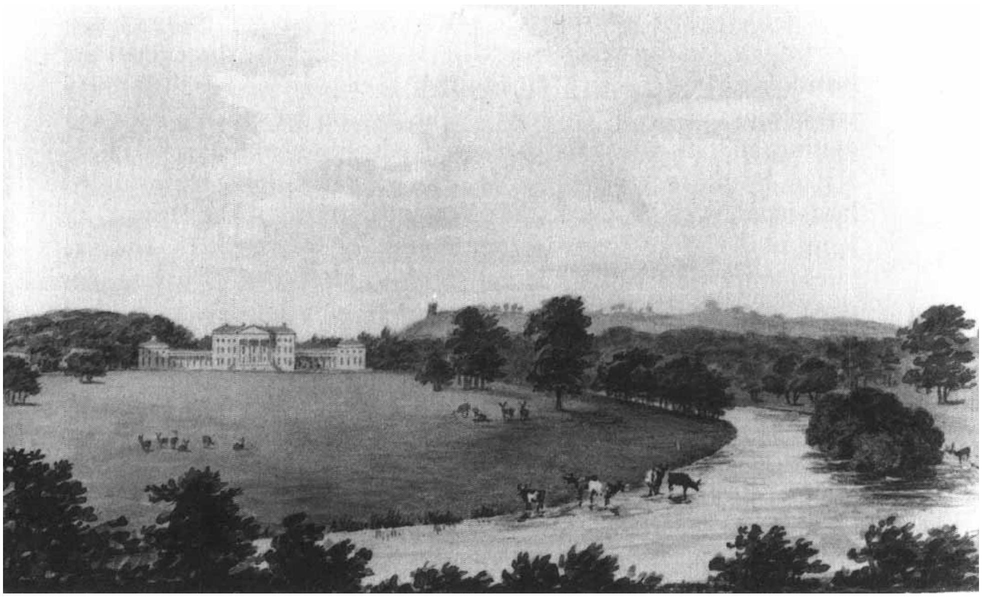


*Figure 36. Number 5 Attingham Park in Shropshire. From Humphrey Repton,* The Red Book of Humphrey Repton, *vol. 3 (Mosser and Teyssot, 1991)*

In about the same time, an ink technique for sketching is used in the whole of Europe (Figure 37).

*Figure 37. Drawing by William Kent to illustrate lines from Michael Drayton's* Poly-Olbion *(Mosser and Teyssot, 1991. Originally British Museum, London)*


*Figure 38. Drawing by F.J. Bélanger (1744-1818) (Mosser and Teyssot, 1991. Originally Bibliotèque de l'Ecole des Beaux-Arts, Paris)*

Even more familiar for architects of today are the quick sketches used during the design process. These drawings, often made with pencil, have had the same expression for centuries (Figure 38).

However, the drawing techniques evolved, closely following the trends and achievements in other forms of art. By the middle of the nineteenth century, presentations could be almost photographic in their expression. The example below utilizes soft shadows and subtle tone variations to produce a strong 3-dimensional effect (Figure 39).

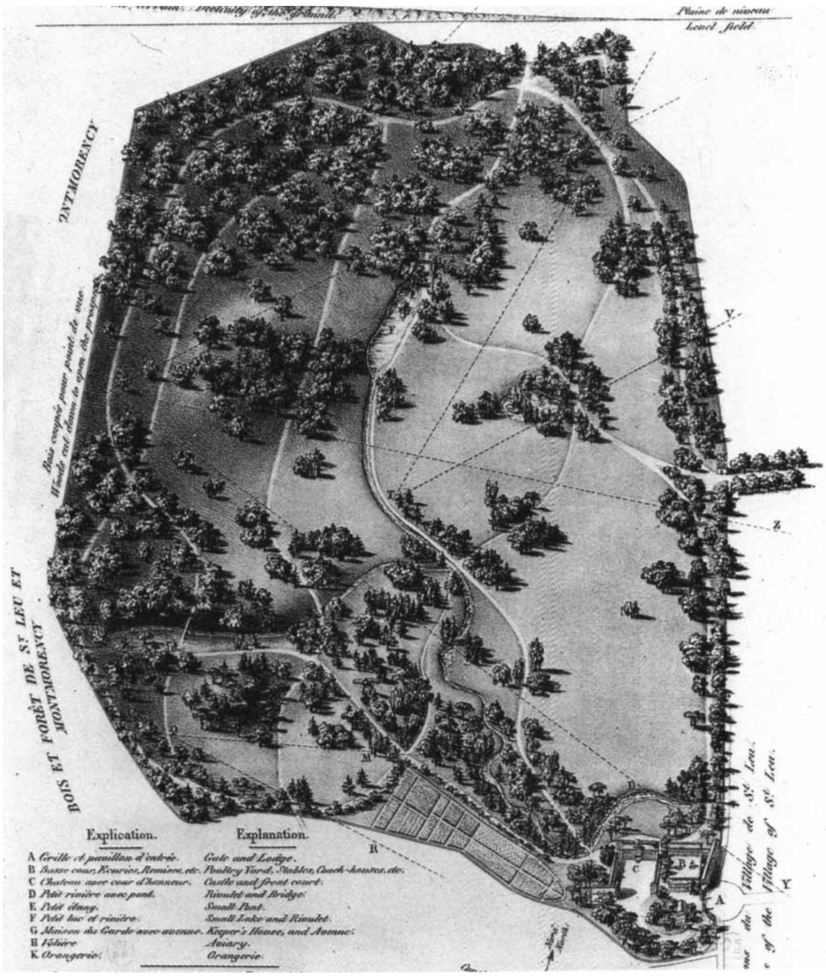



*Figure 39. Axonometric view of the chateau and park of St-Leu-Tavery (Val d'Oise) (Mosser and Teyssot, 1991. Originally in Nicolas Vergnaud,* L'art de créer les jardins, *Paris 1835)*

There is no sharp border between pictures for presentation and pictures made for pure artistic purposes. The wish to convey the spirit of a place, or of the artist's/architect's skills and emotions, can in both cases be strong. The picture below, originally in a soft and even green tone, is with its light and combination of detail and "unrealism" easily associated with the naivistic trend soon to come (Figure 40).

The range of techniques to use thus became larger as time passed. Still in the 1920s, engraving was used to produce illustrations (Figure 41).

Removed of its decorative ingredients, a simple ink line technique evolved into the modern way of illustrating landscape design (Figure 42).

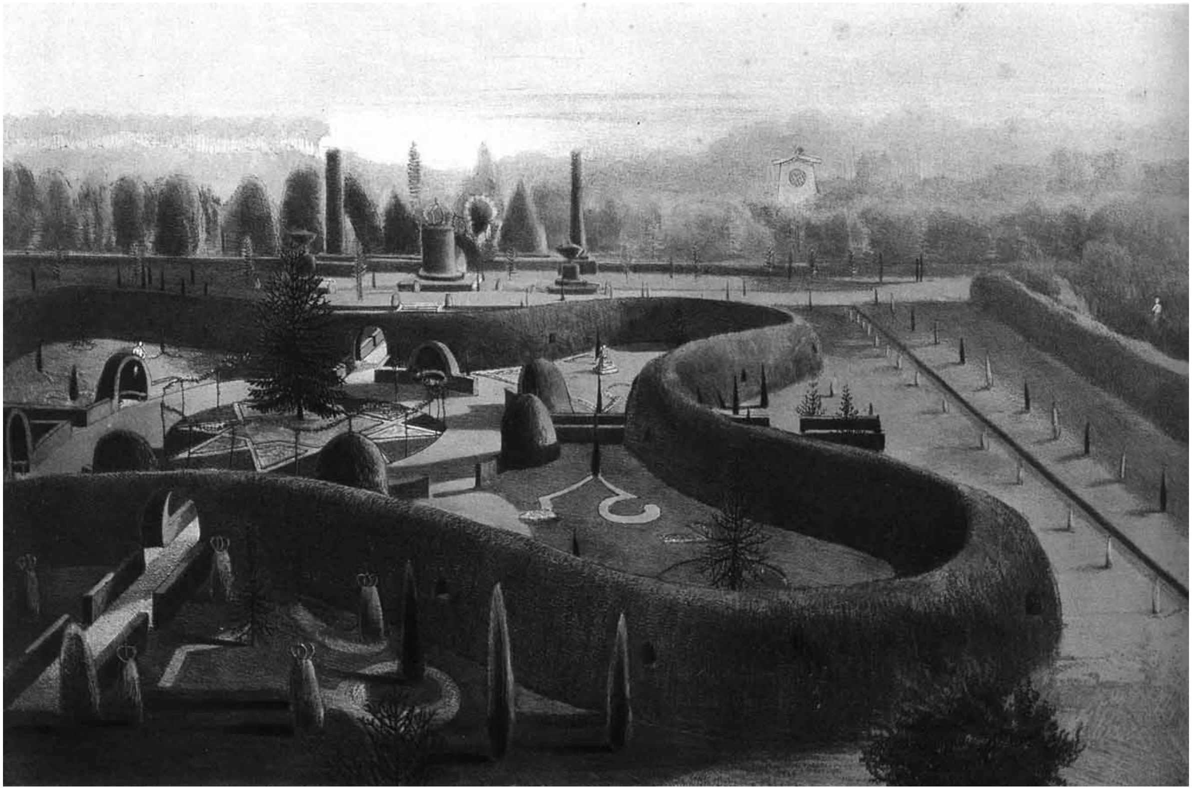


*Figure 40. View of Mon Plaisir in the garden of Elvaston Castle, Derbyshire (Mosser and Teyssot, 1991. Originally in E. Adveno Borrke,* The Gardens of England, *London 1857)*

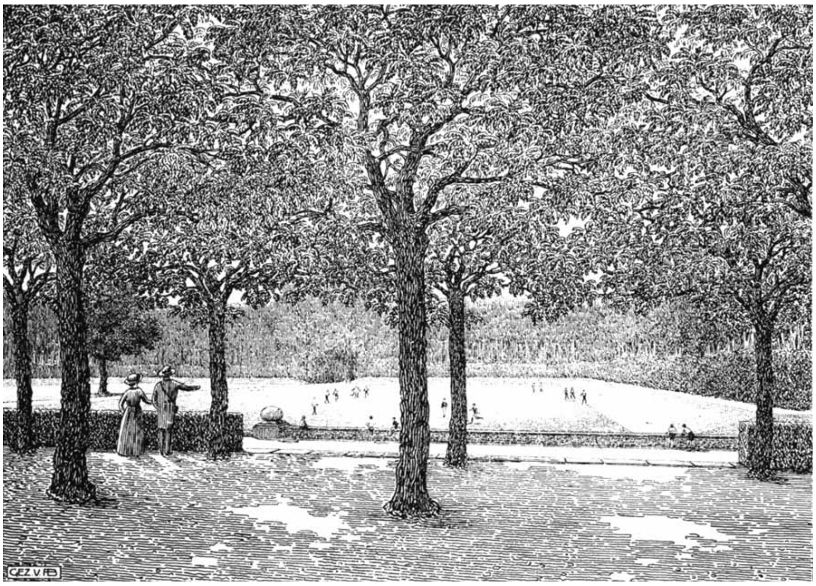


*Figure 41. M. Bromme, stadium in the Stadtwald, Frankfurt-am-Main. View of the Festival Square, 1923 (Mosser and Teyssot, 1991)*

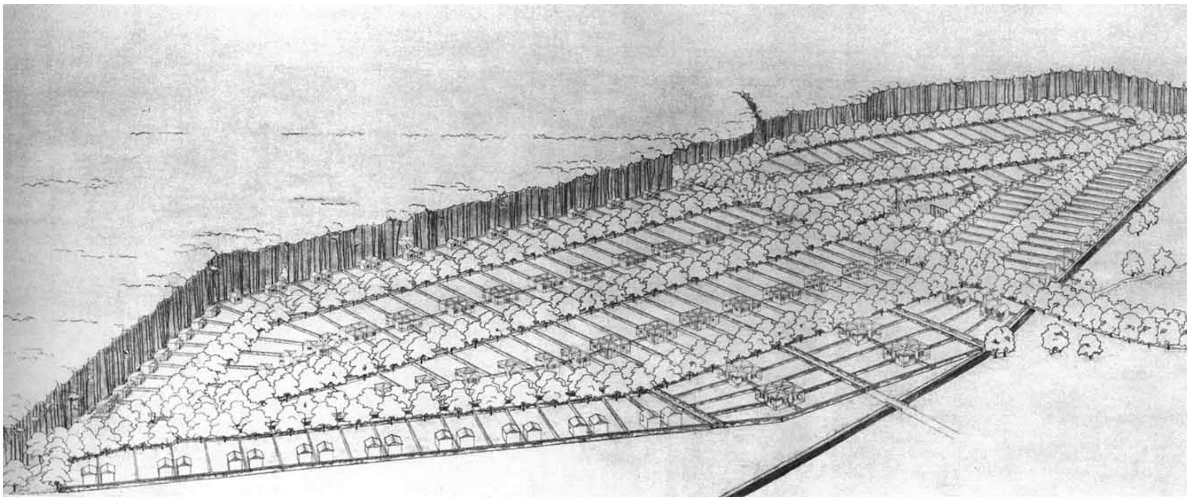


*Figure 42. Scheme for permanent colony of allotments at Königsheide, Berlin-Trepow, designed by E. Barth (Mosser and Teyssot, 1991. Originally Technische Universität, Plansammelung, Berlin)*

Another example of a presentation inspired by contemporary art is by Erik Glemme, designer at the Stockholm Park Department. The casual, almost childish drawing manner was often used by artists of the time (Figure 43).

*Figure 43. Proposal for an open-air theatre in Bellevue Park, Stockholm, Perspective sketch by Erik Glemme, 1940s (Treib, 1993)*

An even more simple style of pen drawings – somewhat resembling cartoons – was used by architect Thomas Church (Figure 44).

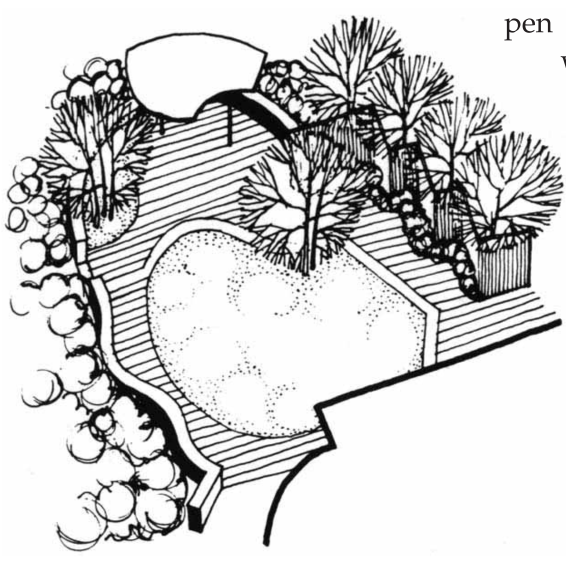


*Figure 44. San Francisco, California, 1939. Drawing by Thomas Church (Treib, 1993)*

Dealing with more large-scale issues, Roland Gustavsson and Torbjörn Ingelög use a variety of image techniques to present methods for environmental conservation and restoration (Gustavsson, 1994). In the first example, an aerial view of a tilled field is shown, using water color, before and after wood plantation (Figure 45). The second example shows a planning map (Figure 46), accompanied by small water color images of before and after situations (Figure 47). The third example is an elaborate, hand-drawn profile of a forest, intended to show the dynamics of tree and shrub growth (Figure 48).

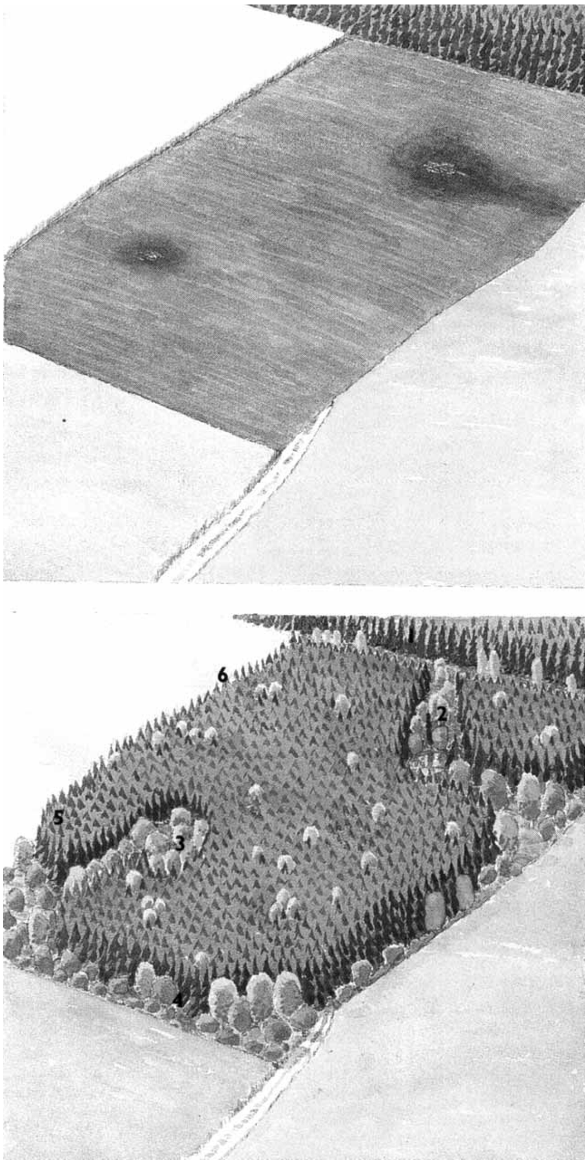



*Figure 45. Illustration of forest plantation of a tilled field, by Lars Helgesson. Numbers indicate different measures (Gustavsson, 1994). (akerskog.tif)*

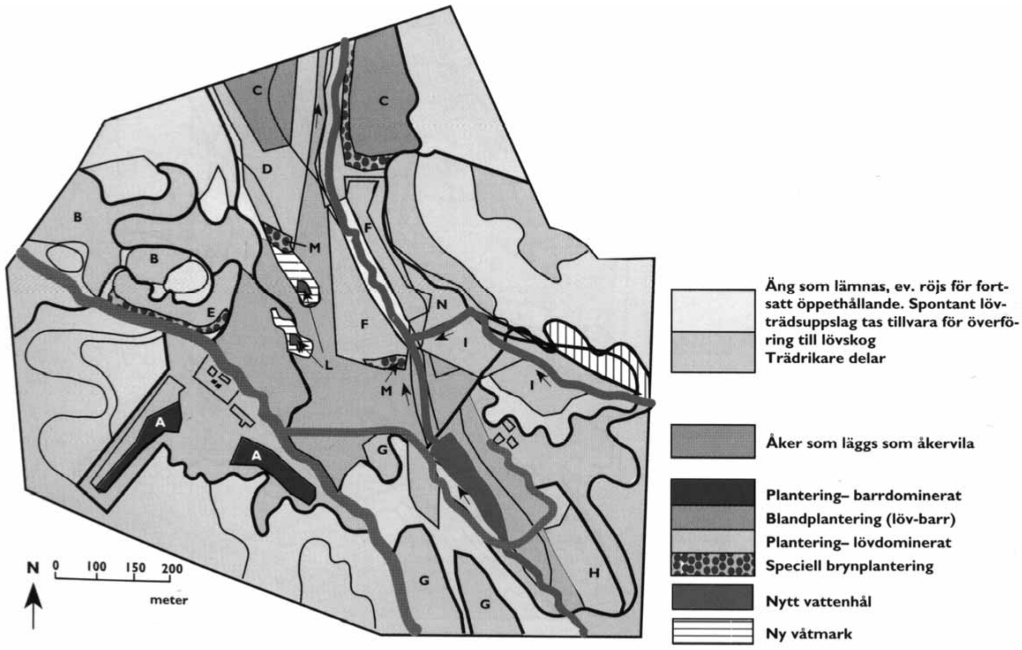



*Figure 46. Plan showing proposed measures for landscape development (Gustavsson, 1994)*

*Figure 47. Pictures showing before and after proposed measures, used to illustrate plan in Figure 45, by Lars Helgesson (Gustavsson, 1994)*

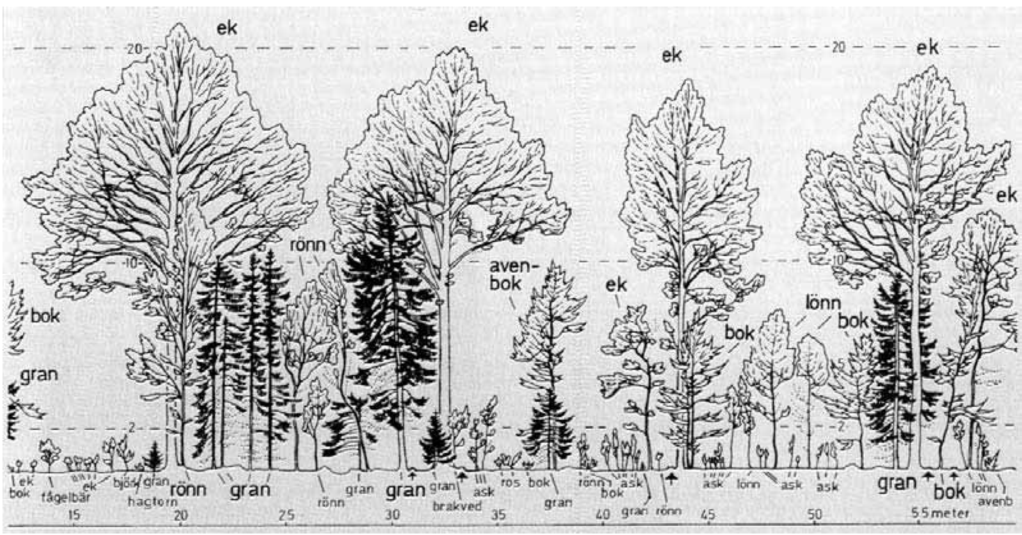



*Figure 48. Profile diagram of a mixed oak forest. Illustration by Roland Gustavsson (Gustavsson, 1994).*

An interesting combination of projections is shown in the example to the right, where the plan is "up-folded" in a way reassembling the old Egyptian method. The original is painted in soft colors, with the circular hedge pinkish red, other elements in natural color shades (Figure 49).

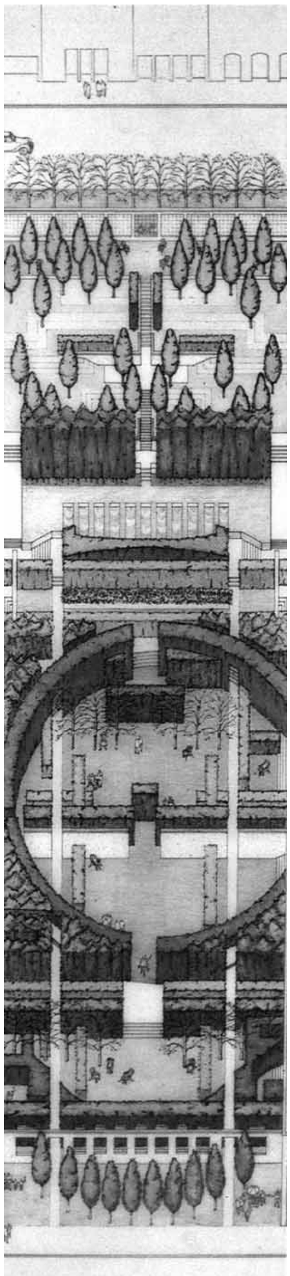


*Figure 49. Eudoxia – design for a new civic landscape. Michael Van Valkenburgh (Lyall, 1991)*

An even more advanced use of simultaneous projections can be used. The next example uses three or four views of an Italian *Palazzo*. It also displays an increasingly popular mix of loose sketching, manually drawn perspective with construction lines showing and strict text accounts. The picture is made with lead pencil and color crayons (Figure 50).

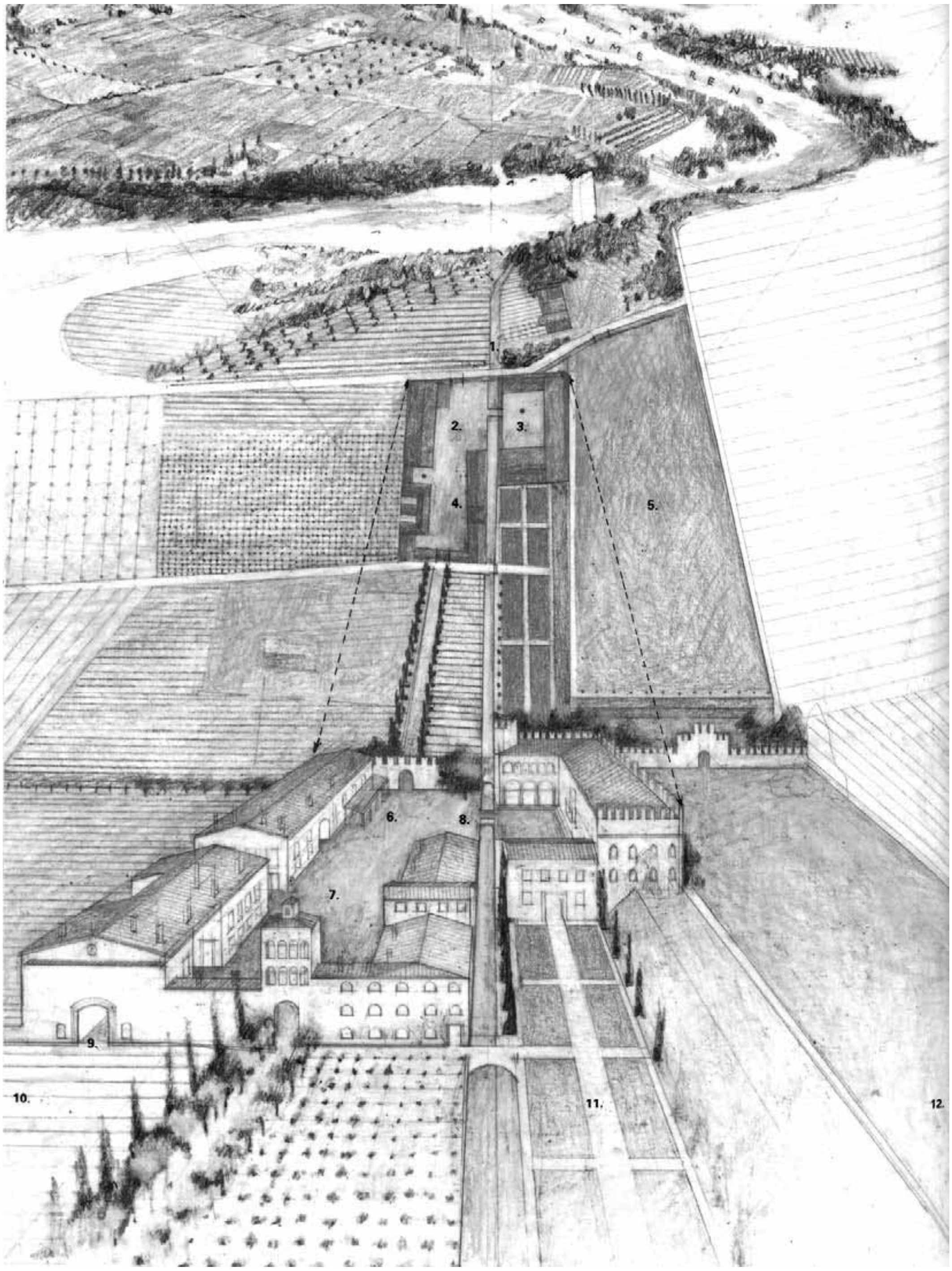



*Figure 50.*
*Pallazzo Rossi*
*(Solomon, 1988)*

As the computer enters the arena, new ways of illustrating design are taken. To show the intentions of the design – surprising, irregular, playful and full of opportunities – the presentation below is a wild mix of projections and perspectives. The clear colors of the computer image are missing in this reproduction, which of course lessens the experience a great deal. Nevertheless, the image in some sense closes the circle – the parts of the image uses individual projections, just as the Egyptians did several thousands year earlier (Figure 51).

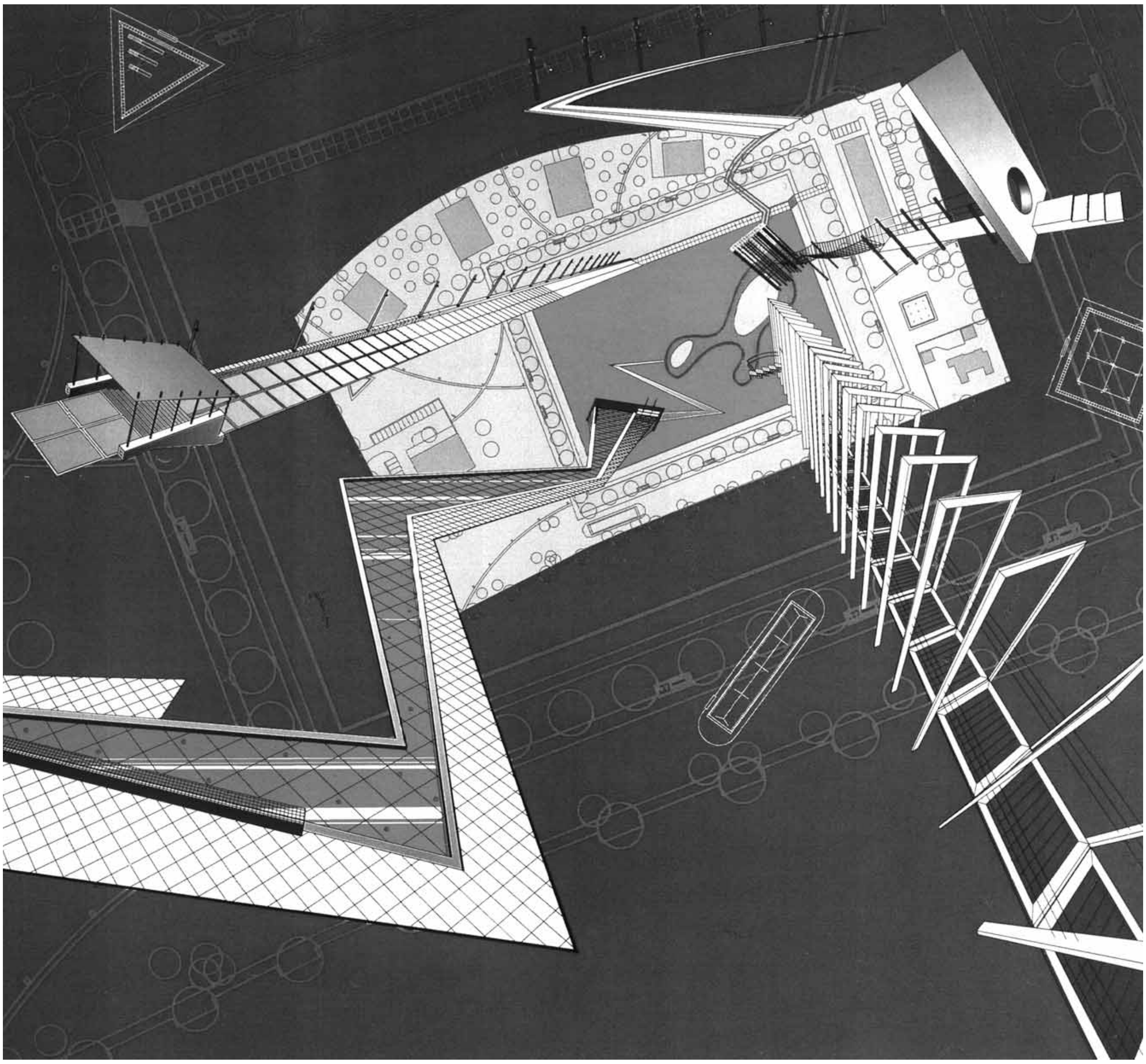


*Figure 51. Kromhoutpark, Tilburg, The Netherlands. Computer image by Bureau B+B, 1991 (Holden, 1996)*

As shown in this historical background, the illustrations of landscapes and gardens are intermingled with the cultural values of its time. Paintings and other forms of art influence perception and appreciation. In present days, old and new ways of describing reality live side by side.

Today, few artists use a naturalistic style when painting landscapes. Inspired by groundbreaking artists such as Picasso and Braque, modern painters finds inspiration in subjective experiences, where time and place are inseparable, and many views can be present simultaneously. Designers – landscape architects and others – seem to have a harder time leaving the Renaissance view of the world: framed and distant.[1]

1. Undeniably, the landscape itself has become the repository of pictorial conventions and landscape architecture the perpetuator of the painterly vision. *(Crandell, 1993, p. 165)*

This overview has shown some of the range of means for illustration available for landscape architects of today. Time will tell if all of these methods will survive. Into what directions will new types evolve? Perhaps the image will continue to compete sucessfully with virtual reality techniques – in new forms, inspired by ancient methods as well as contemporary culture – as a complex, imaginative, inspiring, and intriguing expression of the landscape architect's vision.

*A conventional architectural presentation consists of s series of multi-views (plan, elevation, section) and three-dimensional, single-view drawings (paraline, perspective) which are perceived as independent, informative drawings. However, if the intention of architectural drawings is to illustrate a total project or building, then logically all architectural drawings should "read" as one drawing instead of a series of individual drawings representing segments of the building. When a composite drawing, illustrating sequential and integrated arrangement of individual drawings, is produced, the result is a dynamic and effective presentation of the total design. (Uddin, 1996, p. 2-3)*

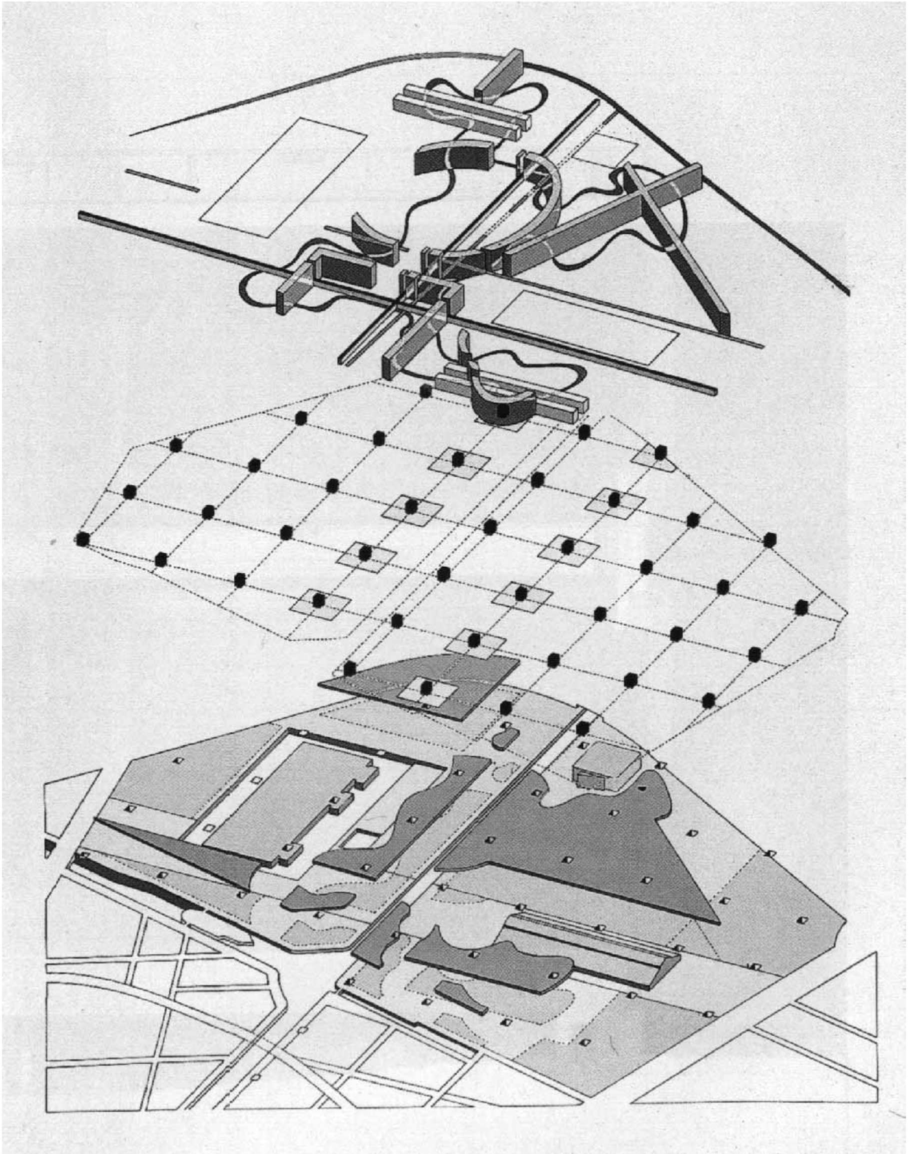


*Figure 52. Barnard Tschumi's drawing for the Parc de la Villette in Paris shows effective superimposition of lines, points and surfaces emphasizing the layers of landscape and build elements. (Uddin, 1996)*

## The Photograph

*1. Photographs have added another concept to the portrayal of gardens; the image might show that the photographer is purposely highlighting decay or neglect. […] A photographer can only represent a garden retrospectively, whereas the artist can become a designer by altering what is seen by the naked eye. The extra freedom the photographer has over the artist is to multiply and diversify his range of images. (Mosser and Teyssot, 191, p. 471)*

Photographic images on paper began to be used in the 1830s. The technique gave access to new ways of representing gardens and landscapes. Using the old techniques, artists could – in order to please their audience – enhance reality freely. Now, the cold eye of the camera registered every detail with sharp realism.[1]

The introduction of the camera had large effects on landscape painting artists. Many saw it as a threat; others welcomed it as a practical supplement to traditional methods. The objectivity of the camera lens was seen as an important step into understanding garden design.

It was not long until the photographic images were being manipulated. In the beginning of this century, the American illustrator Maxfield Parrish projected photographic images on canvas, traced the contours, and then painted the complete image. By this method, he claimed to keep the accuracy of the photograph, while catching, by the use of manual coloring, the spirit and atmosphere of the portrayed garden.

In modern days, photo manipulation has become an everyday experience – perhaps to the degree that our faith in the photograph as an objective portray of the reality has ended.

Since photographs are relatively easy to produce, it is a natural step to use series of images. Put together – in the form of film or video – they are particularly well suited for conveying experiences of space, and of sequences of space.

# CHAPTER 3
# THE LANDSCAPE ARCHITECT – TOOLS, METHODS, AND PROFESSIONAL ROLE

This chapter is based on literature studies and on interviews with landscape architects. It aims at describing the tools, methods and professional role of the landscape architect. The chapter is divided into six sections, based on the system model described in the first chapter:

❋ information
❋ technology
❋ data structure
❋ role
❋ communication
❋ result.

There are of course no sharp borders between these six system parts. For example, the success of efforts to communicate relies heavily on the structure of the data involved. The result is obviously depending on the technology used, and which role the landscape architect has played in the process. Nevertheless, the underlying system model can hopefully aid in analyzing the tools, methods, and professional role of the landscape architect. As far as possible, the description tries to avoid repeating information. Some cross-references are used, when touching the borders between the sections.

To illustrate the discussion, quotes from the literature and the interviews are used. Since the interviews are meant to be the main source, a few fairly large excerpts from them are put into the body of the text.

The emphasis in Chapter 3 lies on the use of information technology. Chapter 2 described in general terms some of the history of computer use in architecture. As a summary of this development, architectural computing can be seen as having four sources of origin (Radford and Stevens, 1987):

❇ *Conventional data processing*, used for office management and other business functions. This market began in the 1960s in governmental and large private organizations.
❇ *Computer graphics and computer-aided design*. The development in this area began in the early 1960s, and spread first to the automotive and aircraft industries, and electronic manufacturing.
❇ *Operations research*. This is a branch of applied mathematics, used for simulation, developed during World War II.
❇ *The design methods movement*, which regarded design as a systematic and analytical process.

Radford and Stevens divide modern architectural computing into the following six areas (Figure 1):

❇ *Computer science* – the field of computer study and development. Architectural computing is only a small part of the vast field of computer science. Few architects acquire the skills necessary for developing new software and computer applications.[1] They can and are of course indirectly involved by submitting their professional experiences to software developers. The actual programming is normally an easier step than designing program functions – programming is more of an implementation of systems analysis and design. For this purpose, architects can play an important role in computer science. All software vendors are aware of this, encourage feedback from users, and use this openness for marketing purposes.
❇ *Information processing* – production of information by accessing and processing data on a computer (also known as data processing). This will be discussed in section *Information*.
❇ *Computer graphics* – creation and manipulation of images, using a computer. The section *Technology* will describe this subject at some length.
❇ *Design theory* – the use of computers as a design medium. Design theory is an interesting and large field, which is only hinted at in this work. It will be further investigated in the planned part 2 of this project.
❇ *Knowledge engineering* – studies of how knowledge can be acquired and represented by a computer and utilized by people who do not by themselves possess that knowledge. The subject will be discussed in section *Information*.

*1. There are of course exceptions – one Swedish example is the AutoCAD application ARCAD, developed by Wikforss arkitektkontor ab.*

❊ *Application issues* – the selection and use of computers in the office and in buildings; training, finance, legal issues, ergonomics of computing and management of computers. Some of these questions have been dealt with in the interviews, and are mentioned throughout Chapter 3.

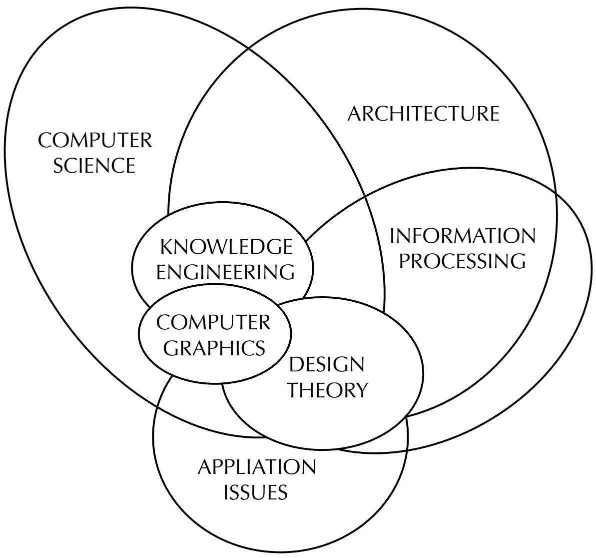
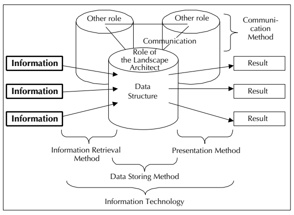



*Figure 1. Diagram by Radford and Stevens, 1987, p. 9*

# INFORMATION




As descried in the model in Chapter 1, the landscape architect is involved in an information processing system. What kind of information is being handled in these processes? What sources are used? What is the purpose of using the information?

## Site Information

Site information is perhaps the most important factor influencing planning and design. Personal visits to the site are essential, but so is the methodic gathering of other forms of information. Legal aspects, such as ownership and previous planning efforts must be considered. Information concerning natural conditions such as climate, water, soil, vegetation and wildlife needs to be collected. Through this work, the planner builds an understanding of the site and conditions surrounding it.[1]

Apart from information concerning the site itself, the planner needs to be aware of the multitude of values and objectives of the concerned parties. The project brief may contain political and ethical statements that are disputed in different ways by many people affected by the planning issue. Furthermore, the values change over time, as does our perception of them. These considerations pose difficult decisions for the planner.

*1. Through the process of plotting, measuring and recording, a spatial appreciation of the site develops, along with an insight into particular relationships between elements. Special places or conditions become apparent and the designer begins to see and feel the site and can decide how best it should be manipulated to accept the changes inherent in the brief. (Filor, 1991, p. 17)*

Planning as a Learning Process

To ease this burden, the planner must have a clear strategy concerning the roles of the parties involved in the planning process. Instead of a futile chase for the perfect plan, where all relevant data has been used and all considerations made, land-use planning can be seen as a learning process. The professional planners must do what they can to gather data and to describe possible effects of certain decisions, but also share this information with others.[2]

*2. The second aspect of learning is how to convey the information so both public and decision makers can comprehend it in order to eliminate or at least to minimize the unnecessary frustrations and misunderstandings about the possible outcomes of a proposes land-use decision. (Fabos, 1985, p. 187)*

Information Gathering

Information gathering (“data mining”) is a time-consuming and often expensive part of planning projects. The efforts needed vary greatly between different types of subjects. An overview of data types used in physical planning can be found in the part describing Data Structure. Data and information sources often lie outside the direct control of the planners.

The increasing demand for digital data is quickly becoming an important commercial market item.[1] Commercial data providers naturally need to have their expenses for gathering, storing, and distribution covered. This also holds true for government agencies in many countries, Sweden being one example. The National Land Survey (Lantmäteriverket) sells maps and geographic databases on a strictly commercial basis.

*1. If you have information, whatever it is, chances are somebody out there would like to obtain it. In many cases, a large number of people will be willing to pay a reasonable price for a copy of your spatial data. The Internet has potential to let them. (Plewe, 1997, p. 23)*

In the United States however, government policy states that all public information should be free, except for distribution costs. This advantageous situation has become even better after the Internet explosion. Most agencies involved in physical planning now have published large libraries of geographic data sets, ready to download. This method is presently being spread down to state and local government. Some other countries, e.g. Canada and Australia, are following the example to some extent. (Plewe, 1997)

There exists today a large number of commercially available software to display geographic data in the Internet.

Many GIS users in Sweden find the cost of geographic data problematic. In a 1997 survey, 58% considered the price too high. In almost every other case, this leads to delays in projects, or that they are terminated altogether. However, most of the data (60%) was produced within the organization. External data, used for referencing in e.g. maps, was purchased from a number of data providers, the largest one being the National Land Survey (Lantmäteriverket). (GIS i Sverige, 1997)

The attitude and experience of city authorities varies greatly. Some are advanced, having digitized much of the data, and have solid routines for handling and selling the information. Others have hardly started the transition into the digital era.

The confusion as how to use digital data is widespread. Even local authorities, being an important source of background information, are insecure in data management.

*They are [keen on providing data], but they are confused. This is my experience of it, a personal experience. If I have a big project, I'll ring the local authorities up, and ask to talk to their GIS person. The GIS person tends to be a buffoon[2]. Somebody […] in the corner, who understands everything about the computer, and the GIS system, but is not very good at selling. Not very good at marketing, not very good at running the business.*

*2. A ridiculous person; a clown.*

*That's probably unfair, but people with a knowledge of IT, tends to be those people who are not very good at communicating, and also, they always seem to* *have too much to do. The sales people, the people who deliver me what I want, don't quite understand how to sell GIS just yet. So what happens is, when I ring, they go '— Oh, we can provide that information', and I say '— Well, how much will it cost?' '— Oh, I don't know'.*

*And you can tell, they're just plucking. They've got the information, they need it themselves, but they don't know how to sell it. They don't know what the market rate is. So, they take a gamble, and it's almost like they go '— 2.000 pounds', and I'll go '— Oh, I'll have that then', and they go 'Damn, I should have asked for 5.000!' [Big laugh] (IS 3)*[1]

*1. Interview Subject 3 – see Chapter 1.*

Information Processing

Modern software can be used in planning for a variety of information processing purposes. First of all, a division can be made between graphic and non-graphic uses.[2]

*2. Typical graphics applications include: computer cartography, site analysis, and site selection; computer-aided design and drafting: and graphic representation of statistical data (such as with bar charts, and data maps).*

*Typical nongraphic applications include (among others): data base management involving collection, organization, storage, and retrieval of data relating to projects, clients, personnel, and costs; forecasts, projections, mathematical modeling, simulation, optimization, scheduling, and other quantitative approaches to analysis and problem solving; cost estimates, budgeting, and quantity surveying; word processing; electronic mail and data transfers; accounting and bookkeeping; and project management. (Mutunayagam and Bahrami, 1987, p. 9)*

Secondly, computer graphics can be divided into five areas relevant to planning, design and landscape architecture (extended from Mutunayagam and Bahrami, 1987, p. 40):

❋ Computer cartography and site analysis.
❋ Photogrammetry and remote sensing.
❋ Visualization.
❋ Computer aided drafting and design (CADD).
❋ Statistical data representation and business graphics.

All of these forms of information can be handled in modern desktop GIS. Emphasis is on the first three kinds, where a number of tasks can be performed:

❋ Generation and display of 2- and 3-dimensional spatial information in the graphic mode – thematic maps and perspective views.
❋ Rendering of 2- and 3-dimensional images.
❋ Creation and storage of graphic databases (maps) for future retrieval of spatial information.
❋ Use of graphic databases to sort and search for sites possessing selected spatial attributes for specific purposes.
❋ Management and updating of graphic data and information.
❋ Performance of weighted and nonweighted map overlays for analyses of site suitability, site selection, regional delineation, etc.
❋ Comparison, analysis, evaluation, and ranking of alternative sites for development.
❋ Visibility analysis to locate vantage points for scenic views.
❋ Estimation of shortest path.

❈ Terrain modeling.
❈ Earthwork estimation.

In most cases however, planners still rely on manual methods for the information processes, or use computers for parts of the work. The goals – collecting, analyzing, and presenting information – are the same, only the tools differ.

## Design Information

The construction sector in Sweden has in the 1990s been forced to a major re-orientation. Building in Sweden reached its maximum in 1965-75, when one million apartments were built. In the late 1980s, another boom in building and property speculation was followed by a large financial crisis. Building statistics crashed down to almost nil. For some years, governmental road projects saved the market from complete extinction. The market today consists of a few large projects, mainly in infrastructure, and many small projects consisting of additions, rebuilding, and changes in existing structures.

This radical change places a number of demands on the industry. The traditional structure and organization was designed for large-scale projects on virgin land. To adjust to the new market, administration has to become more decentralized; time schedules must be shortened, and building costs monitored more effectively (Wikforss, 1993). The use of information technology has the potential to make positive contributions to these changes, by giving:

❈ *Feedback of experiences from project to project.*
❈ *Enhanced accessibility to knowledge bases and information systems.*
❈ *Enhanced methods for modeling and simulation of the conditions surrounding the future building object.*
❈ *Enhanced methods for visualization and representation.*
❈ *Enhanced possibilities for feedback in the process, so that decisions can gradually be made more precise and concrete, based on increasingly better knowledge.*
❈ *Enhanced coordination, i.e. error search, document coordination, and integration of production and maintenance planning in the design process.*
❈ *Improved information quality, i.e. raised productivity and fewer errors. (Lundequist, 1995:2)*[1]

As this list shows, information processing and management plays a central part in the design process. The landscape architect has to deal with a variety of sorts and sources of information. Qualities

1. *Originally from Wikforss, Örjan.* CAD *lämnar nybörjarstadiet.* Skiss nr 2-1990. *Stockholm:* SPA

and constraints found in the site must be analyzed, user demands and wishes must be noted, plans and regulations from authorities provide possibilities and restrictions. Put together, the information influences the evolving design ideas in terms of spatial, technical and managerial characteristics. (Filor, 1991)

As a project advances from planning and design, and enters the phase of construction and drafting, information quality must meet higher requirements. Information retrieval is at all stages an important part of work of the landscape architect. The computer can assist in this process in several ways.

A common distribution of an architect's work is 1/3 in initial studies and outline proposals; 1/3 sketch design and detail design; and 1/3 production documentation (Reynolds, 1993). Especially in the last phase, the computer offers the architect a variety of well-established tools: CAD for drafting layouts and details; spreadsheets for specifications and schedules; software for instructions of construction; automatic bills-of-quantities based on CAD drawings and so on.

The information needed can be of several different types, for example:

❊ Product data: equipment, plants, paving etc.
❊ Regulations and directives from official authorities.
❊ Landscape information: geology, hydrology, climate etc.
❊ User opinions.

When dealing with the views of other parties involved in the process, information gathering is largely affected by the means of communication.

## Maintainance Information

The building and construction industry is often used by the government as a regulatory instrument. In order to survive on the roller-coaster market, many landscape architects also need to engage in the management phase of the built objects. This process seems to be rather slow, partly because maintenance, management, and economy have had a relatively weak position in the educational systems for landscape architects. The Swedish educations in Ultuna and Alnarp are presently trying to respond to this by strengthening management training for the students.

Today, much garden maintenance in housing areas is based on the haphazard interest of the janitor or caretaker – a person often completely without "green" education, and with the main task of indoor service. Many organizations have of course a more qualified model for garden and landscape management, but very often, clear goals and suitable plans are missing.

Even in new projects, the landscape architect seldom gets the chance to convey the ideas behind the design to the people who will take care of it. The person communicating with the architect often neglects to pass on the information. This drop in knowledge level can be a serious threat to the design objectives.

One of the most frequently stated advantages of the use of computerized design methods is the possibility to let the information used in construction move on to the maintenance staff. CAD drawings can be used for green area management. Lists of plants and equipment can be transferred into database management systems. Drawings and databases can be used in geographic information systems (GIS).

This use of information technology is rapidly growing. Many city authorities are engaged in transferring data into digital form. Starting with "hard" information – sewage systems, roads et cetera – extensive databases are constructed. As experience is gained, the focus turns to other areas, such as population statistics, commercial and communal services, parks, and recreation areas. Eventually, these methods will spread to smaller organizations. The opportunities for landscape architects to engage in this development appears to be large.

One of my last assignments before becoming employed at the university was to produce a geographic database of all land property owned by the city of Danderyd. All the areas were surveyed, based on the city map data and measuring in each site. Vegetation, equipment, ground cover, and so on was mapped and assessed. All data was transferred into GIS software, in order to create the topological relations.

With the use of GIS, the city officials could then produce exact maps and specifications of all the areas. The objective was to better control the work and costs needed to maintain their property, and to use this knowledge when assigning contractors. The contractors have recently started to use the data themselves, for logistic planning and other purposes.

## Knowledge Engineering

In order to use the computer help in solving complex problems, the knowledge of the planner/designer must be formalized and structured. The tools for this process are handled in the field of knowledge engineering.[1]

In an open market, the landscape architect sells his or her ability to use the personally acquired knowledge on how to solve problems. For a city planner's office or a landscape architect firm, the knowledge base is a function of all the people working there.[2]

Some of this collective knowledge can be handled by computers. Information can be stored in databases. However, computers do not have to be simple containers of data and information. Artificial intelligence will not be discussed in this paper, since no applications are available at the market today. Databases, expert systems, and decision support systems are, however.

*1. In fact, knowledge engineering simply attempts to transform knowledge, instead of just facts and procedures, into a form that can be represented in computer systems. (Radford and Stevens, 1987, p. 221)*

*2. The knowledge base of an architectural firm is a filtered collection of its service products and the socialized experience of its employees: the firm's institutional memory. [...] A firm's knowledge base includes three components: archives, resources, and guidelines. (Sanders, 1996, p. 9)*

### Databases

The most widely form of knowledge engineering is the use of databases. Data stored in structured ways can be used for complex searching, pattern matching, and information retrieval. The data can be of a number of types, such as text, images, drawings, and different multimedia formats. By using central databases in a network, many users can simultaneously work with the data, thus minimizing the risk of redundancy and differing versions.

In the last few years, Internet use has exploded. Apart from accessing databases on CD-ROMS and in corporate networks, a vast number of databases can be reached on the Internet. Some of these are local or national, presenting e.g. vendor offerings, building materials, and literature references. Swedish examples are:

❄ Hags, http://www.hags.com
❄ Svensk Byggtjänst, http://www.byggtjanst.se
❄ BYGGDOK, http://www.byggdok.se

Others are useful at the international scale, such as plant databases. Some examples are:

❄ The Gardening Archive, http://www.lysator.liu.se/garden/index.html
❄ The Virtual Garden, including the Time Life Complete Gardener Encyclopedia, http://vg.com/

Most important of these uses is the accessibility of building material information. In Sweden, Svensk Byggtjänst administers a database containing the majority of products used in building and construction. As the use of product modeling increases, the need for standardized digital components will be large. Once the efforts within STEP and IAI come to working conclusion, manufacturers will be eager to supply their components to architects[1]. In many cases, this will be done by using on-line databases.

Expert Systems

A database can be used as a basis for an expert system. This kind of computer program uses the same logic an expert would when facing a particular problem. Often, the system is designed as "questions and answers", with the possibility for the user to follow the steps being taken as the systems produces its result and gives an advice.[2]

Desision Support Systems

An expert system can be viewed as one form of decision support system (DSS). A wide definition of this term is devices used to better understand the information necessary for making a decision. A DSS must however be designed to meet the requirements of the user. The DSS designer needs good knowledge of the users' background as well as of the decision process itself.

If this kind of system is used in complex environments – for instance a planning process – it must include local social factors such as political preferences, socio-economy and others.[3]

Parametric Programs

The most obvious problem when creating expert systems for use in the architectural professions is the complexity of the issues. So far, software vendors have succeeded in creating applications for designing parametric components such as stairs and parking. After giving certain key measurements, the computer helps the designer to "fill in the blanks" – suggest number and height of steps, or drawing the maximum number of parking spaces in an area. Helpful as they may be, these parametric programs, or macros[4] have several limitations (Sanders, 1996).

❊ They are not iterative[5] in the sense that the components created by the program remember the procedure, or the parameter values, that created them.
❊ They are sequential, often needing parameter values fed into them in a certain order.
❊ They are not dynamic and visual, giving the user a direct feedback of the result.

*1. This will be discussed further in* Data Structure.

*2. The advice might be a diagnosis of a fault (why the roof is leaking), a recommendation or requirement for action (what to do for passive solar energy), a classification (what type of development the proposed building is under the planning regulations), or an interpretation (whether the proposed design meets the minimum requirements for floor area and height of rooms). (Radford and Stevens, 1987, p.223)*

*3. An SDSS [Spatial Decision Support System] to support a planning process is a system that supports the formulation and evaluation of plan alternatives based on planning factors that can be identified. Integrating GIS [Geographic Information System] with decision support systems and expert systems could lead to powerful systems that support planning and decision-making processes. (Eweg, 1994, p. 28)*

*4. Small computer program, often consisting of a recorded sequence of command.*

*5. Iterate: to repeat; to utter or do a second time. (Webster's, 1979)*

❈ They usually create isolated components, with no links to other parts of the design.

Procedural Components

Components that do "remember" the parameter values used in them are called procedural components. The Swedish AutoCAD application POINT Skiss (Sketch) features procedural building models that can be used in simple volume studies. Once created, the models can be manipulated by adding stories, changing roof angles, and so on.

However primitive, the parametric macros and procedural components do actually help the designer to generate solutions to certain problems. By using well-defined rules, they can be used efficiently in two kinds of situations. The first kind is the one already mentioned – the simple design problem with few variables, such as constructing a stairway. The second kind is the opposite – a large-scale and complex problem, where high specialization is needed. One example is construction management, with its needs for phasing, logistics, resource management, and so on. The number of variables makes traditional planning more costly and inefficient.

The architect often faces the first kind of problem, more seldom the second. In fact, most of the work falls in between(Figure 2).

There are no clear borders between databases, expert systems, and decision support systems. Any comprehensive database with an application used to make queries comes close to being an expert system. An example is Svensk Dendrologi, a tool for choosing among shrubs and trees[1]. The database contains some 1,100 plants. By querying the database, plants that meet specific criteria can be found. The user then, from his own professional experience, chooses the species that satisfies other criteria not found in the program – its beauty, how it fits in with the overall scheme, how it matches other plants, and so on.

As shown, computer software can be useful in some parts of the design process. However, architects are still far from being replaced by the computer.[2]

*1. I was involved in this project as a mediator between the plant experts and the software programmers.*

*2. Ordinary design certainly can be derived from a set of rules, but extraordinary design derives from bending them – from intuition, insight, and leaps of faith. Leaps of faith are relatively difficult to encapsulate in digital formats. Most rule-based software programs are most useful as information resources, not as design tools. (Sanders, 1996, p. 89)*

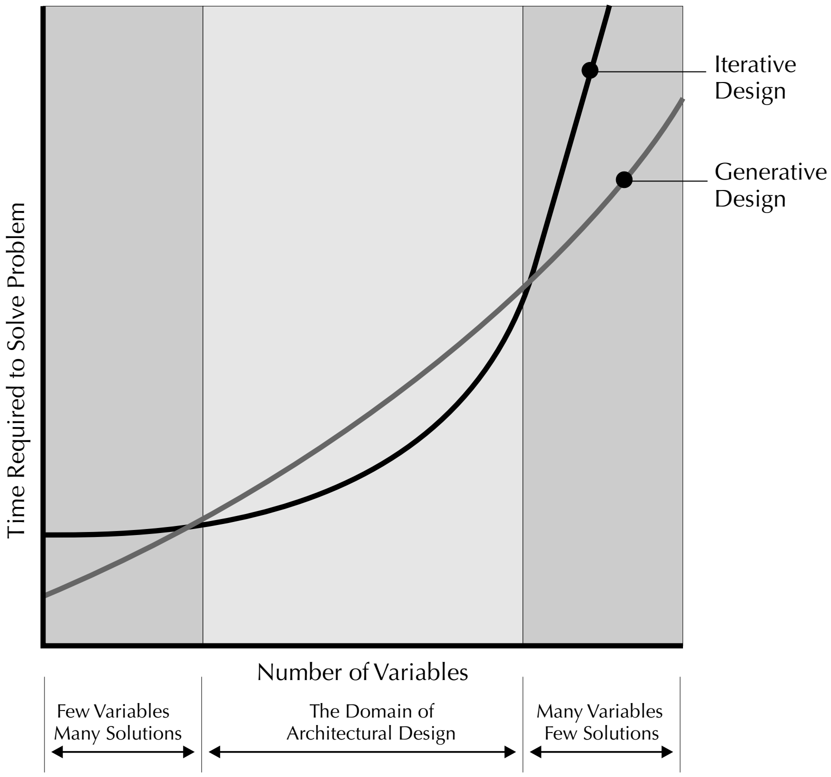
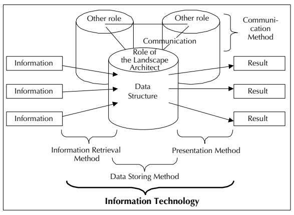



*Figure 2. Iterative design versus generative design. From Sanders, 1996, p. 87)*

# TECHNOLOGY




This part presents the most useful technologies for information processing presently available for the landscape architect. They are grouped into two large areas: geographic information systems, and software for design, drafting and presentation.

## Geographic Information Systems

The method of overlaying different kinds of information and analyzing the result appears to be a perfect task for computers. Geographic Information Systems (GIS) has therefore from its introduction caught the attention of at least some of the landscape architects. The leading GIS software company – ESRI – was founded by and is still lead by landscape architect Jack Dangermond. From being an application for specialists, run on mainframe computers or high-level Unix workstations, GIS is now standard PC software. The competition in the field is fierce, at all user levels, between software developers.

The hopes are high that GIS can and will enhance the planning process, for planners as well as for clients (or participants). In 1985, Julian Fabos expressed his thoughts concerning the new technology and its effect on physical planning.[1]

*1. [T]he development of high technology aids landscape planners in several ways. As spatial data is becoming available in the form of electronic signals, landscape planners will have ready access to ever larger and more accurate data bases which can be retrieved easily. High technology also augments data analysis and assessment capabilities. (Fabos, 1985, p. 171)*

GIS Definitions

Geographic information systems is a wide term, possible to use on a variety of computer-aided systems used for different purposes. There are in the literature a number of efforts to define the concept – a few of which will be referred to here. In their introduction to GIS, held in a popular tone, Malmström and Wellvig present some simple and straightforward explanations. [2] This definition shows the importance of the user: the purpose of the system is entirely dependant on the aims of the user.

*2. A data processing system consists of three components: data, hardware, and software. If you add the user, you have an information system. [...]*

*A GIS (Geographic Information System) is a computer based information system with functions for adding, processing, storing, analyzing, and presentation of geographic data. An operational GIS also includes at least one database. (Malmström and Wellving, 1995, p. 18, 21).*

A more scientific and far more complex definition is offered in Bracken and Webster (1990, p. 26-27). It emphasizes the information flow, and its dependency on the user and his environment. This definition has four components:

1. *The operating environment*: the environment with which the information user is concerned (e.g. a city planning authority).

2. *The perceptor apparatus*: "the system's sensory interface, monitoring the attributes of the operating environment and transforming observations into data".
3. *The storage-processing apparatus*: the hardware which receives data from the perceptor apparatus. Data is then stored and managed, thereby converting it into information. Displaying data on a screen or on paper, using mapping symbols, is one example of this conversion process.
4. The system's *users* ("the effector apparatus"). The users make policy decisions and intervene in the operating environment. The ability of the system as a whole to respond to needs of the users is of course fundamental to the success of the process.

The two definitions above both describe GIS as a system, including users and environment. Often, however, the term GIS simply labels the software used in the process. In this case, GIS can be seen as a set of tools for collecting, storing, retrieving, transforming, and displaying spatial data. In everyday language, the latter definition seems to be dominant – that GIS is a software solution to the processing of planning tasks. In this case, GIS can be seen as the section between database management systems (DBMS), geographic analysis, and computer aided map production (Figure 3).

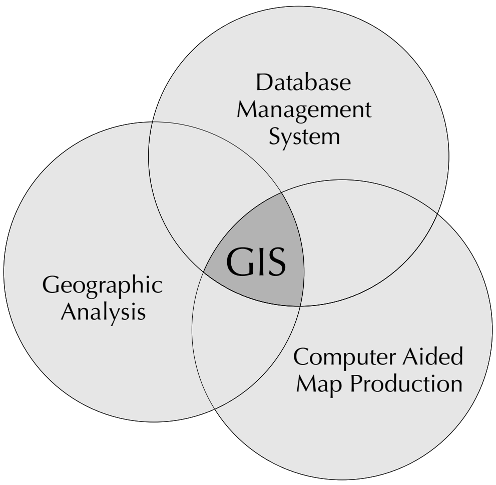



*Figure 3. GIS as a section between of technical applications. From Malmström and Wellving, 1995*

The emphasis on GIS as a tool, rather than as a system, is a reminiscence of its origin in cartography. However, GIS is more than electronic map overlay. The main advantage is the possibility to use graphics in combination with tabular data.[1]

Still, maps can be used in powerful ways in GIS. As cartography also rapidly is becoming digital, the borders to analytical GIS are becoming harder to define. Map data is today often stored in spatial databases, possible to use directly in GIS software. This enhances the possibilities to extract complex information from map data.

*1. This combination is evident in the very name of the leading GIS software: Arc/Info.*

GIS VS. CAD

As shown in Figure 3, GIS and CAD are closely related. CAD software is often used to produce the geographic data put into the GIS. There are however some fundamental differences between the tools:

❊ GIS stores topological[1] data; relations between the objects in the database. An area (polygon) in a GIS database "knows" who its neighbors are; in CAD, the area knows nothing, only the borderlines know where they are.
❊ In GIS, database connections are used extensively to store data about the physical objects described. This can be done in modern CAD systems as well, but with less flexibility, and fewer possibilities to make advanced analyses.
❊ GIS can be used to analyze raster data – photographic images of different kinds. In CAD, they can only be used as a background to the vector data.

1. *Topology: the mathematical properties of an object which exclusively depends on closeness and context.*

The borders between the techniques are however rapidly diminishing. Advanced CAD software such as AutoCAD Map has GIS built in right from the start. The user can easily move back and forth between the two uses. In this kind of software, CAD is simply the drafting part of a geographic information system. The GIS possibilities can be used for projects of any scale – landscapes as well as buildings. In this sense, geographic databases can be the link that ties information from all parts of building, construction, and facility management together. The different parties involved use different tools to access and manipulate the data, exemplified in Figure 4.

If 3-dimensional and object-oriented, the database would in the design and construction phases be called a product model.

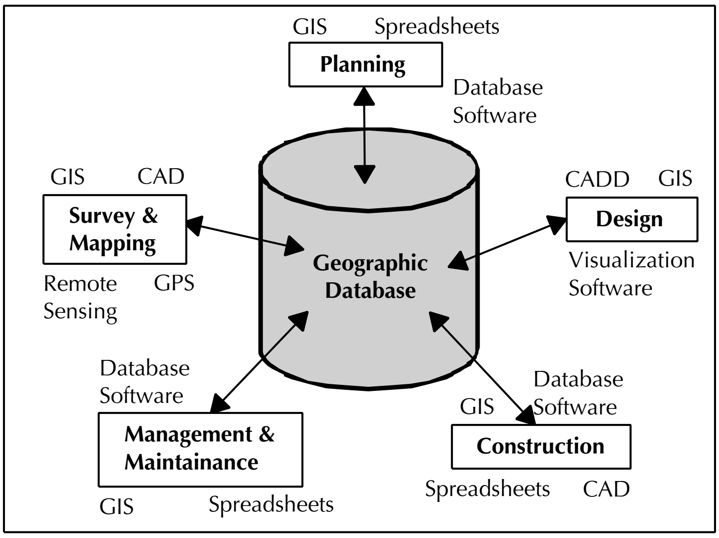



*Figure 4. The geographic database in building, construction, and facility management.*

## GIS in Planning

Planners started to use digital tools more frequently in the late 1980s. This was the result of a development that had started almost 35 years earlier. Torsten Hägerstrand in Lund, Sweden, made some of the theoretical foundations of computer based processing of population data in 1955. He also started research in computer aided cartographic methods. The first practical steps were taken in Canada in the 1960s, for the purpose of storing national thematic maps.

The methods of raster and vector based GIS[1] were improved in the middle of the 1960s at the Harvard University. In Sweden, the Stockholm County Council (landsting) used a GIS system for location analysis from the end of the 1970s.

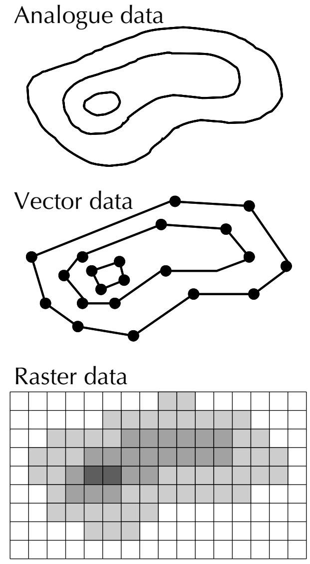
The acceptance of computer use in planning was however neither fast, nor undebated. The technology of the early days was expensive and complicated to run. Mutunayagam and Bahrami (1987) provide a thorough background to the problematic introduction of GIS. First of all, people were threatened by the notion that the new technology would turn the planning tasks into "an automated and noncreative series of activities".

Shortly, this fear was replaced by the attitude that design and planning were far too complex, subjective, and intuitive to be computerized. The early efforts made using GIS were primitive and incomplete, thereby strengthening this opinion. Not in any respect were the computer supported plans superior, aesthetically or in terms of productivity. Not surprisingly, few designers and planners devoted much energy to enter the GIS arena.[2]

The obstacles were simply too great for most small practices to overcome. The time and money needed to acquire the equipment and skills necessary – not least in software programming – would in most cases not be returned with a profit. A few large firms and governmental organisations had the means to solve the problems by hiring software consultants and programmers, but this solution was unfeasible for small and medium sized architectural and planning offices.

This attitude proved to be hard to overcome. It was not until the late 1980s that "desktop planning" became a reality. By this time, the processing power of the PC had become powerful enough for working with image analysis and high color graphic display. Development in software, which made it more versatile and user-friendly, lowered the personal obstacles for using the technology. GIS has since then become the primary tool for collecting and analyzing environmental data. By using the ability of the computer to

*1. Analogue geograhic data is in GIS stored as vectors or as raster images.*




*2. Experiences with computer technology of this period confirmed the notion that certain specialized skills – skills alien to those normally cultivated in an architecture, landscape architecture, urban design, or physical planning curriculum – were needed for users to operate and maintain computers productively for planning and design. (Mutunayagam and Bahrami, 1987, p. 7)* handle large amounts of information and make fast analyses, planners can more easily present several alternative solutions to problems. The desktop planner can coordinate information from a wide range of sources (Figure 5).

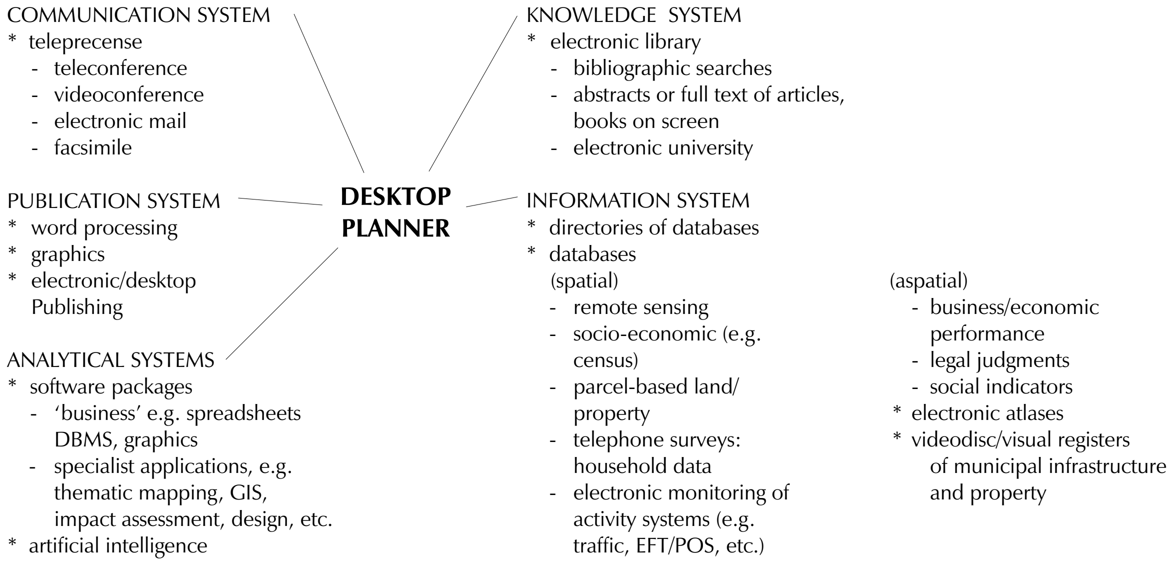



*Figure 5. The evolving desktop planning hardware-software environment (Newton et al, 1998, p. 1)*

A large number of books dealing with GIS were published in the late 1980s. Their topics ranged from practical programming of functions and hardware choice, to philosophical speculations into the role of planning in society. Most of them were filled with examples from planning practices of different kinds.

Computer support – especially GIS – can today be used for a variety of planning purposes. Physical planning is common in most fields of the private sector. The forest industry is a forerunner in the use of digital geographic data. Transport engineering and planning – logistics – combines map information with data dealing with merchandise and traffic situation. In a smaller scale, facility planning of industrial sites can be handled by use of GIS.

Public sector planning is diversified into a number of objectives – land use, environmental planning, exploitation of natural resources, land preservation and urban planning, just to mention a few. In urban planning, 3-dimensional CAD can be used to study effects on changes in the built environment, and how existing structures meet regulations. One early example of this use is Toronto, where a 3D CAD model has been in use since the end of the 1980s.

GIS Use in Sweden

GIS use in Sweden has increased rapidly in the last decade. A survey was conducted in 1997 by ULI, Utvecklingsrådet för Landskapsinformation ("Development Council for Landscape Information) (GIS i Sverige 1997). The questionnaire was sent to 1090 "possible GIS user'. Among the 435 answers, 289 used or planned to start using GIS – i.e. ¼ of the possible users, ½ of the ones that answered. In total, almost seven thousand people used GIS in their daily work. 17% of the GIS using organizations were governmental; 58% city or regional; 7% schools and 17% private. GIS tasks ranged from planning and design to maintenance.

Nevertheless, the use of GIS has been remarkably slow in acceptance among landscape architects. There still appears to be a lot of confusion as to the uses of the tool. The practices that have started utilizing GIS often limit the use to producing "intelligent maps". Qualified GIS analysis is still a rare product.

*[T]he problem, I find, is that people don't really know what they want GIS for. There's a bit of confusion. They use it for mapping, they don't use it for analysis. The analysis side – I guess it's kind of like the drafting and design side – the analysis side interests me more than the mapping side. I want the graphics to look good, but I want my maps to say something. That's why I, like you, find GIS very interesting. You could, for example, have your aerial photograph, and then you have your soil analysis underneath, and if someone clicks on an area on the aerial photo that they recognize, then it tells of all the soil types there. That's quite important. And services, are you going to plant over services or not? There's a big capability of GIS. (IS 3)*

## Computer Aided Design, Drafting, and Presentation

Computer aided methods in landscape architecture is fast growing. In Sweden, a couple of surveys show computer use among landscape architects. Kristina Lundqvist (1991) estimated CAD use in this profession to about 25%, far less than among building architects.[1]

In the end of 1993, I conducted a survey among all landscape architects in Sweden, dealing with computer use of different kinds. Not surprising, the most widespread application was text processing – 92% used the computer as a writing tool. CAD use had grown to around 50%.

However, the computer was seldom used in all phases (one out of three projects), and only 25% used CAD in more than half of the projects. The pressure from clients to use CAD was low, although it was considered one of the main reasons for starting to use the technology. Other reasons were: fast and efficient; coordination within the company; coordination between consultants; meet the future; surveys in CAD files; exact; good for detail drafting.

Some of the advantages of CAD use noted were: fast dimensioning; easy the make changes; good for collecting background information; clean and nice-looking drawings; fewer faults; better coordination; lessened insecurity concerning borders and building footprints; fast, cheap, and correct perspectives.

Notably more disadvantages with CAD use were expressed in the survey answers: time-consuming; too exact; boring; large investment; education necessary; must use daily; CAD drawings give a false impression of knowledge; last-minute manual changes make the CAD files useless for future work; bad and insensitive drafting; ties up the designer – hard to pass on the work to other for drafting; lessens design importance; everyone can't use it; slow to work with; difficult to print the drawings; sketches look too final; not user friendly.

Perhaps the most interesting result was the view on the importance of CAD skills as a competitive edge for the company. As for the own company or practice, most considered it not to be very important. A higher percentage believed CAD to be significant for other practices to use for competition. This pattern can be interpreted in at least two different ways:

*1. One explanation to the landscape architect companies low use of CAD has been expressed in one survey answer, where a landscape architect company claims not to have as much to gain by using CAD in comparison to e.g. architects and building engineers. Every site is unique, which makes the possibility to copy between different projects less useful. Furthermore, a landscape architect works with soft shapes, which is hard to draw nicely with CAD. (Lundqvist 1991, p.20)*

❊ "Other companies must use technical arguments to stay in the market – we can rely on our design skills."
❊ "We are slow in learning the new techniques – others use it to stay ahead."

This question would be interesting to investigate further in a qualitative study. I believe it to be a revealing attitude among landscape architects in general – a sort of insecurity in the professional role one is acting (Figure 6).

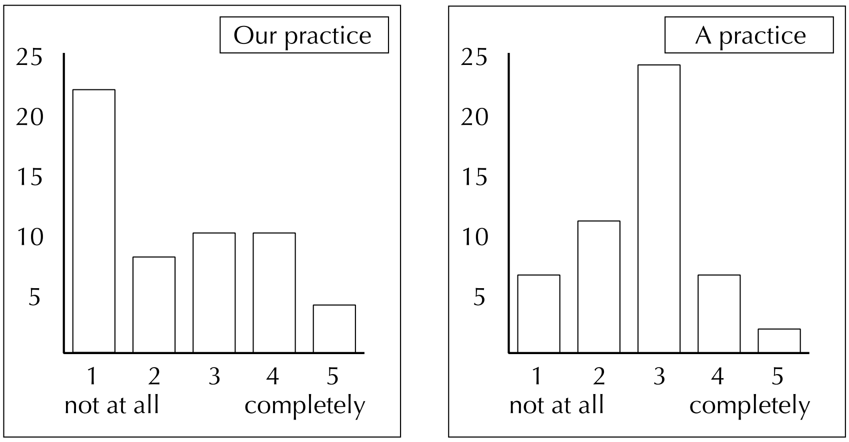



*Figure 6.* CAD *as a means for competition.*

At the time of the survey, practically none of the Swedish landscape architects had any experience in the use of GIS, although several expressed an interest in the technology. Computer-aided visualization was more used, especially photo manipulation. A handful had started to use 3-dimensional rendering software such as 3DStudio.

As for the question were the landscape architects felt most uncertain, and needed information and advice, the answers showed the following distribution: economic analysis (16%); project presentation (15%); hardware (15%); software (45%); other (6%).

The result of the survey was distributed along with a leaflet – Landskapsarkitekternas Datornytt[1] – describing the most important possibilities for landscape architects using IT. This small project, which included a series of small seminars, was supported by Arkus, the Swedish architect's foundation for research and development. Unfortunately, the idea of publishing the leaflet on a regular basis could not be fulfilled. Today, the information would of course be distributed on the Internet.

*1. "Computer News for Landscape Architects"*

## Design and Sketching

Computer-aided and manual techniques for design and presentation are likely to co-exist for a long time. In spite of the fast progress of hardware and software, computers still have problems in imitating the "human touch" of professional handmade images.[1]

In the traditional role of an architect, sketching is the most important phase of the design process. By making quick or elaborate images, the architect tests different solutions to the design problem. Aided by previous experience, alternatives can quickly be examined, and factors that are formally incompatible can be weighted. Ideally, the sketching process is almost intuitive, mixing drawn images with text notations, pulling up knowledge from the professional repertoire, unconsciously using patterns and solutions from "the old masters", from personal experience, from contemporary debate, from colleagues and users. The architect tries to capture the "undecided" and vague, that which only can be shown. Every sketch is thus a test of the architect's judgment (Kjelldahl and Lundequist, 1986).

The acronym CAD is by most architects spelled out as *Computer Aided Design*. Some prefer the term CAAD, for *Computer Aided Architectural Design*. In most cases however, the computer is used in the late stages of the design process, with emphasis on drafting.[2] Sometimes the software package is labeled CADD (*Computer Aided Design and Drafting*) in an attempt to show the two main uses of the software.

Whatever acronym is chosen, the computer can be used in the design process.[3] In this sense, the computer is not different from any other tools. The designer should choose the tools he or she is most comfortable with.

The different phases of the design process are also valued differently among the individual landscape architects. Personally, I put a great deal of effort into the construction phase, where the design ideas are "materialized" in detailed construction drawings. A large part of the design decisions is made during the actual drafting. Others prefer to concentrate on the conceptual design.

*Well, I never liked [the word "CAD"]. Some people spell it "CADD", and if I'd seen that extra "D", I'd probably not gone into computers! I'm not a drafter – people argue that I am, and technically I probably am – but I like to think I'm part of the design process. […] If I can get them to drop the crane height [in a project] because the computer's shown that the impact is too significant, to the planning commission, then the computer is part of the design process. Not drafting! [Laugh] (IS 2)*

1. *Talented humans […] are able to produce renderings of landscapes, spaces and environments which are convincing and compelling and "accurate" in a way which still overwhelms most computer renderings. And there is an evolving community of CAD artists, who have mastered a "craft" in this digital realm, and who clearly produce art […]. Yet what usually moves and impresses us most in design representations is not photorealism at all, nor yet the qualities of "fine art", but that far more elusive quality – expressive abstraction. (Ervin, 1996)*

2. *This is even more evident in Sweden, where the word* design *is used as a more narrow term than in English, meaning something like "the esthetic touch" applied in the very end of the process (most often used in industrial design of tools and utilities).*

3. *[C]omputers offer a design medium that is much richer, and therefore perhaps more difficult to use, than pencil and paper. [… C]omputer design is possible, in the sense that computer programs are able to generate design solutions through the operation of algorithms. (Radford and Stevens, 1987, p. 192)*

Specialized software for the early, conceptual stages of design is still experimental, and has only been developed for building architects. By the use of knowledge based systems, the ambition is to make the computer help the architect in the process of deciding structures, flows, patterns, spatial organization and so on. An overview of the advances in this complex field is given in Visual Databases in Architecture (Koutamanis et al, 1995).

An easier task for the computer to handle is to act as a substitute for tracing paper and other manual design media.[1] This method can be very attractive to architects who are positive towards the computer. The computer is more flexible since it can quickly simulate a number of manual methods, use scanned images as backgrounds, work in several layers, use reference grids, etc.

*1. The biggest challenge has been to use the computer as an initial sketch and design tool. […] By working with a painting program, like Fractal Design Painter, which simulates standard drawing and painting techniques, the designer is able to sketch initial concepts electronically. (Lischewski, 1994)*

3D Modeling

More effort has been put into the development of applications for fast construction of 3-dimensional models. This kind of software, e.g. ARCHICAD, MINICAD, and CONCEPTCAD, is becoming increasingly popular among architects as well as landscape architects. By allowing the designer to explore ideas in three dimensions, the computer "provides a timely break with the tyranny of the plan" (Sawyer, 1998).

The third dimension helps the comprehension of scale, volume, and relationships between parts. When using plans as the main instrument, design tend to focus on the arrangement of objects on the surface – furniture, plants, and such.[2]

*2. This is one explanation for the banality of most urban spaces. Similarly, another reason why so many landscapes are simple is that we can only represent simple things. [...] If you can't draw something, then how on earth do you represent it? Typically, in landscape architecture, you don't. (Sawyer, 1998)*

Another strong argument for the use of 3-dimensional modeling – virtual or real – is that is forces the designer to understand and decide on crucial aspects of the project. In plans and sections, critical points can easily be overlooked, or put aside for later solution at the construction site. By making a model, the designer comes as close as possible to building "the real thing'.

However, creating digital landscape models is difficult. Unlike buildings, landscapes, gardens, and other open green spaces are extremely complex and variable. Making an exact model of a tree is infinitely more complicated than modeling a house. The irregular structures and textures of natural objects are hard to visualize in a convincing manner, and require complex programming and powerful hardware.

Advances in this field are however fast, propelled by the computer game industry. In addition, models used in the design process can be quite simple. When the architect is modeling in order to help the comprehension of how possible solutions appear in three dimensions, simplicity can in fact be more creative, and minimize the risk of halting the process just because "the image is ready". The issue of landscape visualization is discussed further in the part dealing with Result.

The advances in 3-dimensional modeling must however not lead to the abandonment of the paper and pencil. The abstraction necessary when performing 2-dimensional sketching is a powerful tool for the designer. As often, the ideal situation is probably somewhere in between, or rather using both techniques in parallel. By using simple computer modeling, the paper sketch can be studied in three dimensions.

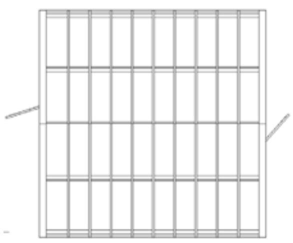
As often is the case, compromises exist between the extremes. In reality, sketching is not performed exclusively on one medium. A common method used by landscape architects is moving back and forth between hand drawing and CAD software.

*I move fairly quickly into CAD. When I'm designing housing areas and such, I make some first sketches by hand, and then move it into CAD. Then it's become a habit to print it out and continue sketching, and when something looks right, I put it in again, and then that's the base for the following sketches. I kind of lock it, piece by piece. I suppose that's the way I work. […]*

*And some testing is done directly in CAD, especially radiuses and such. Trying to find good-looking line movements and so on. (IS 1)*

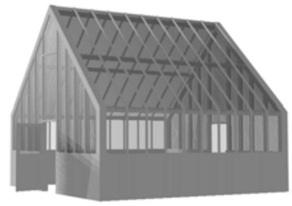
Presentation Techniques

The computer offers the landscape architect a large array of techniques for presenting ideas and design suggestions. By using 3-dimensional modeling in the early phases of design, the amount of work needed to make striking presentations is minimized. Other, simpler technique can also be used for different purposes. The range of technologies used for presentation purposes can be summarized in the following lists.



First of all, images must be produced:

❋ Photographic manipulation. Digital photographs can be used for showing proposed measures of all scales.
❋ 2-dimensional CAD or illustration software. The result can be simple line drawings, or colored illustrations with shadow effects and other methods of making the image easier to interpret.
❋ 3-dimensional CAD. Drawings or screen images can consist of simple wire-frames, or with surfaces shaded in simple colors.



❄ Rendered images from 3-dimensional CAD models. The result can be highly realistic, with materials applied to surfaces, many light sources, and complex treatment of reflections and transparencies. The models can be combined with other images, used as background or for other purposes.

For the viewer, the result can also be more or less static, and more or less interactive. The 3-dimensional model can be used for producing still images, but also for presentations where the viewer can see different angles, or choose what to see:

❄ Animations, where a pre-defined path is followed in a movie sequence, displayed on a computer screen.
❄ Walk-throughs, where the viewer can maneuver around in the model – either by following certain paths, or walk freely, steering with a mouse or some other device. The result is displayed on a computer screen.
❄ Virtual reality, which differs from the previous in that sense that it uses a more sophisticated type of display – special glasses, a helmet, or a room with screens on several or all walls.

These "higher levels" of visualization are undergoing rapid development. Apart from scientific use of images, a major driving force is the entertainment industry – computer games and movies being the most prominent.[1] The breathtaking special effects of movies like Titanic and The Lost World are made with state-of-the-art technology. However, these are rapidly being "sifted down" to more humble technological environments, to be used in low-budget projects.

*1. Developers of computer games often show a remarable creative talent for landscape visualization!*

Most landscape architects are today at the level where the computer is used to produce 2-dimensional drawings. A few have reached a higher level, merging photographs and CAD models. Fewer still are working with walk-throughs and animations, and virtual reality projects are as of today very experimental.

*I can promote the use of digital presentation to landscape architects generally. I think it's crazy, we've got all of these wonderful digital tools for producing drawings, and yet, at the end of the day, we present our work in analogue fashion. We always go back to the same role of drawings, you know. I think that's a real shame, because it mixes out a lot of potential of the digital media. I think that software like Macromedia Director for example, can and will become incredibly* *useful for communication over the next few years. I can see a time, not too far away now, where a CD-ROM will replace the role of drawings. The client just gets an interactive CD that has all the information that they need. It could be videos, or walk-throughs, or text, or images, or whatever. That medium is so flexible, it's very… you know, as a designer, it's very seductive. You can montage all those things together. There are no real limits, apart from the size of the monitor you are displaying on. (IS 2)*

It is important to remember that proficiency in the use of computer visualization tools does not in itself give the designer superior presentation skills. The ability to quickly produce advanced images must be used with the same insights as when working with the traditional skills of sketching, drawing, and painting. The presentations must still be adjusted to the design vision, the means of presentation, and to the audience.

Besides making images, the computer can thus be used for packaging visualizations with text and sound:

❋ Desktop publishing software, e.g. Adobe PageMaker, combining text and images.
❋ Presentation software, e.g. Microsoft PowerPoint, for producing passive or interactive "slide shows", combining images, movies, text, and sound.
❋ Multimedia software, e.g. Macromedia Director, for making passive or interactive presentations, combining images, movies, text, and sound.
❋ Web publishing software, e.g. Microsoft FrontPage, for Internet presentations, using images, movies, text, and sound.

The borders between these types of software are becoming more and more blurred. Most modern computer applications can save files for use on the Internet; presentation software has increasing capabilities for multimedia.

Design and Drafting

As previously mentioned, the areas where architects used the computer first in a large scale was in text processing, construction (as in detail design) and drafting. CAD courses are now at most schools for landscape architects considered standard curriculum. At our department, CAD is still not mandatory, but will soon be integrated into basic courses for the student.

Computer-aided drafting was at first viewed rather skeptically by many landscape architects. Building architects often use relatively simple geometry, straight lines, and repeating solutions such as apartments in a large building. Site design in usually unique in all the details, and often use complex geometry and curves – all of which are more complicated to construct in the computer.

Nevertheless, CAD use grew among the landscape architects. The technique soon proved to aid two-dimensional drafting in many respects:

❊ Site surveys are today often produced with laser instrument, directly feeding data into a file. This is imported into the CAD environment, for use as background information for the design.
❊ City authorities are producing basic maps in CAD format. Using this material increases the information quality concerning property borders, roads, building footprints etc.
❊ Other kinds of site information – power and telephone lines, sewage systems, previous design etc. – can easily be brought into the CAD system. This can be done by using digital data, or by digitizing printed maps. Differences in scale are thus removed from the material, since the CAD file in itself is scale-less.
❊ Information from other consultants can be imported into the site plan. By using an agreed coordinate system, files can be overlaid each other, keeping relations between them constant. Many systems use "external referencing" of files, so that every time e.g. the landscape architect opens a file, information from the building architect and others are automatically updated.
❊ As all site design is drafted in a "1:1" scale in the CAD file, the need for making separate detail drawings is minimized. All planar information is drawn at its right location in the model. For presentation, a number of plan projections can be made, in one or several drawings. The projections can have different scales, depending on the level of detail needed.
❊ By the use of layering, different kinds of information can be presented from the same CAD model. Plans for groundwork, plantation etc. as well as illustrative drawings can be produced from the same model.
❊ The need for re-drawing between the different phases of the design process can virtually be eliminated. The same CAD file can be used throughout the project, gradually being refined as detail solutions are established.
❊ If high-quality site information is used, drafting precision can be kept at a high level throughout the design process.

❊ Information can easily be re-used from project to project. Standard solutions of different kinds of components can be inserted into new drawing, as they are or modified to fit the new environment.
❊ Dimensioning can easily be added to plans and sections. Measurements can be dynamic, i.e. change as the design is altered.
❊ Design changes are fast and easy to make, almost eliminating the tedious task of erasing and redrafting. Drawings are kept nice and tidy, no matter how many alterations are made.

Building engineers have for a long time used CAD for calculating structural behavior of buildings. These kinds of needs are not common in site design, but there are many other areas where computer applications can assist in construction:

❊ Calculating, or simply showing, areas needed for vehicles, e.g. rescue and cargo deliveries
❊ Parking area layout
❊ Surface slopes
❊ Water run-off and sewage dimensioning
❊ Section drawings
❊ Cut-and-fill calculations
❊ Calculating number of plants in planting areas
❊ Automatic bills-of-quantities of surfaces, exterior walls, stairways, plants, equipment etc.

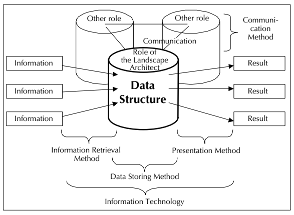
Connecting the graphic elements with component information in databases largely helps these enhanced uses of CAD. This is further discussed in other sections of this report. However, software developers still have problems designing efficient interfaces for "intelligent CAD". The evolvement into object-oriented programming is slow, in lack of standardized ways of describing the objects. Proprietary solutions have obvious disadvantages, mainly in the possibility to communicate with other parties in the design process.

My own experiences with Swedish software for landscape design are somewhat discouraging – no matter how disciplined I was drafting, at the end of the day, I always found myself counting plants and equipment manually. Then again, these technical aspects of the design are perhaps not a primary interest of the landscape architect? However, no matter who does the work, calculations like this ought to be well suited for the computer.

CAD applications are constantly becoming more and more complex. The functionality of the basic software – e.g. AutoCAD – increases as well, with different versions for different uses. Functions for mapping, GIS and 3-dimensional modeling are soon standard utilities for many landscape architects. Whether they are or will be used is another matter. In pressured situations, ease of use is fundamental. The user interface must be well adapted to the profession. CAD vendors have a long way to go in this respect – most beginners find it hard to learn, and far from intuitive.

*The development of such – enhanced – user interfaces must be based on analysis of the existing professional knowledge. Such an analysis of competence is in reality a concept analysis, i.e. an analysis of professional language, learning process and established forms of organization. (Byggnadsstyrelsen, 1985, p. 24)*

# Data Structure




The information processing that takes place in planning, design, and maintenance has always required a certain amount of data structuring. Even very small projects must have some sort of organization for retrieving, storing, processing, presenting, and archiving data – even if it simply consists of a corporate or personal experience in "how to get things done".

As the complexity of the project increases, the demands on data structuring get higher. This is accentuated when the use of digital data increases. The last decade has witnessed some major efforts in formalizing the methods used in practically all sorts of professional activity. Under the banner of "Quality Assurance", millions of hours have been dedicated to structuring the tasks performed in the daily work. By producing and strictly following extensive manual and checklists, a company can eventually receive the quality certificate ISO 9001.

For many participants, the quality work mostly consisted of producing a number of folders containing papers no one ever read. However, the quality assurance efforts led to a much-needed overview of the steps of the data processing, thereby forcing everyone to consider the data structure of their work. Many offices seem to take a rather practical view on the quality aspects.

Perhaps the situation will be clearer as the meaning of the term "quality" evolves. Traditionally, it has in planning and architecture been used to measure "conformance to regulation", concentrating on the legal and formal framework of the consulting professions. As the competition grows in the architectural and engineering business, the definition gradually moves towards measuring "customer satisfaction" over the whole life cycle of a project. (Sanders, 1996) The focus on keeping the information useful over long time periods is a frequent argument for the use of information technology.

## Physical Planning

Data Types

Due to its wide scope, physical planning is the sector where the landscape architect must handle the largest and most diversified types of data. By using GIS, the planner can work with a variety of data types, graphic as well as nongraphic. There are two fundamental kinds of graphic GIS data: vector information and raster images. Nongraphic data is normally used in the form of database tables (tabular data). The classification of data types is equally relevant for information used in manual methods. Maps, pictures, and different kinds of written information, in tables or plain text, can be combined in several types of arrangements.

Another classification of geographic information sources is shown in Figure 7. In planning, archival sources are normally the most important.

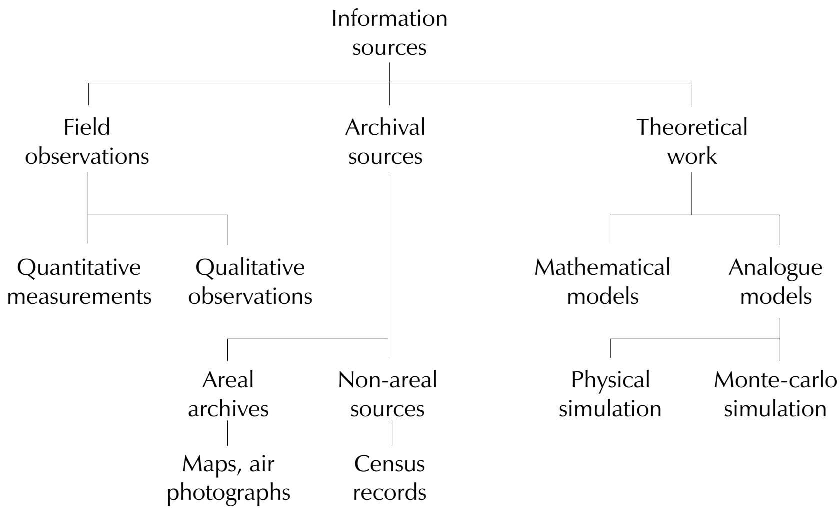



*Figure 7. Sources of locational information in human geography. From Bracken and Webster, 1990 (original source Hagett et al, 1977,* Locational Methods. *London: Edward Arnold)*

All these different sources are of different importance in the actual planning processes. Data acquired through field observations are normally more adapted to the user's need, and thus of higher quality. By manual capturing of data, very detailed information can be processed. The most common sources are listed in the table below, modified from Bracken and Webster (1990).

| Source of information | Typical data | Method of capture |
|---|---|---|
| Field survey | Boundaries, heights, features, vegetation details | Theodolite, electronic distance measurement, global positioning instruments (GPS) |
| Telemetry | Flows; i.e. river, traffic, weather | Remote meters and counters, balloons |
| Social survey | Household characteristics, personal attitudes | Data loggers, market research devices |
| Field observation | Land use, property registers | Direct data entry devices, data loggers |
| Maps | Topographic and thematic information | Digitizers, laser and other scanners, image processing |
| Air photographs | Topographic information | Photogrammetry, scanners |
| Remote sensing | Multi-spectral information, visual/infrared and panchromatic imagery, stereoscopic images, digital elevation models | Satellites |
| Directories/ classifications | Household lists , codes, and addresses | List scanning |
| Administrative processes | Planning applications, development works, land use | By-product of administration |
| Aggregate published data | Population, households, employment, income | Retrieval from censuses and official surveys |

Vector Data

The most used sources for vector data are CAD drawings and digitized or vectorized maps. National cartography bodies all over the world are today making large efforts to produce digital maps in vector format. In Sweden, the National Land Survey (Lantmäteriverket) sells vector data ranging from land use maps in scale 1:10,000 to national maps in scales 1:700,000 to 1:20 million. The maps cover a long range of data: geomorphology (heights), administrative boundaries and regulations, infrastructure, land use, vegetation types, buildings, and properties.

The Geological Survey of Sweden (SGU) publishes maps in various standard series. The maps show different aspects of earth sciences from the Swedish land area, as well as from the Swedish continental shelf. The most common scales are 1:50,000, 1:100 000 and 1:250,000-400,000. Larger scale maps are also produced. Many of the modern maps are also available in digital form, for direct use in GIS software.

An extensive road databank is produced by the Swedish National Road Administration (Vägverket). The data covers road width, carrying capacity, and type of cover.

In Sweden, the laws protecting archeological remnants are very strong. To protect its interests, the National Heritage Board (Riksantikvarieämbetet) is presently engaged in building a vectorized map database, possible to connect to tabular data of different kinds. This is a huge project, with somewhat unclear ambitions in its timetable. The National Land Survey handles the practical aspects of the database management.

Vector data can also be produced from satellite images (remote sensing). By using data from for example the SPIN-2 satellite, vector maps showing building footprints, forestry, land use, infrastructure, hydrography, and digital elevation models (DEM). This data can be imported into GIS or CAD software.

Modern GIS software can directly use CAD data, including properties such as layer names, colors, and blocks with text attributes. The drafting capabilities of the CAD environment can thus be used to produce different types of drawings, maps, site plans, and landscape analyses.

Raster Data

Sources for raster data are aerial photography and remote sensing. Aerial photographs can today be obtained in digital format, corrected for perspective errors (ortho-photo). In Sweden, standard ortho-photos are based on images from 4,600 and 9,200 meters, giving a pixel resolution of 1 meter. Qualities up to pixel size of 0,10 meters are possible to produce.

The image can be used as a passive background in vector presentations, copying the manual method of tracing paper or vellum on top of photographs. It can also be used directly for analysis and presentation. Infrared images are especially suitable for vegetation analysis.

As the resolution of the remote sensing technique rises, its usefulness increases for different kinds of planning activity. The data produced by satellites are renewed at certain intervals, and can thus be used for studying dynamic phenomena such as land use, climatic influence on vegetation, and so on.

In the last decades, remote sensing has evolved from being a predominantly military utility into use in environmental monitoring. The sensing technique has changed from photography to multispectral data mining. Finally, the primary method of collecting data has moved from aircrafts to satellite.[1]

*1. Satellite remote sensing is an evolving technology with the potential for contributing to studies of the human dimensions of global environmental change by making globally comprehensive evaluations of many human actions possible. […]*

*Today, we define satellite remote sensing as the use of satellite-borne sensors to observe, measure, and record the electromagnetic radiation reflected or emitted by the Earth and its environment for subsequent analysis and extraction of information. (CIESIN, 1998)*

Remote sensing has its major use in large-scale environmental issues, and in forestry. However, much of the data produced by satellites can be of use in many kinds of land-use planning. There are today a number of commercially available sources for remote sensing images. Some of the best known are:

Remote Sensing Data Sources

❊ LANDSAT. This is the "classic" earth observation satellite, dating back to 1972. The multispectral scanner instrument provides visible/infrared imagery at 80 m resolution. The "Thematic Mapper", first deployed on LANDSAT 4 in 1982, improves the resolution to 20-30 m.
❊ The French SPOT satellites provide high-resolution visual/infrared imagery. At 10 m (Panchromatic) / 20 m (Multispectral), SPOT imagery offers higher resolution than the major alternative LANDSAT. In addition, SPOT is the leading provider of stereoscopic (3-dimensional) imagery.
❊ KOSMOS. Russian imagery, currently with the highest spatial resolution of any available. The KVR-1000 camera produces imagery at up to 2-meter resolution (panchromatic).
❊ SPIN-2 produces images with the same high resolution of 2 meters (1.56 meter pixel size). The panchromatic digital imagery is ortho-rectified and geo-referenced to very precise accuracy. SPIN-2 imagery can be a cost effective alternative to conventional aerial photography.

From being a strictly military concern, remote sensing has become big business. The Internet has proved to be a perfect channel for distribution of the images. The commercial interest is a clear example of the maturing IT industry. Large manufacturers of hardware and software are becoming content providers – in this case dealing with geographic data. The SPIN-2 images are for instance sold at an Internet site provided by Microsoft, with Compaq as hardware supplier. The commercial jargon is evident from this new kind of data supplier.[1]

*1. The World's Largest Online Database!*

*Have you ever wondered what your neighborhood looked like from space, or wished you could get an aerial shot of your favorite vacation spot? Welcome to Microsoft TerraServer, one of the Web's most engaging sites – providing a bold demonstration of Microsoft's scalability while taking on the ambitious challenge of presenting the earth in a mosaic of photographic imagery. (TerraServer, 1998)*

Tabular Data

Non-graphic data, spatial or non-spatial, constitutes the bulk of information processed in most physical planning. Much of this is captured and stored by governmental and city agencies, or by statistical organizations. Statistics Sweden (Statistiska Centralbyrån) keeps record of e.g. households, incomes, education, employment, properties, agriculture, forestry, and environment. The last field is also covered in more depth by the Swedish Environmental Protection Agency (Naturvårdsverket), which also monitors the use of natural resources. Both of these agencies are active on the Internet, publishing their information through a common web site.

Data Structure

Modern GIS software handles a large variety of data types. This multitude calls for well-prepared methods of storing and displaying data as it is processed.

In the GIS, data is often stored in layers, or themes. One of the most used functions is to make data linkage between the themes, e.g. by the method of polygon overlay, where areas are overlaid each other, and queries are made in order to analyze the effects. The quality of the result of such a process is completely dependent on the quality of the original data. To control this situation, the GIS user must have access to meta data, i.e. data describing the properties of the data itself – origin, quality, owner, date, etc.

Data Exchange

A major problem in geographic data management is the lack of standardized data formats. This has a negative effect on the exchange of data between the parties in the planning process. During the last few years, some progress in international standardization has been made. In ISO, Technical Committee 211 deals with geographic information and geomatics.[2] On the European level, CEN/TC 287 covers a similar field.

*2. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital / electronic form between different users, systems and locations.*

*The work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data. (ISO, 1999)*

Swedish GIS Standardization

In Sweden, this work began in the beginning of the 1980s. The Swedish Association of Local Authorities (Kommunförbundet) produced a code list of geographic entities, known as KF 85. The list is still used for coding data for transfer between different information systems.[1]

The work is today continued within the standardization organization SIS-STG. The STANLI[2] project aims at establishing a foundation of international standards before the year 2001. So far, interim Swedish solutions have been worked out. Apart from a "technical framework" – TK 80 – the work covers property information (TK 81), road and railroad information (TK 126), addresses (TK 130), and technical support systems (TK 133).

1. *The list was e.g. used in the recently published Swedish implementation of the international standard for CAD layering (ISO 13567).*

2. *STANdardisering av LandskapsInformation.*

## Design, Presentation, and Drafting

*It is both the fascination and the difficulty of the practice of architecture that it touches on many different disciplines requiring many different skills. A building is at once an aesthetic and a functional object – a symbol and a shelter – of significance both for its occupants and for society generally. The process of its design and construction is an artistic expression, a social statement, an engineering and management problem, and a business proposition. An architect has to take on roles as a manager, information processor and provider as well as the often-preferred role as a creative designer. Indeed, it is the management of time, resources, and information that makes possible everything else. (Radford and Stevens, 1987, p. 103)*

Architecture is much more than designs of buildings, constructions, and landscapes. The importance of data structure and information processing is rapidly growing for the architectural professions. The more control a party has over the information in a complex process, the greater influence it has. In order not to be treated just as an esthetic expert, architects today need to master computer aided drafting and design, word processing, electronic spreadsheets, database management, business graphics, electronic communications, and information retrieval in databases and on the Internet.

The first decisions to make concern data structure within the office itself. The system of storing, retrieving, and archiving data is perhaps even more important when it is kept in digital format.

Data Types

For a long time, architectural structures were represented in the computer by the use of simple graphics. The computer was used as an electronic drafting device – somewhat hard to learn, but once mastered possessing some major advantages. The most important benefit was perhaps the possibility to connect graphics with information. The first step was to attach non-graphical attributes to the graphic representations. These pieces of information, normally text, could be displayed on the drawings, or extracted into text files or spreadsheets.

The second step was to link graphics to information stored in databases. This was a major improvement. Databases, in use from the early 1970s, can store large amounts of information of virtually any sort. Instead of work-consuming redrawing of the graphical representation, changes can now be made by database management. A wall can be given a new construction, windows can be altered, and door manufacturers switched with a simple "search-and-replace" in a database. Apart from storing component information, an important use for databases is for storing meta-data – document and file information such as name, ownership, status, and relations to other information.

The third step in this development of "intelligent drafting" is product modeling. By using this object-oriented approach, the architect designs by organizing objects instead of drawing lines. All components of the building are stored as virtual objects. Much of the technical specifications – sizes, wall constructions et cetera – can be manipulated by the use of parameters. Manufacturers can supply libraries of objects, ready to install in the virtual building – the product model – that is being constructed. In the ideal project, the completed model is passed from the designers to the contractors. After changes made during the physical construction, the product model is finally delivered to the owner, who uses it for maintenance purposes.

CAD Principles

In Bygghandlingar 90, Del 8[1] (Löwnertz et al, 1996), the following principal types of CAD drawings are defined:

*1. "Construction Documentation 90, Part 8. CAD Presentation"*

❊ Drawing oriented CAD *is a pure copy of the manual method of producing drawings. Every CAD-file includes a drawing sheet and label, and lines and texts that depict the part of the construction that in the chosen scale of presentation fits inside the sheet. Drawing original on paper or vellum is produced by direct printing of the CAD-file.*

❊ Model oriented CAD *means that the construction is depicted in its whole. If the model is divided, this is done reflecting the division of the construction itself, instead of the drawing presentation. The depiction (the model) can consist of* CAD*-files containing graphical information, but also of descriptions and schedules in text and numbers. The models are presented in drawings and in other documents.*

*Three different types of* CAD *models can be defined:*

❊ Planar models *(2-dimensional), which can depict plans, facades or sections*
❊ Volume models *(3-dimensional), which can consist of strings, surfaces or solids*
❊ Product models*, which are object oriented, and where the structure normally is stored in a database instead of in the graphically oriented* CAD*-file.*

Presently, most CAD work in architecture and landscape architecture is produced using two-dimensional model oriented CAD. Some architectural software uses 3-dimensional modeling, but the models are still mostly converted into 2-dimensional plans as construction drawings are to be produced.

Efforts in designing software for product modeling are slowly beginning to reach the market. For these to spread however, agreements must be made on how to define, store, and exchange the product model data.

Data Structure

As CAD work evolves from drawing orientation to modeling, the importance of data structure increases. In a single CAD drawing file, drafted by one person, organization does not matter as long as the printed drawing looks correct. However, if the CAD file is a part of a large project, worked on by a group of people, viewed and referenced by others, the internal structure of the file is of vital importance. In order to make the project participants cooperate efficiently, the structure of the project itself must be agreed upon.

CAD Layering

As for the structure of the CAD file, the most important aspect is layering. The layer concept differs between CAD software brands, but common for all has been the confusion concerning naming conventions. Most companies produced their own scheme, which naturally led to many problems when data was to be exchanged. Application designers tried to provide their customers with automatic layer naming, but this had only a limited impact. Finally, in 1996, an international standard – ISO 13567, part 1-2 – was produced. As application vendors include this standard into their products, the confusion will perhaps diminish. The standard can also be used as an intermediate format when exchanging data between different CAD software.

There are a number of other areas where standardization has not started, or is impractical. The simpler form of assigning information to graphic data by using attributes is one such topic. This data, stored in databases or in text files, often need to be exchanged. Project specific agreements must then be made for the exchange to work. The same applies for project coordinates, necessary for positioning constructions and objects correctly.

If a project is organized as an integrated process, where all parties store data on a central file server, agreements must be made concerning file naming and folder structure. In Bygghandlingar 90, Del 8 (Löwnertz et al, 1996), a suggestion for file naming was presented. The system follows the Swedish Standard for drawing numbering. For CAD model files, the name includes type of model.

Meta Data

The increasing complexity of CAD files and other forms of digital data, and the growing rate of data exchange, show the need for the use of meta data. This "data about data" can show a user all sorts of aspects of the information at hand. In the CAD example, meta data can include project name and number, status, drawing type, scale, producer/owner, date, folder path, and so on. The meta data can be stored in simple text files, or in some database format.

Bygghandlingar 90, Del 8, suggested the use of a text file, and included a number of possible fields of information. The use of meta data in building construction documentation is presently the task of the ISO workgroup that produced the layering standard.[1] To work out an international standard for meta data will probably prove to be an even greater challenge for the group.

*1. I have the pleasure of being secretary of the group (ISO TC10/SC8/WG13). Convenor is Kurt Löwnertz, SWECO.*

Drafting Standards

As noted in Chapter 2, several standardization efforts have been made in the field of drafting. In Sweden, *Bygghandlingar 90 Del 7* was successful in the sense that the powerful Swedish road and railroad authorities agreed to contribute to the work. It is also presently being incorporated into Swedish CAD applications. All landscape architects do however not embrace the drafting recommendations. One objection is that the technical appearance of the drawings badly conveys the more subtle properties of a design. According to this view, if a proposed site is to be beautiful, it must be represented by pretty drawings.

Because of the existence of national drafting manners, international standardization is hard to achieve. When it is, few countries actually follow the recommendations. The current ISO standard in Construction drawings - Landscape drawing practice (ISO 11091, 1994:1) is heavily influenced by the British standard. In spite of this, few landscape architects in Britain are using it.

*There is a very well worked out and comprehensive set of British standards for landscape drawing. But I think you'll find that most British landscape architects don't actually use them. I don't know why that should be really. Maybe, it's got something to do with the fact that landscape architecture historically has never really been constrained into the sort of symbols methodology they should use producing drawings, and that persists now.*

*Most British software which is landscape specific actually will work in British standard mode, if you wanted to. All the layering names would be British standard, the symbols and everything. Most people don't use it. It doesn't seem to be a necessity to use it at the moment. Even when you get involved with other disciplines, you share information, it still isn't necessary. Generally speaking, standards tend to be project specific rather than general standards. In most of the large projects that I've worked on, the project coordinators will tell you what layering system they are using, and you conform with that or whatever. It's an interesting point that. (IS 2)*

The impact of the present ISO standard in Sweden is probably non-existing, except from the parts that were included in Bygghandlingar 90 Del 7.

In this particular area, it seems as if international standard work is slow in market penetration. The role of ISO and CEN standards will perhaps be more positive as the economical bonds in Europe are strengthened. At least for large-scale projects, bidding has to be offered to the whole European market. This will probably lead to increased pressure on architects and others to produce drawings with standardized graphics.

As the use of CAD increases, implementation of standards will be quicker. If software vendors support standards for graphics, layering, metadata and so on, users will be more willing to – or forced into – start using them. This will increase the possibilities for successful communication between the parties involved in projects.

When finally computer-aided construction starts using product modeling, the graphic representations of objects will have to become more standardized. When drafting as such is abandoned in favor of printing the appearance of database objects, new demands will be put on architects as well as the parties working for international agreements on product modeling.

**Standards for Data Exchange**

In order to work efficiently, the exchange of data produced in product modeling requires standardization. Once standards are agreed upon, information generated during the design, construction and maintenance can be used for a variety of purposes.

At present, two systems simultaneously compete and cooperate – STEP and IFC. The first is an acronym for the STandard for the Exchange of Product model data. The advocates of this standard are naturally positive about the effects of using the standard. At the STEP Tools Inc. web site, promises of "faster design times, better communication and longer lasting data" are delivered.[1]

*1. If you develop or manage product data then you cannot afford to ignore the better geometry and version control in STEP. It is being written into a growing number of contracts worldwide because of the scope, flexibility, and quality of its product representation capabilities. (STEP Tools Inc., 1999)*

**STEP**

STEP is a set of ISO standards (ISO 10303) for the exchange of engineering product data. The purpose is to allow data to be used throughout the life-cycle of the product, independent from type of computer system used. Data can be used for file exchange, product databases, and archiving (NIST, 1999)

The standards also contains:

❊ The EXPRESS information modeling language.
❊ An EXPRESS-driven data exchange file specification.
❊ An EXPRESS-driven application programming interface.
❊ A conformance testing framework.
❊ A library of general purpose information models for things like geometry, topology, product identification, dates, times, etc.
❊ Industry-specific application protocols that are built from the library of general models, dealing with drafting, 3D assemblies, automotive design, and many other industry branches.

**IAI**

International standardization is often a slow process, full of compromises. In order to speed up the progress, some major software vendors initiated the IAI (International Alliance of Interoperability). This non-profit organization have members from a variety of parties in building and construction: "architects, engineers, contractors, building owners and facility managers, building project manufacturers, software vendors, information providers, government agencies, research labs and universities with member Chapters in North America, Germany, United Kingdom, France, Singapore, Nordic Countries, and Japan".[1]

With the help of IFC, architects can progress from using just simple office software and primitive CAD into working with "intelligent" components in a complete building product model. The model can be used for a number of purposes – visualizations, plans, elevations, sections, specifications and cost estimates. Once construction is complete, the model is used in the facility management. This way, IAI argues, cost of design will decrease, and fewer errors occur.

*1. Its mission is to integrate the AEC/FM [Architecture – Engineering design – Construction / Facility Management] industry by specifying Industry Foundation Classes (IFC) as a universal language to improve the communication, productivity, delivery time, cost, and quality throughout the design, construction, operation and maintenance life cycle of buildings. The Alliance is committed to taking advantage of the collective power of the industry to produce a standard for communication which will propel it into the future promoting collaborative efforts and global expansion. (IAI, 1998)*

OLE

Yet another attempt to handle complex building objects is an extension of Microsoft's OLE (Object Linking and Embedding). With this technique, data from one Windows-based application can be transferred into another, keeping all of its properties. If an object is activated, the relevant application for manipulating it is automatically started. A group called DMAC (Design & Modeling Application Council) has been formed, aiming to enhance the OLE technique into "OLE for Design and Modeling Applications", and thereby creating "foundation classes" in the Windows environment. (Engvall, 1997)

DXF

The tasks for the standardization groups are formidable, to say the least, and their progress is slow. Even simple 2-dimensional drawing transfer between different CAD systems is difficult today. De facto standards such as DXF (Drawing eXchange Format) have several interpretations, and the CAD systems have intrinsically different system designs.

Proprietary Standards

The market shows a healthy reluctance to accepting the promises of the vendors of object modeling software. Autodesk (AutoCAD) is beginning to market a product called Architectural Desktop, and Bentley Systems (Microstation) their Enterprise Engineering Modeling system (EEM). They are equally confident of the future of these products. Keith Bentley, CEO of Bentley Systems, stated the following in an interview by Martyn Day.[2]

*2. While CAD systems of today have proven invaluable versus manual drafting techniques, their ability to truly influence enterprise productivity has been limited when the information on which they operate is a series of disjoint documents which, taken together, can be potentially redundant and potentially inconsistent. I maintain that a true EEM system can have a tenfold greater return on investment than we've achieved to date. (CADdesk Magazine, 1998)*

Product Modeling

Probably, this kind of vision will continue to be slow in its fulfillment. 2-dimensional construction documentation is a fast, simple, and efficient method for graphic communication. The traditions in building and construction are based on this kind of data exchange, and the patterns of roles and responsibilities will be hard to change.

Product modeling has today a number of disadvantages. Some of them will in time vanish; some will be harder to overcome. The list below shows some of the peculiarities of the building and construction process of today, and the effects on the introduction of product modeling (partly based on Sanders, 1996):

❊ Construction drawings are highly schematic. Many of the actual decisions are made on the construction site. This is often efficient and appropriate.
❊ The traditional process distributes responsibilities and risks among the parties. If the architect was to complete a product model in all (or most) of its details, this balance would shift radically. The calls for a change in the relationships between the parties before any changes can be made in the information flow and data exchange. There will be strong feelings and heavy economical arguments involved in such a change.
❊ Most buildings and sites are prototypes, produced only once. This decreases the advantages of product modeling, such as it is used in for example the automotive industry.
❊ The documentation phase is often a very important part of the design process. Many problems are solved as they are drafted. Assembling a product model from pre-defined components cannot easily substitute this way of solving the design tasks.
❊ Although 3-dimensional studies are important, the 2-dimensional abstraction remains a direct, fast, simple, and efficient way of investigating spatial problems.
❊ Buildings and sites have a vast number of components. Many of these, especially in site design, are complex and irregular, and thus hard to define in a product model.

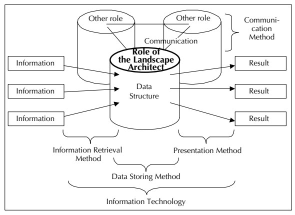
As often, the solution to these obstacles will probably consist of a compromise. The evolution from 2-dimensional drafting to 3-dimensional product modeling will continue to be slow and uneven. In many cases, the former will for a long time remain the most efficient work method. Small projects and small architectural offices will have difficulties in applying model orientation. The problems are also greater in landscape design and planning, where standardized objects are much harder to define, and the geometry usually is very complicated.

In complex and large building projects, the pressure on the parties to rationalize the data exchange will be greater. Product modeling will increase in this market, using standardized methods of defining the components used. Data produced in design will be used in all phases of life of these buildings, but the road is long and winding.

*Unfortunately, parts of Autodesk's white paper vision for its object-oriented Industry Foundation classes sound suspiciously like the literal three-dimensional building model pipe dream. As long as the A/E/C Interoperability Association focuses on simple and practical object-oriented languages and tools, the standards defined by the Association may significantly help architects, engineers, contractors, and clients to easily share information with each other in formats supported by multiple software developers. Otherwise, the Association's efforts will likely experience the same fate as dozens of other literal three-dimensional building model software prototypes over the past two decades, and fail to materialize within useful tools. (Sanders, 1996, p. 112)*

Taking the full step into product modeling is probably still far away. The effects it will have on work methods and role are hard to imagine, even for an experienced landscape architect.

# ROLE




The landscape architect profession has over time broadened its scope of tasks. Today, it is possible to find trained landscape architects in such diverse roles as garden and park designer; municipal, regional or national planner; parks and facility manager; environmental impact expert. This part tries to shed some light over the influence of tools and methods on this diversification of roles.

## Physical Planning

Physical planning covers a vast field, with different scales and complexities – environmental assessment studies for different types of subjects, land-use planning and resource management, recreation planning and management, urban policies, pollution control, restoration et cetera. The role of the landscape architect also varies greatly, from being a project manager to acting as a consultant for certain aspects in a project group. The borders between planning and management are also very hard to define, since landscape issues are dynamic to their nature.[1]

As a result of the varying circumstances, the documents produced by the planners must be easy to understand for the layman, for different parties to discuss, and to adjust to the will of the policymakers. Ideally, the planning documents can also easily be transformed into guidelines for future changes, and thus seamlessly become management tools.

GIS Use

As mentioned earlier, many experts hope that the use of GIS will change and strengthen the role of the planner. Aided by the calculating power of the computer, larger sets of data can be handled. It will be possible for the planner to investigate more alternatives; consider more variables; take into account more criteria; respond faster to new demands. According to Julius Fabos, this will make it easier for the public to engage in the planning process. The planner can demonstrate the effects of a large number of alternative ideas and interests – from political parties, other city officials and from the public.[2]

Ten years later, the tone has not changed much. Dutch planner Rik Eweg finds many advantages of using digital tools such as GIS and knowledge systems in planning. For one thing, since data must be entered into the system, the work of the planner is easier

*1. Management, rather than planning, is increasingly being emphasized, to focus and co-ordinate the actions of landowners, resource developers and statutory authorities. (Filor, 1991, p. 17)*

*2. In short, this emerging form of landscape planning may lead the way for planners to become more than ever a catalyst for learning and action in local land-use planning. Perhaps these developments will also make planning more democratic. (Fabos, 1985, p. 171-172)* for an outsider to monitor.[1] This can lead to a creative discussion concerning the planning process itself – the data used, and the organizational circumstances.

As a positive side effect, this openness, or transparency ("glasnost") will force the planning organizations to focus on the process itself, and how the work is organized. Since the users are part of the GIS, the system in which the users are active must be organized in a conscious way for the digital planning process to work efficiently. (Eweg, 1994)

*1. Because GIS obliges the user to work systematically and explicitly, the planning process becomes transparent, in contrast to the "black box" it often is at present. (Eweg, 1994, p. 157)*

The use of GIS is thus expected to make the planning process not only deeper and wider, but also faster, more open, and easier to understand. It can also affect the role of the planner. Land-use planners must learn to master the new tools, or else be sidestepped and watch other disciplines take their part.

According to Fabos, the planner who accepts the challenge will be richly rewarded, becoming an indespensable part of society.[2] That is truly a tall order for the landscape architect! By mastering the technology, the role will become as important as the "great leaders" of society! This calls not only for wisdom and judgment, but also for a truly democratic and open approach to politicians and to the public, and for superior communicative skills.

*2. The visionary planner may also return, not as a form giver to large urban areas, but instead to influence decisions the way that successful political leaders or intellectuals with great charisma and wisdom do. (Fabos, 1985, p. 206-207)*

Few landscape architects would probably accept this bombastic description of the task of the planner. However, if the tools indeed help in giving the public insight and influence, then the role of the planner would be more appreciated, and also more personally rewarding.

## Design, Presentation and Drafting

Using computer-aided tools for design, presentation, and drafting clearly affects the daily work of the landscape architect, in the way any technique would. True computer proficiency can also change the very tasks undertaken, and thereby the role in different kinds of projects. Again, this has little to do with the fact that the tools are digital. In probably all organizations, special assignments are given the person who is most skilled in the area. For presentations, the "artist" in the group will paint most watercolor perspectives. The best engineer will write the instructions for solving difficult technical problems. For drafting, the junior architect is most likely to be assigned.

## Sketching and Drafting

In the computerized office, CAD skills will often make some of the employees to do most of the drafting. There are a number of risks with this policy. The designer who always stops when the sketches are completed, will loose the important feedback given when the solutions have to be fitted into the exact environment of the CAD file. The opposite applies for the CAD-oriented architect, who stands the risk of reducing the ability to make quick and creative sketches when trying to solve a problem. The CAD environment is well suited for many spatial investigations, but often the necessity to define exact dimensions can hinder the intuitive thinking in images, which is the hallmark of the architect.

The natural solution to this problem is that all the landscape architects acquire sufficient CAD skills. The mixing of tools can for many be a stimulus – the renowned designer knows how to express ideas in a construction drawing, and the CAD specialist gets the chance to drop the mouse or digitizer in favor of a soft pencil.

The introduction of CAD (or in this case, CADD might be the more suited abbreviation) has resulted in a workload shift for many architects. As CAD facilitates the use of archived solutions to certain problems, and the need for re-drafting between the phases of the design process, more work can be done in the early stages. Especially the drafting part is increased in schematic design and in design development, and by roughly the same amount decreased as the construction documents are produced (Figure 8).

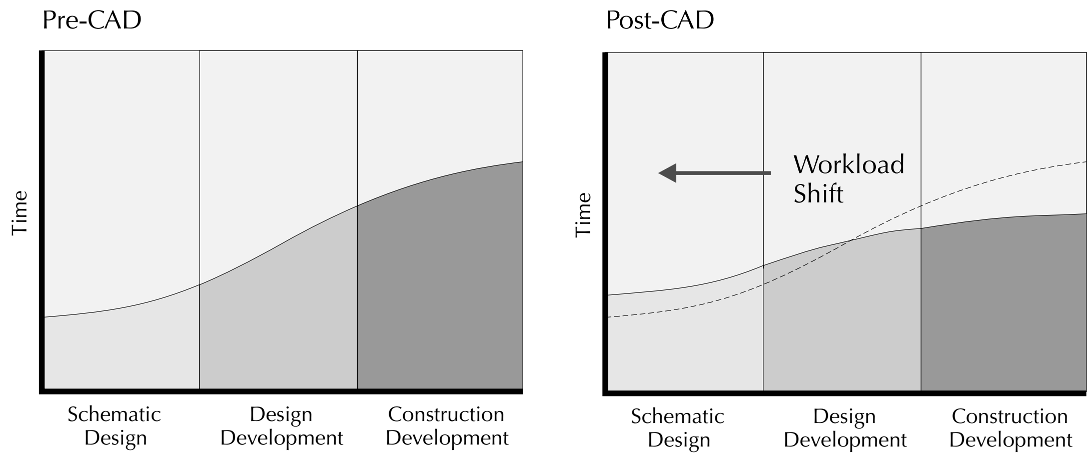



*Figure 8. CAD workload shift. From Sanders, 1996, p. 377*

However, it is highly doubtful whether this transfer of work time from documentation to design actually increases the time spent in the early stages. A more common effect is that the total amount of

1. *Fees that support more design time are negotiated by firms who design well, not by firms who document efficiently. (Sanders, 1996, p. 382)*

time is reduced, as the architect is expected to increase his productivity by using computer tools. In order to be paid for more design time, the design itself – not the tools – must be made the issue.[1]

This confirms well with my own experience. When CAD was introduced at the office where I worked, clients gladly paid extra for the time spent doing CAD work. As everybody grew accustomed to the technology, and the computer actually started to raise the efficiency, total budgets were cut. The company's proficiency in CAD was used for marketing purposes, but also as an argument for the clients to keep the fees down.

Visualization

Naturally, the fascination for the computer tools can for some landscape architects become a factor that gives them specialized roles in projects. For example, the skills needed to produce 3-dimensional images still require relatively long and regular practice. The "rendering artist" can contribute by helping others to visualize ideas.

Not all architects have a talent for producing vivid manual pictures for design presentations. Computer-aided methods can compensate for this, and give the architect the power of using good-looking and convincing images, publications, texts, and other means of communication. Presentation skills lead to a higher degree of self-assuredness, hereby strengthening the architect's professional role.

The use of computer-generated images can strengthen the credibility of the presentation made by the landscape architect. The first amazement of the mere possibility that highly realistic images can be produced seem so have simmered down. The images can instead make the work of the architect highly influential.

*We're in a very interesting stage as a design company at the moment. I can actually show pretty much what a scheme will look like [...]. Sometimes I'm drafting in a way because I have no influence over the design of the architect's building. But we do the architect's building. The buildings are sometimes very ugly.*

*Now, I've produced this image, and I would like the client to say 'Oh, I don't like the look of that building! Let's change it!' Then I think I've got into design. But what actually happens is that they go off to public enquiry, and then everyone doesn't like the design of the building, and it actually gets thrown out of the enquiry at that stage. It's just happened in all those projects. And then they'll revisit it, they'll produce a different building, probably a different architect will produce a different building, and they will go back to the process, and eventually it will get accepted.*

*I would like to sort all those problems out, before it goes to public enquiry. I'd like to use the computer to produce the most realistic model of the building, and then we'd all sit around a table and agree whether we like the building or not, but that doesn't seem to happen. It just seems… you try to get it built, if it fails, you go back to the drawing board. […]*

*[Y]ou should use the computer, in my opinion, to weed out bad ideas and bad designs, before you file an application. But often, I feel that clients are, I don't know… they aren't willing. Once the ball starts rolling, they aren't willing to change direction. Occasionally […] the rich client will walk in and say '—That's crap, that's rubbish, I don't want that, let's start again'. But a local property developer, tight budgets, whatever, it's almost like they put their heads in the sand, and say '—Hope it goes through'. And sometimes it does, and sometimes it doesn't. (*IS *3)*

Personally, my computer skills has on several occasions helped me prove my point. When cooperating with building architects, I could easily show the effects of different layout schemes for residential areas by making simple 3-dimensional models. Thereby I managed to enter a field where many architects feel they have superior knowledge.

The landscape architects that have specialized in the use of computer tools face the risk of being caught more or less permanently in that role. As a specialist in visualization, for example, you can loose touch with the design aspects of the profession.

*One comment about photomontage, when we're doing public enquiry work, is that you're trying to show that there isn't an impact. And so, you have the building, as appeared here [*IS *3 shows an image], and there's another type here, different kind of housing, but visually, they're not very interesting. Public enquiry work is bread and butter work, it makes a lot of money, but it's very boring, as far as I am concerned. Get me back to design! (*IS *3)*

When you are called in to perform specific parts of the project in this manner, the degree of freedom obviously gets smaller. Specialization will probably increase as the technical development moves on. The generalist landscape architect will perhaps have problems in selling his or her skills on a more competitive market.

*It's a wonderful profession, we go outside, we get to build, we're the Jack-of-all-trades. But, I don't think that serves the client always best. It serves you personally best, but the client wants a good product, which requires only a few skills.*

*We're already doing it here, we have teams who are specialized in hotels and resorts. They won't be involved in environmental assessment, because their skill base isn't right.*

*One of the directors was doing a talk the other week, about knowing your team, to make it a winning sort of squad. For example, you wouldn't put Ronaldo in the goal! So, you would probably have a CAD specialist, and if it's a landscape architect, that's a bonus, in the team. You would probably have a director who is good at client liaison, and doing the fees. So you mix the team together. I think specialization, you just can't avoid it. Especially on the IT side, which change in every three months. I know, and I'm sure you do, my head is full of software that I'm never going to use again. DOS, what's that? Now it's Java, and Visual Basic, and that will be dead probably in 5-10 years. You can't avoid specialization. (IS 3)*

On the personal level, specialization in IT has both good and bad sides. It is however obvious that IT skills are attractive on the market. In practically every employment opportunity advertised today, knowledge of CAD and GIS are assumed. Computer skills can even be the key to entering other careers.

*If this office closed down, I would be one of the few people that would get a new job tomorrow, on a bigger salary, but it won't be in landscape architecture. Whereas a lot of these landscape architects here would have to start their own business, and try make ends meet. (IS 3)*

But then again, the interviewees are highly interested and motivated computer users. In that sense, they are far from typical. Far more common is a cautious attitude.[1] This hesitation is most interesting – in fact, it is the reason this report was written, and also the reason why I hope to continue the investigation.

*1. Why landscape architects have been hesitant in exploring these technologies is a reflection of the conservatism of the profession. Certainly most would agree the barrier to these tools is more cultural than technological. (Sawyer, 1998)*

Product Modeling

An increased use of product modeling would shift the balance in the construction business. Today, with the often highly schematic drawings produced by the designer, many decisions are in fact made at the building site. If the design process was to result in a (more or less) complete computer model of the proposed project, then more responsibility would lie at the designer. Controversial as it may be, this would strengthen the role of the architect.

*Otherwise, when you've done it, really defined everything, then the contractor wouldn't have much to argue with. You could really say that. If it works in the computer, then it works in reality. All estimations are correct, to the last cubic* *centimeter. […] That may be the salvation for the consultant, really. Presently, the consultant is squeezed hard from all sides. No fun at all.* (IS 1)

There is of course much to say about a statement like this. Even if it would raise the level of influence for the architect, it would to the same degree increase the risks involved. The inevitable errors that occur during construction would more likely be blamed on the designer.

*I think more work will be needed. You have to define everything all the time. You really don't have to do that today, you don't need to… certain things you don't have to worry about, in a sense. Then you suddenly will have to define everything. You can't leave anything out because it's implicit how it should be done. That might make it more difficult. At least initially, it will. Then again, it might simplify the process in the long run. You will have to put much more data into the system.* (IS 1)

## Marketing

The landscape architects appear by tradition to be a rather shy and unobtrusive profession. Boasting about their skills and products – plans, designs, and presentations – seems to be awkward for most professionals as well as students.

There are of course exceptions to this rule. Some landscape architect practices are increasingly aware of the broadening of the professional field. They don't necessarily need to acquire the skills in-house – by clever marketing, and use of free-lance expert, they can take on new types of tasks.

*I think marketing is a large part of it. Marketing is becoming a very important… some practices can get work that they're really not suited to (laugh), or even capable of producing, on the basis of good marketing. You know, a lot of practices now work on that basis, they actually have a very small core of full-time people, and they will go for all sorts of projects, and they will employ free-lance people to suit their current workload.*

*Q: People like yourself?*

*A: Yeah, exactly. So, any landscape practice can say 'We can do photomontages', and the next day I will get a phone call saying, 'can you come and help us?' It's nice for me, but it's kind of indicative of the way private practice is going at the moment.*

*Q: How is this marketing being done?*

*A: I think it's just… I don't think the techniques have changed really, it's just that people are getting more skilled at it. They're getting more skilled at presenting themselves, they have a basic understanding of the technologies involved and required, and they are able to speak reasonably knowledgeable about it, although they are not capable of doing it themselves. It's to do with making your client confident in your abilities, and I think that's the main thing.*

*Q: Are landscape architects taking these offensive roles? Showing of, so to speak, '— I can do anything! We know the technology?'*

*A: I don't think it comes easily to most landscape architects. Some practices do, and are renowned for it. […] A lot of the work they do are won largely on the basis of what they say about themselves. I think they're the exception rather than the rule. […] I don't know, you can characterize landscape architects as being fairly unassuming. I think they find it difficult to shout about they work that they do. I think generally, the profession suffers because of that. It's unfortunate, but I think that's the case. (IS 2)*

Some of the blame for this surely lies in the education environment, where the presentations too seldom are required to reach professional levels. This pattern is often repeated in landscape practices.

*That's why I think, you know, in the landscape courses, students need to be taught how to talk to an audience, how to present their work to an audience. And that's why I think some of the packages like PowerPoint can really help, enable the students to structure their thoughts and ideas, help with the presentation. The classic student presentation is the work goes up on the wall, have no time to think of what to they're going to say, or how they're going to say it, because the hours are up before they're going up, and then in front of an audience, kind of blinking in the light, and just kind of gargle… […] Students are generally allowed to get away with being a little to shy about their work. (IS 2)*

There are of course exceptions to this rule – practices that thrive because of their ability to market their skills, even for acquiring high-status assignments. Proficiency in the use of IT can play an important role in this marketing, although its role can be hard to appreciate even for the directors of a company.

*[W]e make sure that […] people get the message, we have technology. Clients come to us partly because they know we have the same resources as them. The British Airport Authority insists that we e-mail timesheets to them every week. They know we have the technology to do that. Smaller firms might not.*

*It's a difficult one. Some of the directors here aren't really computer literate, and so they sell landscape architecture. But when it comes down to actually doing the job, I sometimes find the directors saying to me: 'Oh, we don't need to use computers', and I say to them 'How did you get those drawings that you're looking at at the moment?', and they've just been e-mailed to the director, but he didn't see that as using computers. And then it's just been plotted, and he didn't see that as using computers. I don't have a problem, in a way, with them not recognizing the computer, because the computer is a tool, it's a means to an end. And so I don't have a problem, until they really don't see that the computer is playing a big and important part in their lives. I don't think they recognize that. In terms of our profile, within our organization, the IT is very important. (IS 3)*

The landscape architect that specializes in the use of IT must thus aim the marketing not only towards clients, but equally important within the own organization.

*I was really kind of fortunate, I had a different skill base from [my predecessor], he concentrated on AutoCAD, and I came from visualization, doing 3D work, Corel… well, visualization and graphics. I knew Photoshop, I knew Corel Draw, I knew a few other packages that [he] hadn't come across. So I managed to make a good impact straight away. We won [a large] project, and it was a 100,000 pounds worth of fee, for that one project, on photomontages. And I basically bought a scanner for 700 pounds and Photoshop for 50 pounds, and suddenly… People here had always said that computers just cost money. Now they could see there was an advantage, there was a market for computer work.*

*It wasn't competing with the drawing board, which had happened in the past. It was moving into a new area, doing 3D work, which could be verified, which was scientifically based, which could go to public inquiry. And then there was the graphic side of it as well. Color plotters arriving at the market, and things like that. That was my initial step into [the company]. (IS 3)*

## Corporate IT Strategy

For many practices it has become a necessity to engage themselves in using digital tools.

*[A] few of the larger practices got into [using computer tools] quite early off, but largely as a result of larger resources. I mean, they have plenty of cash to invest, and they saw it as a way of staying ahead of the field. A lot of smaller practices steered away from CAD for a long time, principally for the cost of it.*

*But what's happened during the last two to three years is that the use of CAD is now a prerequisite for being involved with many projects. If you don't have*

*CAD , you're not invited to be part of the project. And so, it's now a must really, there is no choice left anymore in landscape architecture. There used to be a choice, now there is no choice. You have to do it, otherwise you don't get the work. It's as simple as that. (IS 2)*

Whether forced or not, most landscape architects need to make a conscious decision concerning the use of computer tools. Writing down an IT strategy can be an efficient way of reaching a corporate attitude in these issues. In this process, personal prejudices must be overcome – regardless of the level of ambition that is put into the strategy document.

*I don't think computer drawings intrinsically have any greater value than any other medium. As a designer, or as a communicator, computers are just another, a different medium. You use the medium to transfer your thoughts into a communicable medium. Whichever you feel most comfortable with, whether it's manual drafting or it's computer drafting. That's my view, as somebody who uses computers and knows how they work. I suspect there are still some people who may have a bias both for and against computers. In landscape, there has always traditionally been a bias against computers. Basically, because of the perceived quality of the drawings which are produced. (IS 2)*

Even practices that don't profile themselves as expert IT users can benefit from using computer support in a well thought-out fashion. The IT strategy can be a simple document, stating the structure of data storage, backup, and reuse; which software to use for different purposes; means of communication etc. For high-profile practices, the strategy can be rather complex. The range of appropriate software is increasing rapidly. Computer support can be used for a large number of tasks.

*The strategy at the moment, is bringing them all together, in this office. I think five years ago, you had AutoCAD in a corner, and then you had your secretary in one corner, doing Word or WordPerfect, generally. The two never met. No network. These days, it's grown more; you've got to communicate with each other internally, on the network. […] Then you've got to deal with the outside world, and then you've got the Internet. You've got Wide Area Networks, virtually private networks, where you deal with clients, and sort of send things on to a billboard. (IS 3)*

This broad approach to IT use needs substantial financial base. Working in a large office, IS 3 has managed to expand the use of computer-aided tools.

*We were definitely one of the first, and the scale of the projects, as you can see, that's where we got a big influence. Where some people would do individual photos, we'd do 120 photos. It's a different kind of scale, we need more resources.*

*A lot of landscape architects will have a machine in a corner, there'll be one machine, and they'd say 'We do AutoCAD and we do visualization, we do ground modeling', and they'd probably do, but not all at the same time, whereas I can walk you around in the office here, and there'll be ten machines, the first machine doing Photoshop, and that person is doing AutoCAD , and you can swap the people around now, and they've all got a diverse skill base. (IS 3)*

## Client Expectations

The need to keep in touch with reality can be helped by considering the use of technology from the clients' point of view. Often then, the need for introducing state-of-the-art visualization software lies well down on the priority list. Clients are seldom critical to the architect's creativity and ability to convey design ideas. More probably, the client is interested in the architects' skill in gathering information and opinions, and in keeping the project within budget.

Therefore, the best investment might be in better communication systems, in dynamic archiving, and in document flow software. The advanced course in 3DStudio should perhaps be replaced by project management and vocal communication.

In some areas however, client demands dictate the tools and methods to be used, and the quality of the work.

*[Environmental assessment studies] are becoming more and more advanced, the demands are getting higher. The first I did were quite easy. The demands are higher, you have to get expert opinions and so on.*

*Q: The clients have become more skilled then?*

*A: Well, no, it's the county administration [Länsstyrelsen]; they are raising the demands, I think. As they see what people are doing, they kind of think that if one can do something, then everyone can. […]*

*Q: So at first, they were pleased there was something for them to see?*

*A: Yes, right. It felt as if they thought it was great that someone did anything at all. [Laugh] (IS 1)*

Photo Manipulation

Photo manipulation is a technique that has been commonly recognized as a powerful technique.

*What's driven it really is client expectations. And I think its' contribute is quite high. A lot of smaller landscape practices are being asked to produce what is technically beyond them. I think with photomontage specifically it's a very fashionable thing to want. Every project: 'Oh we must have photomontages'.*

*Q: Says the client?*

*A: The client, yes. Because they know it's doable, and also they know that in terms of visual evidence it's a very persuasive tool, and so it's used more and more widely. And I think part of the reason is it's now doable at a reasonable cost. The software needed to produce good quality photomontages is now, you know, a few thousand pounds. If you put AutoCAD , or even a cheaper CAD package, together with Photoshop, then you really have most of the tools you need to do the job properly. [Many projects] will go to public inquiry. That kind of material is practically a de facto standard for that kind of project. A public inquiry, with photomontages showing how the scheme will look like when it's completed. (IS 2)*

As mentioned, the use of CAD in design projects is a very common requirement. Sometimes clients also demand delivery in digital format. As for CAD drawings, AutoCAD DWG is almost a de facto standard, although in some cases Microstation DGN is used as a basis in project communication. If a practice has invested in the "wrong" system, these demands can be quite awkward to handle. Import and export functions between competing CAD systems and versions can be time-consuming, and result in loss in data or data quality. CAD Use

The client expectations of digital delivery can be more or less based on actual needs and knowledge.

*Well, it's often the case that you're supposed to deliver a digital file. Now, most of the time the clients don't know what they are talking about. They kind of simply write that everything is to be delivered digitally, and you deliver it as PageMaker-files, and they haven't got a clue what that is. They think if they say 'digital' they will get Word-documents. It feels a bit like that. Excel too, if it's supposed to be advanced! [Laugh] (IS 1)*

Handling client expectations has of course always been an important part of the designer's methodology. Choosing the right medium to communicate is one consideration to make. Photo realistic presentation is not always the ideal to strive for. Presentation images must be adapted to the audience.

*I think certainly, in a situation where [...] you're producing materiel for public presentation, photomontages have been very well received. I think that, probably for the wrong reasons.*

*I think that it's generally perceived that, you know, if you produce a sketch, then it's possibly to fudge the issue and make it look better than it really is going to be. Roses in the corner, you know, or whatever. If you produce a photomontage, it's more realistic. What probably most people maybe don't realize, or are fooled into thinking, that you can be just as devious by using photomontages as you can with any other medium. Given that you want to show the proposal to its best effect, or to its worst effect, depending or which side of the argument you're on.*

*Largely, that's a case of public education. That's an ongoing thing. Computer drawings, ten years ago, were 'correct' just because they were made on a computer. Well, everybody knows now that computer drawings are only as good as the work that goes into producing them. (IS 2)*

## Management and Maintenance

Managing the already built is an increasingly important task for landscape architects. Apart from being a rewarding field in itself, the possibility to continue the design process as a site matures after construction gives important feedback into future work. As no other designer, the landscape architect is depending and relying on the element of time.[1]

As time changes both the man-made and the natural environment, design and maintenance thus becomes an integrated and continuing management function.

In this study, no landscape architects active in this area have been interviewed. The issue of the dynamics of the professional role for managers will have to wait for the planned next phase.

*1. Indeed, for many landscape architects it is through an unraveling of the dynamic natural and human processes which have shaped, and will continue to shape, the site, that they define and solve the design problems. For them, the restoration of damaged land, polluted water or an unhealthy build environment provides the spark, the driving motivation for their design concept and solution. (Filor, 1991, p. 9)*

## Personal Attitudes

Successful use of computers in planning, design, presentation, and management requires not only powerful and flexible hardware and software. The attitude of the user is of vital importance to the result. One of the interviewees, working in a large practice renowned for its IT skills, was asked if the proficiency of the staff was the result of a company educational strategy.

*No, I actually put it down to the person. Everyone can make excuses. I mean, I've had the same problems as anyone else, getting hold of computers at college, I wasn't the best, or the first, I just sort of worked hard, I did late nights. You'll see, well, maybe I was stupid, but I worked until two or three in the morning, four in the morning sometimes, to get something out. […]*

*I'm probably being very hard on people, but I've always found it very frustrating, there's always opportunity in CAD, and people don't seem to want to grab it. They are doing it now, for being fair, I'd say, in the last 12 months, 2 years, more and more people are getting involved with computers, but initially, it was really down to the individual person.*

*It's not to do with education. You could say it's partly to do with education, but if you have an interest in something, you find a way around it. I just saw the computers are the future. If I looked five or ten years ahead, in say 1990, there was only one way things were going to go, and that's why I got involved with it. (IS 3)*

This sort of strategic choice can of course be more or less based on calculation and reasoning. Some people actually enjoy the computer as a tool, and thereby acquire a high level of skill. It must be fun to work!

*Q: But how come you work this way then, and not more manually?*

*A: Because I think it's fun! That's my only motivation, to have as much fun as possible at work! [Laugh] (IS 1)*

This light-headed attitude could easily be interpreted as reckless or unprofessional. It could also be considered wise, in the sense that efforts made during inspiring circumstances are more likely to produce good results. Having seen some of the work produced by the interviewee, I support the latter interpretation.

Keeping Up to Date

Even the interviewees, with their special interest in IT, found it problematic to keep up to date with the technological progress. It takes time to learn new computer software, or to improve in the ones already in use. Tight time schedules often restrict the learning process to the minimum required to produce what is expected.

In one respect, the fact that many practices are small is a problem for the landscape architect profession as a whole. Time spent in learning lessens the inflow of cash, and for a small landscape architects business, this can be a short-term problem. Raising the IT skill level in the profession becomes harder. As a teacher, I have seen examples of students immediately becoming "IT gurus" in small offices, and expected to start using a computer which has been sadly under-used since the investment was made.

If the skill level as a whole is rather low, software developers have few incitements to improve their products.

*I think that the attitude that the software should come to the landscape architect is sadly very wrong. The contrary in actual fact is probably true, because landscape architecture is such a small profession, as far as software companies are concerned, it's a very small market sector, so it actually requires very little attention. […] So I think that landscape architects, rather than waiting for the right product to come along for them, actually have to buckle down and make do with what is available, because it's not going to happen like that. […]*

*Q: Perhaps it's also an effect of the width of our profession. We're supposed to be oriented in almost everything, which means we can't be fanatic about anything?*

*A: Absolutely, yes! Landscape architecture is probably one of the most wide-ranging professions. It is very difficult for people to become good at more than a kind of niche area of the work they get involved with. Many landscape architects see IT as just another thing they have to get to grips with, and can really do without. That's a reasonable attitude I think, for a lot of people, who are already under pressure from one end in the planning work right down to very fine detail planting design. A vast range of not just skills, but scales, and conceptual frameworks within which to work. For landscape architects to do a good job of that, of going through the whole gamut[1] of environmental scales and sciences, which perhaps makes them reluctant to take on more. (IS 2)*

1. *Range, extent.*

If these obstacles are overcome, the work at the computer can, at least for some, in itself be rewarding. The fascination for the possibilities given by modern software is evident among most of the students in my IT courses. Even experienced users can get a thrill out of the result, especially when working with 3D visualization.

*Yes, I think it's fun, especially when you're faced with a problem. It's only when problems occur that it's fun, really, but that's the same with every task, it's no fun when it's routine. But I'm still fascinated by the fact that something does happen – you've been building something in AutoCAD and it doesn't look like anything, and then you transfer it [to 3DStudio], and Wow! I still get that feeling, that it's really cool! (IS 1)*

However, the majority of landscape architects have neither the interest, nor the prerequisites to become expert computer users. All of the three interviewees are "computer wizards", but yet interested in the issue of the problems facing less skilled user was discussed. The teacher in the group has often noticed the difference in ability among the students.

*I think it's a natural thing. There are different skills and capabilities, not just because of their educational background, but intrinsic to them. Some students find it easy to get the grips with, and some students don't. Probably, most years, average class size is 20-30. Each year there may be two students who find it very difficult. So it's actually, as a proportion to the whole, relatively low. But those students who struggle, they do struggle, they find it very hard. (IS 2)*

Computer software must "by nature" follow a strict logic. No matter how much time a person spends on training, some will not feel comfortable and familiar with this logic. IS 2 finds it "a fact of life" that some of the students never reach this level of conceptual understanding.

*There seems to be some kind of deep-seated logic within people's minds, which either enables them to comprehend immediately what's going on, or not. It's more than just teaching, it's something more fundamental in the individual involved. (IS 2)*

The same pattern is found among people already in business. However, IS 2 finds their motivation generally higher than that of the students – companies feel a pressure to use certain techniques, and are therefore highly motivated to acquire the skills needed.

The difficulties that many have getting comfortable with the computer will for some feel as a threat to their professional career – for others result in a comforting support from more technically oriented members of staff. Larger companies will have a mixed staff of architects and computer technicians, where hopefully everyone will find the tasks and tools they prefer. Many landscape architects want to concentrate on the design aspects, and care less for the technical aspects – especially CAD.

*They don't jell to well with the computers, because they want to go on site, you know. There's a lot of investment in the computer, so I now find I employ an equal number of pure CAD technicians, who want to know everything about the software, and they've worked with landscape architecture long enough to know what the landscape architect is after.*

*I don't know if there's another solution, because the software is always changing every three months, and the people I can rely on to know the software aren't landscape architects. People that I can rely on to get the most out of the software aren't landscape architects. The people in this business will work all night on the latest software, landscape architects will work on a design all night, but they* *won't… Well, computers are changing so quickly, they find it very difficult to keep up to speed, getting the best drawings out of the computer. So I have to use a balance between the two.*

*[…] The landscape architect's a chief, but you can't have too many chiefs, you've got to have Indians as well. And you might find that you've got more CAD Indians than chiefs. At the end of the day, the client gets a delivery. There's always this pyramid structure, the Indians are producing the deliveries, and they're not landscape architects. I mean, you're going to need more of those people than you are of the guy making the decision. (IS 3)*

Other companies prefer to have architects and landscape architects do the CAD work as well. In this case, the risk is obvious that some people will get stuck behind the computer. As architect Gunnar Gustafsson puts it: "beware of the CAD swamp!"[1]

According to Gustafsson, this division of labor must end. Every architect must master the tools of the time. It is a betrayal by the older generation if they leave the architecture in the hands of the young and un-experienced for the simple reason that the young can handle the computers.

*1. The CAD-knowledgeable drafts and the non-CAD-knowledgeable runs on meetings and administers. Since it, for some reason, is thought higher of running on meetings and desperately trying to administer projects, this folder carrier is rewarded with higher salary than the architect who, stupidly enough, learnt CAD and is productive. (Gustafsson, 1999)*

But then again, IT in landscape architecture is more than drafting with CAD software.

*Oh, software is going to achieve so much more for landscape architects! Whether they can do it on their own, I doubt. If you take GIS for example, you can take a whole county, and analyze it, and the landscape architect would love that ability. But he's going to get all that information together, package it in the right way, before he can do any analysis. And it might be beyond the landscape architect to do the ground preparation. As land values go up, things become more sensitive. And clients will be willing to pay more to get it built.*

*I think the software will develop further, and the landscape architect will just have great fun with some of the things you can do. I mean, right now, one of the guys downstairs is doing sunshade diagrams on a 3D model. We're looking at summer and winter, you know, spring… what the shade will be at a specific time on a specific day. Which is, it's all good fun, and landscape architects never used to do that. (IS 3)*

Office managers as well as teachers must understand and deal with these deeply personal aspects of computing. IT strategies must consider the great differences in skill level, interest, and capabilities of everyone involved.

Increased specialization will most certainly result in landscape architects engaging in practices with specific IT profiles. Some of them will be able to act as free agents on the market; other will be incorporated into larger companies. All three of the interviewees are much used as "visualizers", producing images to present schemes designed by other architects. With growing experience, this role can be highly influential and rewarding.

*Q: Do you think […] that you will hire someone who specializes in say 3D visualization in GIS, if you don't have that skill yourselves?*

*A: We would probably buy the company! [Laugh] We've had these discussions recently, there's a few visualization companies out there, but they're not big companies, they only employ 12 people. We could actually go in and probably buy them. That's been an option, but the problem is, if we were to… or maybe make a partnership with them, it's a serious thought, we might do that. But I think, at the moment, we've got people in house, and if we were to bring in somebody else, they would get very upset. It's a fine balance. So we'll just play it by ear, and see what happens. But if there's a technology that we lag behind in, or an area in landscape we lag behind in, then, like EDAW[1], we would buy somebody. There's nothing new about headhunting! (IS 3)*

*1. A large U.S. consultant company, quite recently established in Britain.*

One of the interviewees runs a part-time one-man practice, selling his IT skills to colleagues.

*Q: Are there people apart from yourself that have found niches in this profession because of their proficiency in the use of IT?*

*A: Yes, there are a few others. I think it's an increasing number of younger people [laugh], students who are coming out of college now who have IT skills learned on their course, the kind of things that wasn't taught in my undergraduate course. They are now able to market those skills quite effectively. I still have the advantage of age and experience over most of those kinds of people. But I think it will be increasingly difficult for me to maintain the position which I currently hold! [Laugh] (IS 3)*

One area of specialization that landscape architects can move into is CAD management in large projects. However, this is a field far from the design, and therefore only appreciated by the most technically oriented. Obviously, it can be a task more or less forced on to the person best suited.

*I think it's really boring, but it's something that has to be done. [Laugh]*

*Q: What is that makes you take that role? Do you decide yourself, or?*

*A: I'm the one with most experience at the department.*

*Q: Your boss divides the work between you?*

*A: Yes, you could say that.*

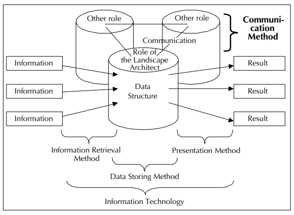
*Q: So he tells you, you have to move in here and organize things?*

*A: Yes, you could say that, sure. It's really governed from higher up in the organization, every department should have a CAD coordinator, or IT manager. I don't know what the term is. I don't know if I'm officially selected. I got an e-mail concerning what the organization should look like, and I was supposed to be responsible for these parts. (IS 1)*

As of today, these examples of new roles are not very common on the market. On the contrary, it appears that other professions are more aggressive, taking advantage of new opportunities. IT skills play a role in this development, although other factors – market conditions, client expectations, planning policies etc. – seem to be more important.

*Landscape architects get involved with a lot of planning work, and the planning work seems to continue through the recession. People were still buying land, and increasing the value of the land by acquiring planning commission and those kinds of things. I think the architects saw that happening, and are now starting to move in on that, because it's a safer long-term base. It's more even. I think that's a larger part of the reason than the strictly IT thing. (IS 3)*

# COMMUNICATION




As a part of a planning or design process, communication with other parties is of vital importance to the landscape architect. The growth of information technology, especially in respect to networks and the Internet, has introduced a number of new tools for collaboration and contact within projects, with government and local authorities, as well as with the public.

Besides enhancing the transfer process, information technology can also improve the quality of the products themselves.[1]

These aspects of the use of information technology are however seldom discussed among architects. The computer is not simply a tool for producing maps, sketches, drawings, and images. Its role as a link to the world outside the architectural studio is becoming increasingly important.[2]

*1. Architecture, after all, is a business of communicating ideas and managing information. To the extent that technology improves an architect's ability to communicate effectively, it certainly improves the quality of the work. The applies not only to the legibility and consistency of design and construction drawings, but also to the look and feel of correspondence, proposals, presentations, agreements, budgets, schedules, timesheets, and other documents. (Sanders, 1996, p. 10)*

*2. CAD is not really about better design, or about economic efficiency. It is about gaining market share and controlling people. The sooner the profession realizes this, the more effective it will be in using computers. (Stevens, 1991)*

## General Communication Tools

E-mail

Most important of the new tools for communication is e-mail, which played an important role in the rising popularity of the Internet. It is today rapidly replacing the fax as the number one utility for fast communication of printed and drawn information. It has introduced a new tone in conversation – less formal than a letter, more structured than a telephone call. By using the "reply'-function, a discussion concerning a specific problem can be followed historically, since the original message is included in the answer. Each reply simply indents the former statements one step further. Used correctly, the e-mail message can thus be used as a simple document-flow utility. New readers can quickly get oriented on the arguments so far.

E-mail Lists

By subscribing to e-mail lists, it is possible to communicate with other people sharing a certain interest. There is a vast number of these lists, covering an endless array of topics. For landscape architects, the most widely spread is Larch-L Digest, distributed by the CRLNet at the University of Toronto. Anyone can become a member of the list, read the opinions of others, and contribute at will.

Newsgroups

Closely related to the e-mail list is Internet News (Usenet News). This service requires dedicated but simple software, and is distributed by a large number of servers around the world.

Many of the discussion groups are moderated, i.e. censored by a responsible group leader; others accept all contributions. The informal rules can nevertheless be hard – any message "out of line" with the on-going discussion can be aggressively responded to, as the contributor gets "spammed" with indignant replies. As the number of users have increased, the tolerance level seems to have risen. As a result, unmoderated lists tend to quickly become less interesting for professional use.

The number of newsgroups is large and growing, today covering tens of thousands of topics. Some of the large companies, such as Microsoft, administer their own set of newsgroups for customers to debate in, mostly to help each other find solutions to technical problems. As a whole, Internet News, as well as e-mail lists, can be extremely valuable sources of information, and are rapid communicative tools.

Chatting

Another popular form of Internet communication is chatting. By signing on to a specific server, people can discuss by typing online, in groups or on a one-to-one basis. Some of these services use a graphical 3-dimensional interface. Users choose their own Figure to represent them – an "avatar" – and are then able to move around in a virtual reality. As they meet others, they can type and read messages.

Chatting is dominated by young people, involved in free communication with their peers. However, a vast number of services are centered on specific subjects – computer technology, homosexuality, fishing, politics, and so on and so forth. The general subject of landscape architecture is probably not suitable for this form of debate. However, as part of education and counseling it can be quite useful. Students can chat with their teacher; clients ask question to a consultant.

Video Telephony

This form of pedagogic communication has existed for quite some time in the shape of video tele-conferencing. When bandwidth improves on the Internet, virtual meetings will be everyday events. Telephone technology is quickly tearing down the borders to data communication. Telephony based on the Internet protocol (TCP/IP) is increasingly available. Soon, the telephone, or perhaps the computer screen, will include a small video camera as standard equipment. When talking to someone, it will be natural also to see her. If she is not in, simply record the message on a video film and send it by e-mail.

Telephone and Telefax

The telephone and the fax machine – the "old" techniques – are still the most used means of fast communication. Besides Internet telephony, other crossover techniques exists. Messages recorded on telephone answering machines can be relayed as sound files, and fax gateways can transform fax messages to images files. These files will then be sent as e-mail attachments to the receiving party. Services like this can be used free of charge.

## Physical Planning

The Internet can be used for communication between the different parties involved in planning issues. During the last few years, a number of products and services have been developed, resulting in a new form of information presentation. By accessing the Internet, users can now find all sorts of geographic data: maps, images and analytic reports.

There is of course an acronym for this sort of data presentation: DGI (Distributed Geographic Information).[1] (Figure 9)

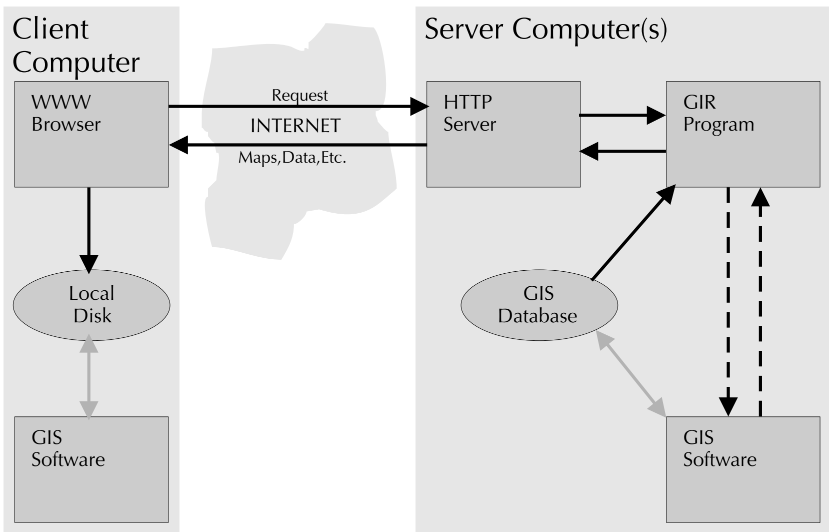



*Figure 9. The multi-tiered client/server model of most DGI services (Plewe, 1997)*

A request from the client is processed by the server, which translates it into internal code for the GIS software and database. After processing, the result is translated back into an Internet-standard format and returned to the client. This can be read in a web browser or in the local GIS software.

One of the most elaborate examples of DGI activities is the REGIS program at the University of California at Berkeley. A project called GRASSLinks[2] publishes a wide range of analysis tools for the San Francisco/Sacramento region, including themes such as roads, water features, wetlands, zoning, aerial photographs, and

*1 DGI applications range from simple, pre-drawn maps on a Web page to network-based collaborative GIS in which GIS users at remote locations share common data and communicate with one another in real time (not yet widely available). (Plewe, 1997, p. 2-3)*

*2. http://regis.berkeley.edu/grasslinks* parks. The site thus not only offers maps and other kinds of raw data, but a full-scale GIS, where complex, multi-step analysis processes can be done.

One example of planning communication via the Internet is the California Institute for Smart Communities, an organization with the aim to help cities in California to successfully use IT in dealing with the increasing economic and social challenges. The Governor of California, Pete Wilson, regards this new technology as an opportunity. The days are over, he claims, when society can be governed "in the old, hierarchical, top-down style". Internet communication is putting an end to all that.[1]

In Sweden, a few cities and other authorities have started using the Internet to present planning proposals and other information to the public. By using simple GIS functions, anyone can view plans, pose questions and read background material. The new medium is hoped to reach a larger population than normal exhibitions at the city hall. One example is the city of Hedemora, which has published a plan on the Internet[2]. Another example is the county administration of Västra Götaland, publishing environmental information on a website[3] .

*1. The "smart community" concept says that local leaders know far better than State or national officials how next-generation technologies can best be marshaled to a community's benefit. It says that only local political, civic, business, and education leaders, working in cooperation, can bring people and technology together in time to capture the competitive and civic advantages that the telecommunications revolution makes possible. (Wilson, 1998)*

*2. http://193.15.32.208/ims/smedby/kartan.html*

*3. http://opgis.lst.se*

## Design, Presentation, and Drafting

As discussed in the part dealing with data structure, data exchange within construction projects is increasingly important. This is mainly due to shortened time schedules and growing complexity of buildings and other constructions. The times when one person, most often the building architect, could grasp and control the whole process is long gone in many kinds of projects. The increased complexity has resulted in a specialization among consultants, and the rise of a new profession – the project manager. Old constellations of consultants are broken up, and specialists are more and more frequently associated on a project-basis.

### Virtual Organizations

The new infrastructure that is being built for the purpose of transporting bits instead of atoms – as Nicholas Negroponte puts it – is rapidly extending the reach of the global computer network. As new tools are being produced to utilize the new possibilities, the barriers between people in terms of organization, distance and time are diminished. New forms of organizations are emerging – virtual groups, based on some sort of common interest. The focus will shift, David Moshella argues, from individual productivity to virtual communities.[1]

Temporary organizations have already been widely practiced in the building sector. By tradition, architects are used to working in short-term groups, often simply hired for a specific design or planning project. In smaller markets, the groups could however be fairly constant, with the same group of consultants moving from project to project. This will probably change for many practices. The next step, to create virtual groups that meet mostly by electronic communication, is not very hard to imagine. The communicative tools erase geographical borders between workgroups. In large international projects, members of the group can be situated around the world, and the project be worked on 24 hours a day. In smaller projects, the threshold for consulting specialist in specific issues will be lower.

In a large practice, this technique can be used to distribute tasks between different offices. IS 3 has experience in this field, as people from all over the country sometimes are involved in a project.

*But it seems to be IT projects [; visualization, or AutoCAD]; if it's a landscape project, we'll just bring a member of staff down from the office, or we'll go to the other office and actually work with the team. (IS 3)*

The breakthrough of virtual organizations will not come, however, until the technical parts of Internet communication are solved.

*I think the difficulty with communication is bandwidth. If you're working on drawings, or even worse photos and photomontages, which can be 20 or even more megabytes, then communicating them over the Internet is really not a good idea. That's part of the problem at the moment. I mean, the technology is there to do it, but I think the fact that it's the telecommunication infrastructure isn't capable of delivering the speed that is required, means that people haven't really thought about too seriously.*

*Q: But that will change I guess?*

*A: Oh yes, definitely. If you look at AutoCAD now, it's very web-aware. In theory, two people can work on the same drawing from different sides of the world, and very easily. The technology is available to physically allow it to happen. It's just the communication infrastructure which needs to be completely redesigned to cope with it. (IS 2)*

*1. These communities will exist primarily within the emerging cyberspace. Over time, their influence in business, the arts, the sciences, politics, religion, and other key societal domains is likely to be profound. (Moschella, 1997, p. 103)*

This is an area of great interest. So far, the prospect of this idea has been surrounded by a lot of "hype". The need for stimulating personal contact within project group must not be underestimated. Also, a lot of practical questions, and traditions concerning role distribution between the participants must be answered. Fees, responsibilities, leadership, and other issues must be resolved, before the organizations can truly become virtual.

Communication within Projects – CAD-organization

When computer support is used in the design process, clear rules are needed for structuring, communicating and storing the information produced. If this is achieved, chances are high that all parties can benefit.

*Compared to manual methods, you can for instance get:*
*❊ better support for early decisions*
*❊ better coordination between the parties*
*❊ greater possibilities for adjusting documents to fit their requirements.*
*(Löwnertz et al, 1996, p. 45)*

In project communication, data structure is of utmost importance. As discussed earlier, several organizations are working with international standardization in this area. Many agreements must however be made in the specific projects. For improving communication in integrated projects, agreements and specifications should encompass the following areas (Löwnertz et al, 1996):

❊ CAD-organization – coordinator and contact persons; routines for communication, coordinate system, data exchange; file storage structure; layer naming etc.
❊ Technical specifications – hardware, storage, printer and plotters etc; operating systems, software and versions, project specific applications; means of communication etc.
❊ Information exchange – scope, frequency, responsibility etc.
❊ Delimitation and common information – borders between responsibilities.
❊ Bases for technical coordination (coordination drawings).
❊ Version management of documents.
❊ Delivery.
❊ Responsibilities and ownership.
❊ Archiving.

Internet communication is increasingly being used within large projects. Often a central server is conFigured to act as a common storage facility, reached through a web browser interface. Depending on the role in the projects, the parties can view, upload, and download construction documents of different kinds.

In this way, communication speed is enhanced, and the cost of copying and distribution of documents – which is large in more traditional processes – is minimized. Server administration can be assigned to one of the consultants – often the architect – or be handled by a specialist. Copying firms are also active in this field, trying to minimize their losses caused by the decrease in paper distribution.

Increasingly often, large construction projects are presented to the public on web sites. One example in Sweden is the bridge presently being built between Malmö and Copenhagen. This controversial project has an extensive web site, showing the design, and minute-by-minute progress on site. Also presented are environmental impact, economic facts, and so on.

This technique can also be used in construction projects.

*[W]e've got a site […] which is on-line at the moment. [W]e're going to have three cameras looking down at the site, and then every contractor will have a page, and basically, the design will be explained. And the process, as things are being built, you can look at in. In Japan, they can go to their web page, and look how progress is going on their site. The photos are being updated every hour. So, that will be a great project, it starts in 1999.* (IS 3)

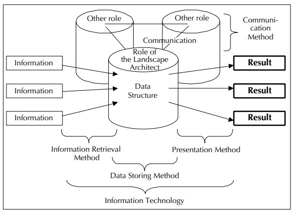
## Management and Maintenance

Few landscape architects get the opportunity to complete planning and design commissions by informing the management staff. Projects budgets and time schedules are often so tight, that the time and cost needed for producing maintenance documents does not exist. Client organization often hinders communication between designer and caretaker.

By using digital data in planning, design, and drafting, the effort for transferring information into the management and maintenance phase is minimized. GIS and CAD drawings can easily be transformed into maintenance plans. Pre-written documents can quickly be adjusted to a specific project by the use of text processing. One of the main purposes of the STEP and IAI projects mentioned above is to keep data "alive" into the management phase.

A major obstacle in this line of reasoning is the difficulty to communicate the information to the people doing the actual maintenance work. No matter how refined the structure of the digital data is, it must be conveyed in a format that is understandable and useful. This puts heavy demands on the pedagogic skills of the landscape architect, as well as on the communicative efforts.

# RESULT




What then is the result of all the uses of technology mentioned in this chapter? Do the plans, drawings, and images really differ in any other respect than not being hand-made? Do the digital methods result in different solutions to spatial problems?

According to some, computer aided methods can really make a difference. Using new technique can really change the way we conceive and design landscapes.

*At the end of the day, I am interested in real landscapes, not simulated ones. Virtual reality, in my mind, is a cop out*[1]*. Representing landscapes digitally may be a more intuitive way to mediate between the concept and the reality and ultimately to understand space volumetrically and not planametrically. Perhaps it is through the exploration and use of these new digital tools that a more contemporary expression of landscape architecture will emerge, and the clichés that plague current landscape representation will then be wiped away. Finally it is about liberating landscape architecture and creating the opportunities to conceive radically different and exciting spaces. (Sawyer, 1998)*

*1. To back out (as of an unwanted responsibility); to avoid or neglect problems, responsibilities, or commitments*

This section of the work will examine the output produced by landscape architects in different roles; result produced primarily using digital methods.

## Physical Planning

Much of the physical planning being produced with computer support still mimics the manual methods. Using GIS still gives the user a number of advantages:

❇ By using databases, the planner can handle large amounts of data and information.
❇ Modern software can process a large variety of data types – tabular data, photographic images, vector data from CAD and other sources, remote sensing data, and so on.
❇ Data can be displayed and processed in different combinations, depending on the needs.
❇ Very large sites can be stored and displayed in different scales. The same result can be presented in different sizes and using different means of output – paper, large and small screens, video.

❈ The processing power of the computer gives the planner opportunity to perform more calculations, and thus explore more alternatives. The queries can encompass large datasets.
❈ The graphic capabilities of the software makes the map or drawing production relatively fast, and produces clear and readable images.
❈ Plans can be displayed in three dimensions, showing landforms and buildings. Aerial photographs and maps can be "draped" over the terrain model.
❈ Plans can be published on the Internet, giving a larger audience the possibility to react to the plans.
❈ Data and planning result can be stored and distributed in digital format – on disk, CD-ROM, or on the Internet.

Apart from these advantages, geographic information systems can actually give the planner new working methods.

Digital Site Design

The use of GIS is rapidly spreading among landscape architects, especially in the United States. For landscape analysis, the McHarg method is often applied (see earlier discussion). However, as GIS users mature, this method develops. Landscape architect Karen Hanna has described "the digital site design process" (Hanna and Culpepper, 1998). Computer tools are used throughout the planning process. Digital spatial data can be used as background material in policy making and goal setting. Program analysis can be performed using decision matrices in spreadsheet applications, and bubble diagrams constructed in drawing programs. Site inventory also uses existing databases, alongside with CAD drawings.

This far into the process, the computer tools do not change it in any major way. However, when reaching the site analysis phase, Hanna suggests a different approach than McHarg. His all-important weighting of the relevant factors is substituted by a much more simple binary decision: a factor either accommodates or affects the proposed land use, or it does not. To increase the quality of the analysis, several binary maps can be generated from the same basic theme. These do not have to be all positive or all negative – as long as the resulting map is easy to read and interpret, vastly different values can be analyzed.[1]

The site design process then moves on to ranking the themes, similar to the step taken in manual site analysis. When this more or less subjective phase is completed, "placeholder values" are

*1. In this regard this method differs greatly from McHarg suitability maps, where all conditions must be either positive or negative in terms of their development suitability. This requirement can limit creativity, to say nothing of the confusion it often causes with lay audiences. (Hanna and Culpepper, 1998, p. 138)*

*1. [It] gives the designer a much more intuitive product with which to work. The site analysis [suitability map] allows the designer to use traditional thought processes and to retain more control over the information. (Hanna and Culpepper, 1998, p. 142)*

assigned to each mapped condition, and the overlays are summed. The result, a suitability map, is fundamentally different from a map made with the McHarg method. According to Hanna, this process eases the task for the planner.[1]

The many shades of the McHargian map make it hard to read and to use in a creative way. The GIS graphic method keeps the outlines of the mapped conditions more intact, making it easier to mentally translate back into the existing landscape (Figure 10 and Figure 11).

The placeholder values assigned to each theme follow the doubling principle; 1, 2, 4, 8, 16, and so on. Since each condition has a unique value, the overlays can easily be analyzed and translated. Every combination of conditions in the overlay gets a unique value; 1, 2, 3, 4, 5 and so on (1 means only 1; 2 means only 2; 3 means 1+2; 4 means only 4; 5 means 1+4; 13 means 1+4+8…). These combinations can then be recolored for legibility, still keeping most of the natural borders intact.

When the analysis map is completed, vector objects such as roads and buildings can be added to the map, to further enhance readability. Finally, a legend, text, arrows, and other graphic elements are added – directly in the GIS software, or in a separate drawing application such as Corel Draw! or Adobe Illustrator.

*Figure 10. Standard suitability map, using the McHarg method. Many colors and slivers make it hard to read. (Hanna and Culpepper, 1998)*

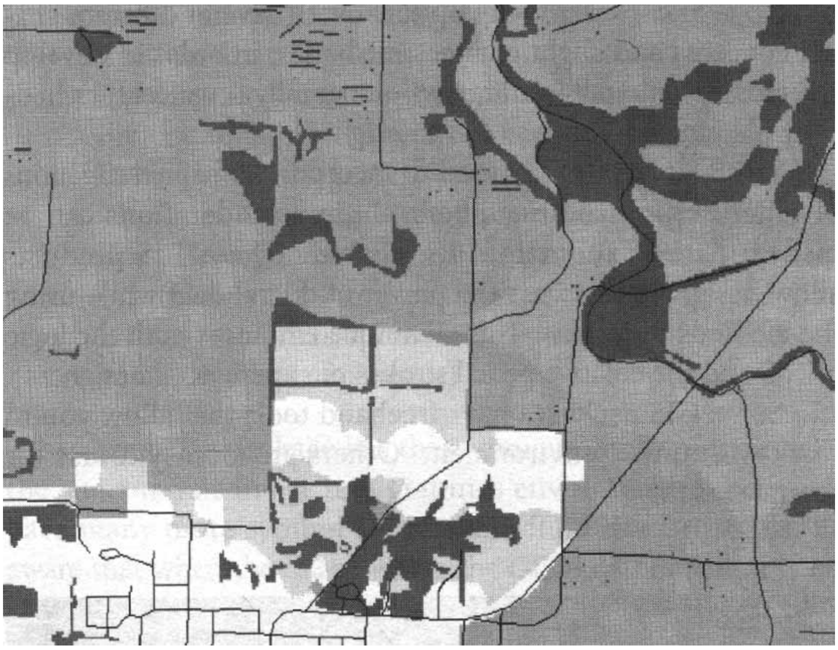


*Figure 11. Suitability map produced by the GIS graphic method. The distinct areas make it "direct read'. (Hanna and Culpepper, 1998)*

One way of making the plan even easier to read is to have an aerial photograph as a base for the map. This is quite easily achieved in modern GIS software. The map and photo may even be "draped" over a 3-dimensional terrain model, and viewed from an angle (Figure 12).[1]

*1. The photo over the terrain model gives many visual references. Because it is in three dimensions, many people who struggle to understand maps can comprehend the relationships between proposals and physical landmarks. The ARS [Area Relationship Study], when represented as a tint overlaid on the photo, is unmistakable. It is realistic and comprehensible even to the graphically uninitiated. These images never cease to be the topic of conversation. (Hanna and Culpepper, 1998, p. 157)*

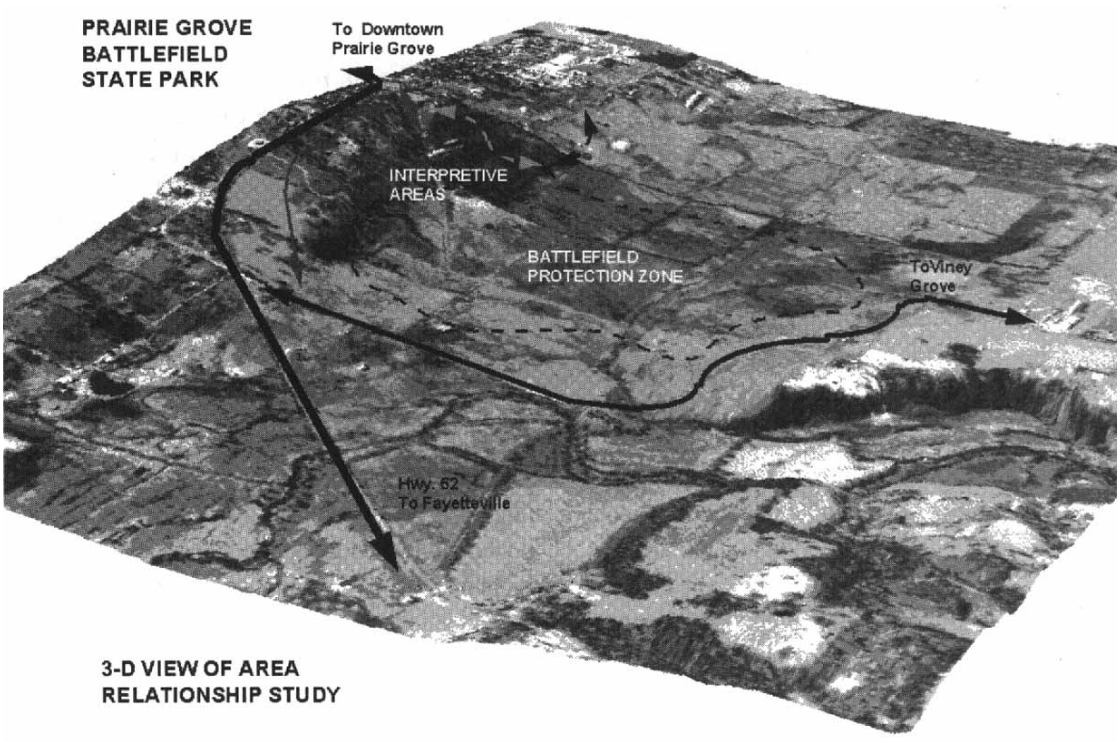



*Figure 12. GIS map and aerial photograph draped over terrain model. (Hanna and Culpepper, 1998)*

When the studies are completed, the data can easily be moved into the CAD environment. The design process can thus continue to be digital, all the way to final design. The CAD program can add more benefits, such as cross-sections, earthwork estimations, and so on.

As shown by Hanna, computer support can actually improve the methods of the landscape architect. The fast calculations made by the computer makes it possible for the designer to test many combinations, experiment, and thus make the land use proposals in a more intuitive way. The digital site design method brings planning closer to traditional sketching, which is the foremost tool used in the creative work of the architect. The 3-dimensional possibilities in modern GIS software should make it even more attractive.

GIS and Scientific Visualization

The use of visualization is not limited to architectural problems. Creating models and pictures has always been an important tool in many scientific areas. In recent years, computed-aided methods have been taken into use. This field of computer use is known as Visualization in Scientific Computing (VISC).

The word visualization has acquired several different interpretations.

❊ As a verb, the process of forming a mental image, or vision, of something not visible, as an abstraction (Webster's, 1979).
❊ As a noun, the picture formed in the visualization process.
❊ A synonym for VISC (within this field).
❊ In VISC, the use of computer technology for exploring data in visual form and for experiencing virtual worlds using all the human sensory channels (Hearnshaw and Unwin, 1994, p. 18).
❊ In VISC, focusing attention on the use of computer graphics for acquiring a deeper understanding of data (Hearnshaw and Unwin, 1994, p. 18).

The advances in VISC have been a source of inspiration for GIS developers and advanced users. As increasingly complex spatial datasets are handled in planning projects, visualization techniques become more important. This is even more critical when GIS is used as a spatial decision support systems (SDSS). GIS use is also becoming more interactive, and potentially includes computer-supported cooperative work (CSCW).

VISC aims at stimulating the user to gather insights into problems, thereby finding possible solutions. It must be truly interactive – not only changing viewpoint or moving in a model, but true feedback possibilities, which change the underlying data.[1]
The array of VISC methods includes:

❊ Full colored photographs.
❊ Highly diagrammatic images (not just maps).
❊ 3-dimensional surfaces and objects.
❊ Different depictions and different perspective views of the same dataset.

Optimization of the design of visualization sequences is increasingly complex. It includes not only data manipulation and display, but also formal human-computer interaction (HCI) models and other aspects of computer science.[2]

In using visualization in GIS, a number of aspects need to be taken into consideration. Many of these conditions are different from the scientific use of images.

❊ GIS is often used as a communicative tool, where "experts" try to convey complex situations to non-professionals – to decision-makers or to the public. In visc, the scientist rarely needs to convey the images to other than colleagues.
❊ A primary objective for the scientist is to use a tool that is highly interactive. In physical planning, the result of GIS analysis is mostly presented in the shape of ready-made maps or images. This is however changing somewhat, as geographic data is published on the Internet.
❊ The degree of abstraction must be decided. For the public, highly abstract representations can be difficult to translate back into the "reality". The scientist, on the contrary, often needs symbolic images in order to simplify complex situations and relationships.
❊ The problem of how well data used in the process represents the phenomenon for which it provides a model must be addressed. Data accuracy can also vary greatly. This calls for the use of metadata[3]. Important is also to consider how data is displayed by the computer graphics, the choice of colors, symbols et cetera when addressing an external audience. The scientist has a higher degree of freedom in this respect.

*1. A kind of interaction could be identified in pre-computer research methods but, through the slowness of data manipulation and graphics output, it often fell rapidly behind the speed of the mind as it explored beyond such static displays. New facilities for probing, tracking, steering and post-processing offer important advances in investigative research. (Hearnshaw and Unwin, 1994, p. 4)*

*2. The growing real-world requirements of GIS are being constantly reviewed to identify which new facilities should be developed. The changes will be brought about by expansion of existing software, new modules or even links with existing visualization systems whose superior powers of rendering can be employed. (Hearnshaw and Unwin, 1994, p. 7).*

*3. Data about data; e.g. origin, quality, owner, date.*

The introduction of computer tools does not, however, disqualify traditional maps as tools for scientific and systematic geographical analysis. The topographic map, with its layers of different kinds of information, remains an important instrument for data collection and information processing.

## Design, Presentation, and Drafting

Over the years, computer aided techniques have evolved to a wide range of possibilities for use in design and presentation. Most of these are used for presentation in the later stages of the design process. However, several of them have matured into reasonably fast and cheap methods, suitable also for the designer's search for solutions to the problems at hand.

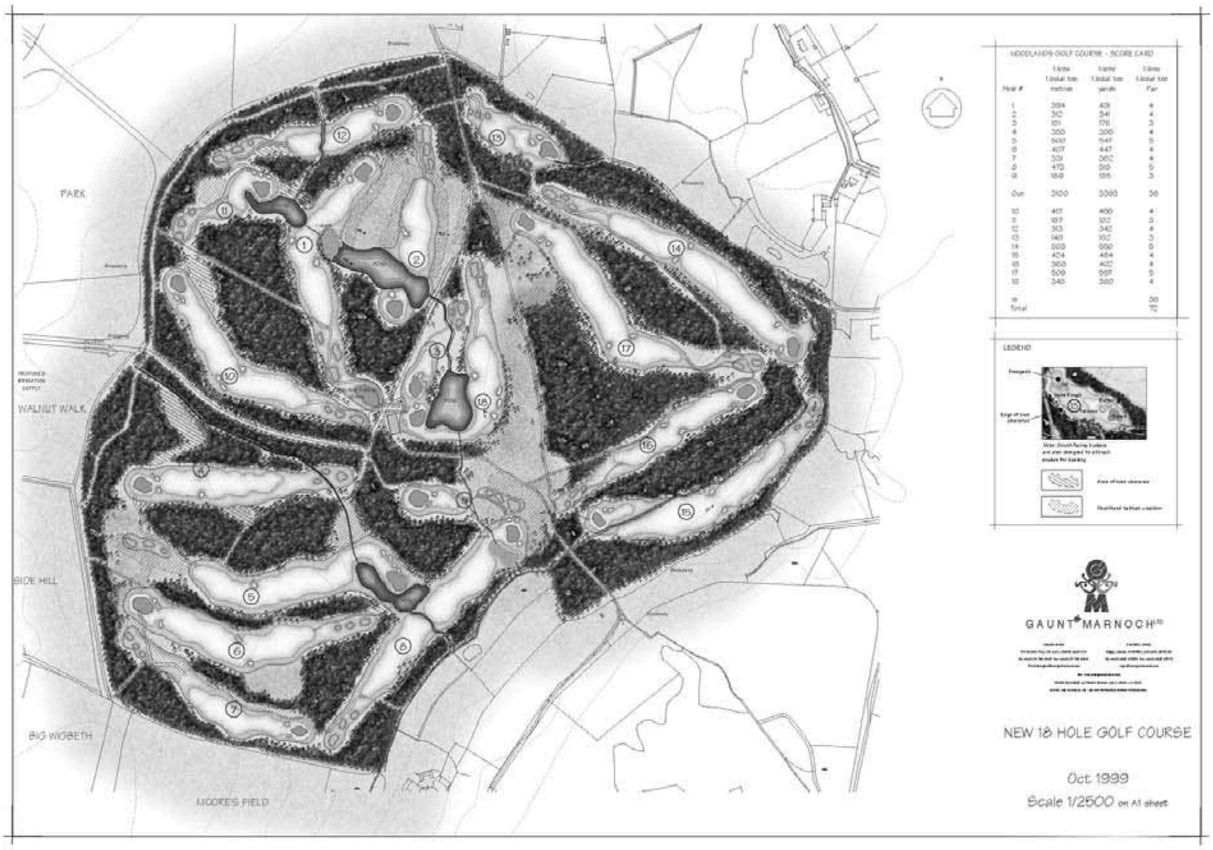
The large variety of tools available for design presentation can complicate the task for the landscape architect. Different types of images convey different attitudes and atmosphere; they are more or less easy to comprehend; they must be adapted to the audience. Or perhaps the choice of tool is not difficult – maybe the problem is simply finding the method most agreeable.

### Illustrative Drawings

The most common form of conveying design and planning ideas is using illustrative drawings. This area is by many considered to be the weakest area in computer-aided techniques. As noted by Stephen Ervin above, computer drawings seldom have the "expressive abstraction" that a skillful manual presentation can result in. This cultural conflict was extremely evident in the early days of CAD, when the drawings produced were primitive, using one weight for all lines, and a technical typeface for lettering.

Modern CAD software is in this respect much improved. Lines can be varied, on screen well as on the printed drawings, and written information can be presented using all of the typefaces accessible in the operating system. Add-on software can even simulate manual drawing techniques, by making lines "shaky", by crossing meeting lines, and by using typefaces that imitate hand-written text.

In my former role at the landscape architect practice, I produced a "corporate typeface" for use in the CAD drawings produced. This was later incorporated in the Swedish software AutoShake, used for this kind of "fake" manual drawing. The market is however somewhat limited – most architects still prefer using true manual techniques for presentation material. One digital example

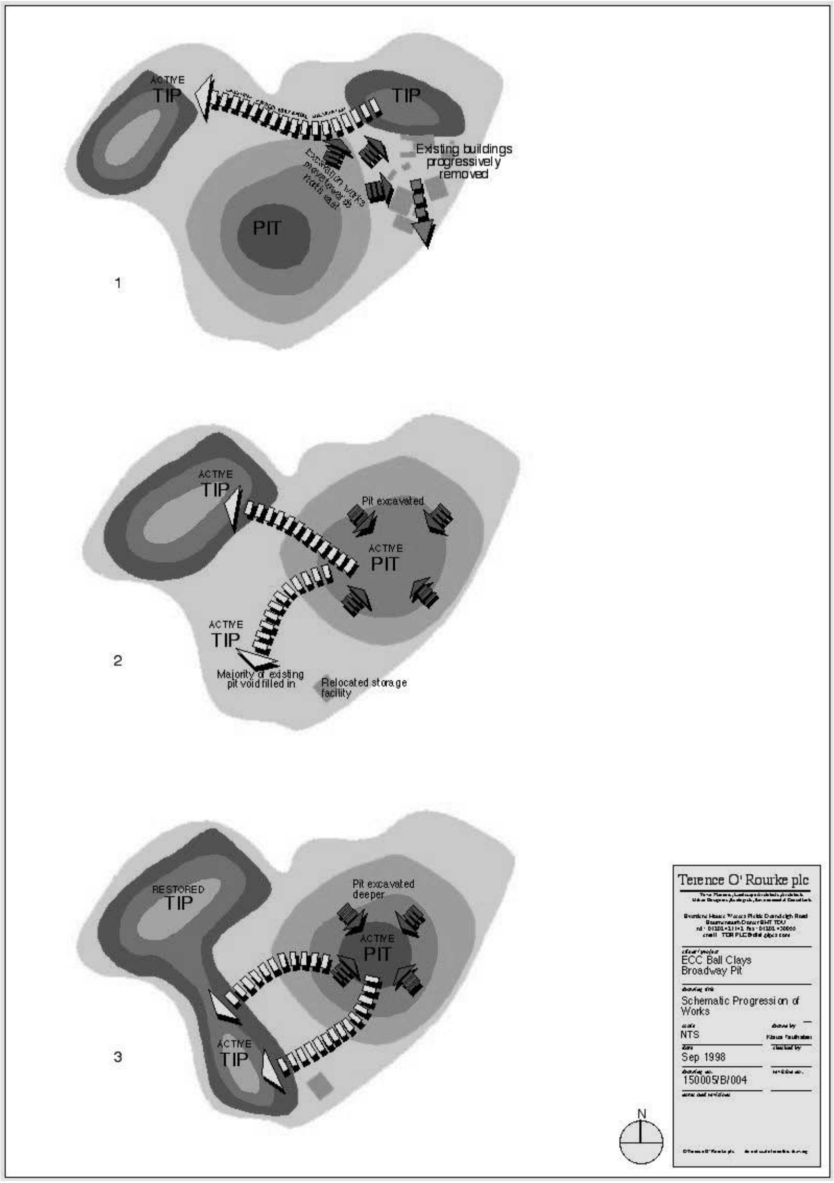



*13. Golf course illustration, courtesy of Klaus Faulhaber.*

is shown in Figure 13, where a CAD drawing has been given a manual appearance using digital manipulation.

A more commonly used method is to print the CAD drawings and enhance them manually, by applying color, shadows, and hand lettering. CAD drawings can also be imported into graphic software such as Corel Draw! and Adobe Illustrator, to produce the desired result. In the future, this will probably be an unnecessary step – CAD software is steadily improving its graphic capabilities, as shown in the example above.

The drawing quality is however still a far way from giving the subtleties expressed earlier by Stephen Irvin. The "artistic" capabilities of CAD software is contradictory to the ambition to standardize drafting techniques. One solution to this problem is to utilize the possibility to use the CAD file for multiple purposes. By using complex symbols, including illustrative as well as technical symbols, illustration and construction documents can be printed from the same CAD model. The symbols can be made up of entities in different layers – by changing layer visibility the different




drawings can be viewed. This can be an efficient way of showing the design in a fashion a little more readable for the non-expert. Slowly, with the combination of better software and more skilled users, the situation will become better.

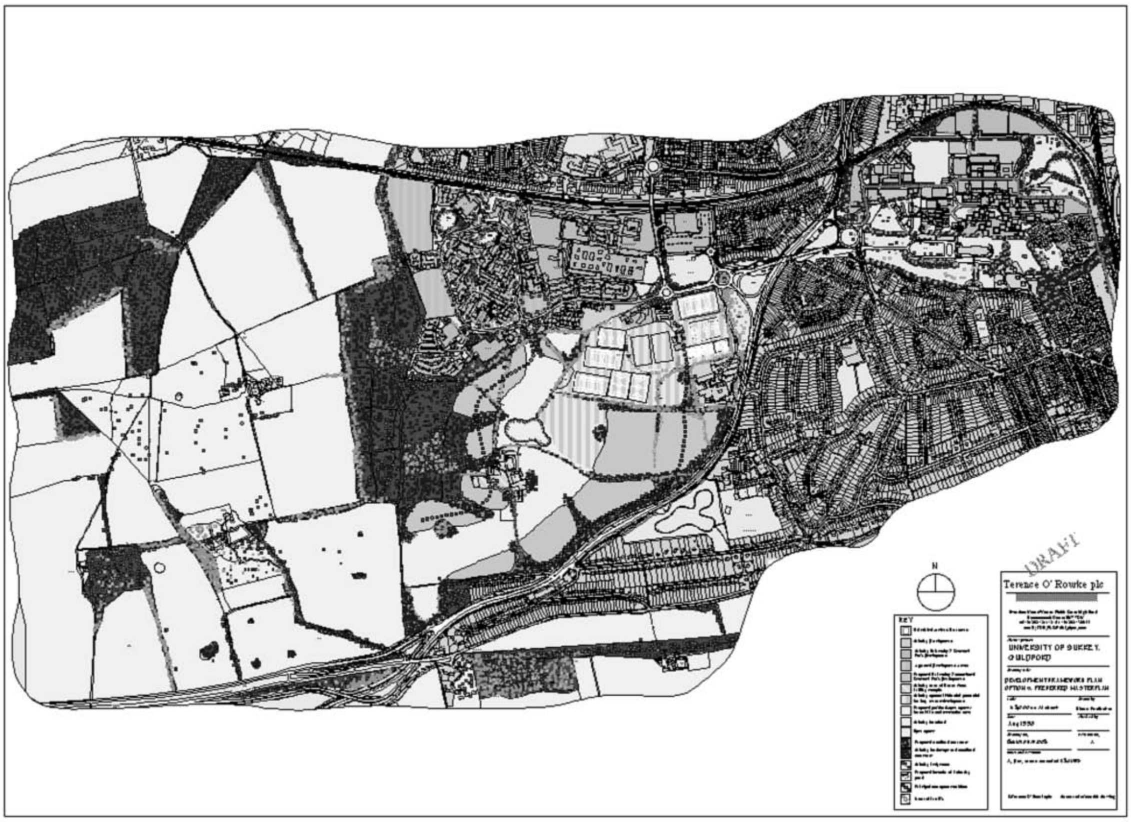
Figure 14 is another example, where CAD software had been used to make a schematic presentation. This graphic clarity is hard and time-consuming to achieve with manual methods.

GIS Presentation

Visualization also plays an important role in geographic information systems. The progress in 3-dimensional image rendering is rapidly affecting the tools used in physical planning. Several of the GIS uses, e.g. environmental impact analysis, can benefit from the use of photo-realism, volume visualization, and virtual reality. In many cases, the non-scientific audience prefers images with a maximum of information and a minimum of abstraction. The more "natural" the image appears, the easier it is to interpret.

*14. Schematic progression of works in a clay pit. Illustration courtesy of Klaus Faulhaber.*

Often, however, it is more appropriate to simplify the images in order to express certain qualities or patterns, and to hide what is irrelevant. Computer support is giving us the opportunity to produce strikingly realistic images of large landscapes as well as small details. Using the sheer power of the computer, the planner can produce very complex plans and drawings quickly. Figure 15 is an example, showing a detailed master plan.




*15. Master plan, courtesy of Klaus Faulhaber.*

These possibilities must not hide the fact that a highly symbolic graphic language can sometimes better put a message across. By "simplifying reality" in terms of dimensions, scales and forms we can use the highly effective language of the skilled mapmaker.[1]

This is an important conclusion, relevant to all forms of visualization. The quest for "realism" in the images presented must not be followed to such an extent that the simple but clear picture is forgotten, or discarded as being outdated. On the contrary – a conscious use of a combination of realistic and simplified images can help the process of interpretation. The human thought process is simultaneously concrete and symbolic, logical and intuitive. Presentation techniques should appeal to both of these aspects – or sides of the brain, as the popular term denotes them.

The use of static 3-dimensional and realistic images emphasizes visible changes in the environment. Other aspects important to planning – ecology, pollution, costs, and so on – risk to be forgot-

*1. While there has been considerable advances in the achievement of realism, there has not been corresponding progress in automation of map design and generalisation. Our inability to devise algorithms which can mimic the cartographer's art implies that despite nearly thirty years of research we do not yet understand the cartographer's internal visualization. (Hearnshaw and Unwin, 1994, p. 23)* ten or underestimated. One way of dealing with this problem is to use animated presentations. Expected changes, such as traffic flow, can be presented using visual simulation instead of tables and pie charts. (Hearnshaw and Unwin, 1994, p. 62)

By the use of modern technique, the planner can combine realistic and symbolic presentation. Mapmakers have always known this. By using cartograms[1], specific features can be emphasized in the map. Normally, a geographic area is drawn to show it's physical area. Instead, an aspect of a planning project can be presented by drawing areas so that their size on the map represents their value in regard to the aspect. 3-dimensional GIS can draw areas with their height representing a certain value. Since any projection of the real world into a map has to be a simplification, cartograms need not to be regarded as distortions of the world. They simply represent some particular aspect of it. Cartograms are particularly useful in human geography, but can be used to represent many other issues as well.

*1. Symbolic images or representations used in cartography.*

The inspiration from scientific visualization into the GIS community has already greatly enhanced its tools for describing complex issues. Exciting theoretical and practical development is being done in areas such as perception psychology and human-computer interaction. This will continue to aid the development of computer-assisted visualization, in GIS as well as in other uses of information technology.

### Photographic Manipulation

As mentioned earlier, the use of photographs for representation of gardens and landscapes has a long history. Also, extending the possibilities of the photograph by manipulating the image has been done for almost a century. Today, this is possible to achieve without the use of manual techniques. Using software such as Adobe Photoshop or Corel Photopaint, many landscape architects make presentations using manipulated photographs of proposed designs. There are several ways of making original photographs digital – scanning paper copies and slides, scanning negatives and have them transferred to a photo CD, and using digital cameras.

Image manipulation is the easiest way of using computer aided presentation techniques. Compact disks with royalty-free pictures can be acquired at a low cost, to serve as a picture library of plants, people, vehicles etc. By using "cut and paste" in the software, a picture showing existing conditions can simply be turned into a proposal. This method has successfully served as an introduction into advanced computer use for the landscape architect students at the department.

Photographic manipulation is more and more widely used in planning projects. Often, the initiative comes from the client – the planning authority. The photomontages must be used with caution. A skilled user can easily construct images that are impossible to distinguish from "the real thing". If the constructed image is not clearly presented as such, a viewer can be deceived.

Photographs can also be used in a new type of software, where a series of images are stitched together, shaping a 360° panorama. The image is viewed interactively, allowing the user to rotate freely. Several panoramas can be hyperlinked to eachother. This way a simple form of virtual reality is achieved. The images can be shown on a stationary computer, in a network, or published on the Internet. (Figure 16)

*Figure 16. Panorama showing the Department of Landscape Planning Ultuna*

## Image Creation

When the designer needs to present ideas by creating images, a number of tools exist – manual, computer-aided, and combinations of different techniques.

Hand-drawn perspective images are fast to produce. It is easy to emphasize certain aspects to enhance readability. The talented artist can also produce images that in themselves are beautiful. However, the manual method has obvious disadvantages as well. For the less skilled, they are hard to produce in a professional manner. The possibilities to "lie", or exaggerate certain parts, are also endless.

The opposite applies to manipulated photographic images. It is of course possible to erase objects, but more common is to make additions to an existing photograph. Backgrounds and other objects can make it hard to see what is new in the image. However, the manipulated photograph can be made "true" in a way not possible in hand-drawn images. This can be a great pedagogic advantage. It is easy to get suspicious regarding a pretty handmade image, in a way that in a sense puts the viewer in a weak position. The viewer knows that things are missing, or exaggerated, and also that the creator is pleased with it. This makes it harder to express a critical opinion. In this sense, the photograph is more democratic.

Images created by rendering CAD models are somewhere in between these two extremes. They often look artificial, to an extent that can make them hard to relate to. The geometry is however "correct", and weak spots in the design can be harder to conceal. By post-processing the images, they can be "softened" and given an artistic tough, making them more closely related to hand-drawn images.

3D Visualization

In the late 1980s, ordinary computer hardware became powerful enough for use in 3-dimensional CAD modeling. From these models, pictures can be rendered. The images can be simple wire-frame models, solid models with colors, or more advanced rendered 3D models with textures and backgrounds. Software used for these purposes includes AutoCAD, Microstation, Archicad, and MINICAD. To enhance the built-in rendering possibilities, they include libraries of textures, backgrounds, and supplementary objects such as vegetation, people, and vehicles. Add-on applications, such as the British Key 3D Blocks, supplement with extensive object libraries. The quality of the images possible to make is steadily improving. Most software now includes the possibility to use different light sources, raytracing, shadowing, radiosity, and other advanced techniques.

*Figure 17. Computer image courtesy of Reality Graphics, Australia. Modeled and rendered in Softimage | 3d Extreme*

As a complement to the CAD programs, even more sophisticated software for modeling, rendering, and animation can be used. Most popular in the PC market is 3DStudio by Kinetix. The program is capable of creating very complex geometry, but more useful for the landscape architect is the possibility to import CAD models. 3DStudio Viz is especially oriented towards architectural design, including such functions as setting the sun angle and positioning CAD models into background photographs. In this kind of computer applications, add-ons for landscape and garden images can be used.

*Figure 18. Image rendered in Vistapro, based on geographic data from a GIS program. Image courtesy of Alf Ivar Oterholm*

There is also a range of software for use in workstations, especially machines from Silicon Graphics. The powerful hardware makes the most out of software such as Alias | wavefront and Softimage. They are however seldom used by landscape architects, but rather by industrial designers, and presentation and animation designers (Figure 17).

For large-scale landscape project, CAD models are often unnecessarily exact. Instead, special computer-modeling programs can render images of virtual landscapes. Software such as Vistapro (Virtual Reality Labs), Bryce (Metatools), and World Builder (Animatek) can generate random landscapes, or work with pixel-based GIS maps (Figure 18).

Some of this kind of software has the ability to import 3-dimensional CAD models, or to generate landscapes based on spline outlines. The software can also be used for recording video sequences of walks or flights through the landscape model.

With this tool, the landscape architect can model landscapes in order to visualize changes and analyze ecosystems. The software produces amazingly realistic images, complete with landforms, vegetation, water, sky, sun and moon. Some include animation effects, such as the rippling of water surfaces and wind blowing in the grass!

In order to enhance the realism, advanced procedural modeling[1] routines can be used for creating vegetation, clouds etc. Large plant databases completes the newest software in this category, allowing the landscape architect to produce complex 3-dimensional vegetation, where every plant is an individual, with the natural morphology of the species. (Figure 19)

Landscape images, where thousands of these plants are shown, obviously need high performance rendering software. The French landscape simulation program AMAP Orchestra can show billions of polygons in a rendered image. Through this, highly realistic views – e.g. showing vegetation change over time – can be produced (Figure 20 and 21).

*1. The idea behind procedural modeling is to let the computer create much of the detail in response to a general instruction that defines the basic parameters of an object. Instead of trying to create objects by combining geometric shapes, the computer produces the detailed geometry of the object by following programmed procedures. (Sipes, 1996)*

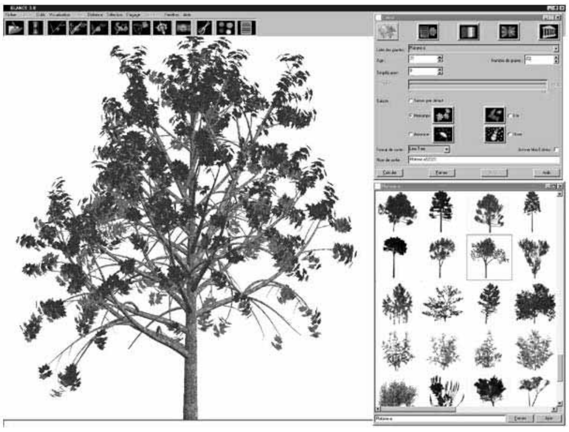


*Figure 19. User interface of AMAP Genesis, "plant growth engine".*


*Figure 20. Image rendered in AMAP Orchestra, courtesy of GVA Agency, Paris.*


*Figure 21. Image rendered in AMAP Orchestra, courtesy of GVA Agency, Paris.*

None of the interviewed landscape architect has had experience in this area. It has however been used in the department for a couple of years, giving students an opportunity to do large-scale landscape modeling early in their education. Figure 22 is an example of an image created to introduce the students into the possibilities. It took no longer than two hours to produce, from the first test with the software.

*Figure 22. Computer image by Klas Eckerberg. Modeled and rendered in Vistapro*

Other imaging software is oriented towards smaller landscape projects. VisualPhile, from Visual Applications Inc., boasts with the following benefits from using the software (Figure 23):

*VisualPhile Personal Visualization Software provides a unique in-home sales presentation tool for builders, remodeling contractors, landscape architects, and interior designers. Show your customers various brand name products and merchandise as they will appear on their home or on their property.*

*Clients see their projects as real photo images - no more hard to understand CAD style drawings or scratch pad illustrations. […]*

*It helps customers visualize the final project before actual construction is started, sets appropriate customer expectations, and increases customer satisfaction. Customers make decisions easier and faster when they can see a finished project before any work begins. […]*

*Helping clients see a completed design is the first step in closing a sale. While scratch pad sketches help, they are not accurate. CAD drawings are exact but they are time-consuming and difficult for the client to understand. Visualization software is the key. It is both quick and realistic looking. With VisualPhile you will set yourself apart from the competition and your customers will be more satisfied. (Imagine Software, 1998)*


*Figure 23. Computer image courtesy of Visual Applications Inc. Photograph manipulated in* Imagine your landscape

There is a number of imaging software aimed at the consumer market. One example is Imagine Your Landscape, also from Visual Applications Inc. The purpose is to help the garden owner to visualize changes in the home environment before it is built. In Sweden, computer software developer SPCS markets a Trädgårdsguide (Garden Guide) (Figure 24):

*With the Garden Guide, bushes and lawns, paths and planting areas will be a pleasure already at the planning phase. You will quickly draw a plan sketch over your garden and then build paths and planting areas just as you want them.*

*You start with a plan sketch over your garden. After that, you place the ready-made symbols for houses, garden furniture, and decorations. You choose your* *plants, vegetables and fruit trees from the large plant database, with approximately 2,000 different European plants. All plants are shown with one or more color pictures where the most of them are real color photographs. You can search for plants by either Swedish or Latin name, or by plant data. This means that you can search among plants that are suitable for your climate zone, height, color, flowering time, demand for light, soil, watering et cetera.*

*In the maintenance almanac you will see what needs to be done and when, month by month for every plant. For each advice there is a description and in some cases also an animation (moving pictures). In the year plan, you can get an overview over what needs to be done during the year for your garden to be taken care of in the best way. If you choose to place garden lighting, you can let the program show you what the garden looks like at night.* (SPCS, 1998)


*Figure 24. Working environment of* SPCS *Trädgårdsguiden. Image courtesy of* SPCS

Unfortunately, this all-round approach does not meet the standards of the professional garden designer. To be frank, it is highly doubtful whether the amateur can benefit either. The rendered pictures are primitive, and the plant database is inaccurate, to say the least. The effort is worthy to note, however. Programmed with more professional skill in all the disciplines involved, this kind of software could come to use in garden centers and among advanced amateur gardeners.

## Virtual Reality and Animation

As the software and hardware evolution continues, the possibilities of producing realistic images increases. In this possibility lies a trap that often must be avoided. Especially in early stages of the design, the purpose of studying volume relationships and overall space design is better aided by simple models, without material mapping, advanced lighting, shadows, and so on. A client can easily get the impression that "everything is solved", when presented a photo-realistic image of a design. The designer can also be distracted, and get caught in making decisions that are pre-mature in the level of detail. Realistic images should mainly be reserved for presenting finished products, not be used for communicating ideas in the design process. (Sanders, 1996)

True virtual reality presentations consist of a 3D model viewed at surrounding walls with projected images, large video screens, or in glasses (or "helmets") with small screens in front of the eyes. The viewer can maneuver through the model, using an input device of some sort – a joystick, a mouse, or perhaps a glove. This market is growing rapidly, mostly for use in computer games. In this field, steering wheels and pedals or joysticks can control battle airplanes or racing cars. The experience can be enhanced by the use of seats moving in coordination with the virtual vehicle, or with joysticks jerking as the airplane fires rockets at enemies. The use of sound also plays an important role.

Interactive models of this sort are starting to be used also for architectural purposes. In landscape architecture, it is more rare. Far more common is the use of a more simple form of "virtual reality", namely animations. A CAD model can be the base for video recordings of a walk-through. Combined with photographic backgrounds, this kind of recording can be used for presentation of proposed roads, buildings, and other projects.

Ed Flaherty, American landscape architect, active participant in international discussions on the Internet, has strong feeling about the use of images. A long quote will show some of his arguments:

*It is my conclusion that the plan, section, elevation and perspective methodology for communicating our design is at the heart of this perennial communication problem described as the definition of landscape architecture. […] How many perspectives, elevations and sections does it take to describe a park? […]*

*There are two fundamental areas where the use of computers will dramatically change [the landscape architect's] work and it is already beginning. The first is in the presentation technology, overcoming the problems addressed* *above. I [am] talking about the software that lets you compose the animation of the walk through to generate the IRL [In Real Life] experience. I am talking about the software that lets you reconFigure the seasonal and time variables in the walk through. And I am talking about the software that in half an hour lets you customize the issues and points of your presentation to your audience.*

*All this happens with Electric Image or 3DStudio or QuickTime VR put into Director or summarized in PowerPoint. The root work for these kinds of presentations comes from some variety of CAD, images from GIS or remote sensing, eco-landscape items from Tree Professional and World Builder type software, site furnishings from FormZ or InfiniD. But the key is in the composition into the final products the story of the project, and the ability to manipulate according to the audience.*

*This was just not possible with pencil and paper work. As far as the issue of passing savings to the client, c'mon – he has been short changed for decades and this work costs money. It has only been either the honesty, past reputation, or the excellent selling capabilities of the landscape architect that gets the work sold and built. Very few people ever really understand from the "pencil and paper" drawings what they will get. Please note that I am including computer rendered single viewpoint perspectives within the category of "pencil and paper" drawings. My point is that the walkthrough is most important. And most of us know that cheap simulations do not make it either. Most of us know that excellent simulations cost bucks in hardware and software. We have got to do it. (Flaherty, 1998)*

Hopes are high that the use of virtual reality and animations can not only help the clients understand proposals, but also to strengthen the role of the architect. The architect that masters these technologies will be able to express new ideas in new and better ways.[1]

As mentioned in the presentation of this chapter, using virtual reality as a means for architectural presentation, may in the long run actually change the way we perceive and design buildings and open spaces. Swedish architect Petter Aaro, active at a small company devoted to visualization, expresses it this way.[2]

The problem with using animations and virtual reality as a presentation tool is of course the great efforts needed to produce results of acceptable quality. A combination of software like AutoCAD and 3DStudio takes hundreds of hours to master.

However, sometimes simpler tools can be used. Animated GIF[3] images have become very popular on the Internet, where they are mainly used for producing moving advertisement banners, logo-

*1. The convergence of virtual reality, active databases and open systems in the vision of intelligent architecture creates an opportunity to regain its role as an arbiter of the future, and it is for architects to seize that opportunity. (Zampi and Morgan, 1995, p. 154)*

*2. Even if you create environments for use only in the computer, as for instance a game, it often looks like something that really exists. Sooner or later this will change. You learn to see the virtual world as its own, with its own expression, and then there should be a possibility this experience bounces back and influences the physical reality. (Emilsson, 1999)*

*3. Graphics Interchange Format; a compressed graphic file format.*

types, and other eye-catching effects. The graphics used in the animated version can be fairly large and complex, showing a proposed design.

*You go around in animated GIF-files, you travel around. You use is as an Internet application so to speak, it's an HTML-file. It's really a very flexible way to deliver such a presentation, it's super! You don't need those multimedia software and such, which requires some drivers [for the operating system] and Windows 95 and NT […]*

*It's meant to be used locally, so there are no limitations. The animated GIF-file is over three megabytes or something. A hundred frames or something like that. So you can't show it over the Internet, it's not primarily designed for that. […]*

*I have actually made very small animations that I've sent to the architects, just to tempt them a little – see here what you can do! In 3DStudio you save in AVI-files, and they can be problematic. But in GIF Animator […] you can import the AVI-file. You can view every picture, as many as you have done, even if it's three thousand images. Then you can check every image, and decide the time span between them. I think it's superb! It's one of the most enjoyable programs I've come across recently. (IS 1)*

Virtual reality can also be used on the Internet. VRML (Virtual Reality Modeling Language) is a file format for sharing 3D worlds on the Web. As with other standards, it is platform-independent. The models described in VRML can be interactive and animated. They can also include hyperlinks to other Web documents.

The first standard was established in 1995 and described static models. A year later, the "Moving Worlds" proposal was introduced. Behind this proposal was a consortium of companies, SGI (Silicon Graphics Inc.) being the most well known.

VRML resources can be found at http://www.sdsc.edu/vrml. Popular software for creating VRML worlds include

❊ 3D Builder http://www.3dconstruction.com
❊ Atlas 3d Modeler http://www.vnd.com/Atlas3D/Atlas.htm

Viewing VRML is possible from any modern web browser, equipped with a special plug-in. The language is however still only capable of handling rather primitive models. As transmission speed between computers increase, we will most certainly witness a rapid growth in this technology – in appearance as well as in use.

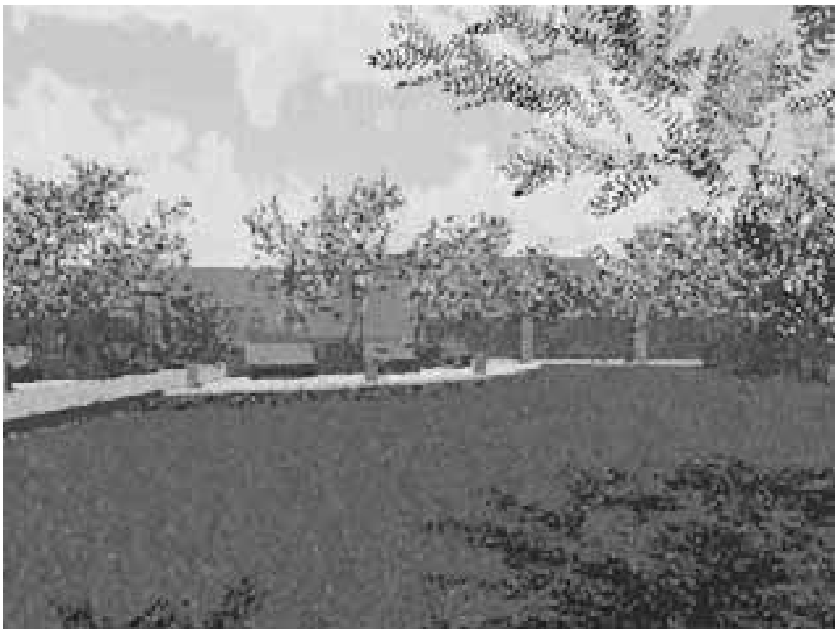


*Figure 25. Still image from AVI movie, courtesy of Jan Apelgren*

One example of a simple animated presentation is shown in Figure 25. A 3-dimensional CAD model was rendered in and animated in 3DStudio. Several small movie sequences where then used in a multimedia presentation, produced in Macromedia Director.

A CAD model can also be used for producing interactive models. The most simple method is to make panoramas, in the same way as with photographic images (Figure 26).

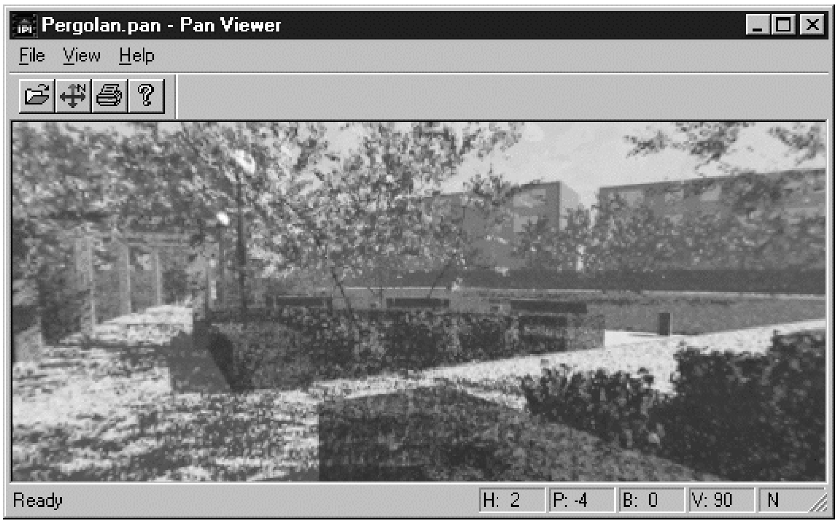



*Figure 26. Panorama image from CAD model, courtesy of Jan Apelgren*

Combination Methods

In practice, different methods are often combined. Most of the imaging software is capable of importing and exporting different file formats, which can be combined to produce the desired result. One example is rendering in CAD programs, where background images can be combined with the internal 3-dimensional model. The image in Figure 27 was produced in a few hours. AutoCAD was used to create the greenhouse model. Materials were mapped to the model; the image was rendered in AutoCAD, with a background picture from a photo-CD. The image was transferred to Adobe Photoshop, where a new pathway and shadows were added.

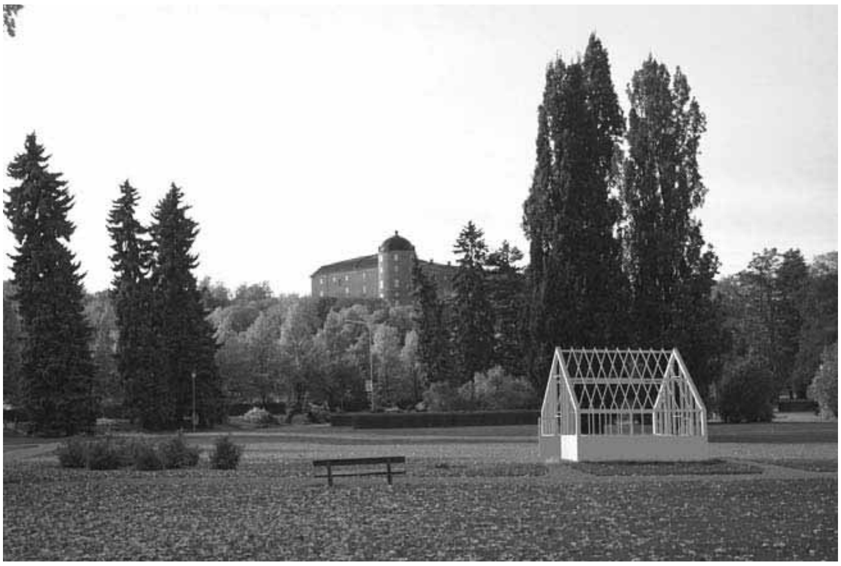


*Figure 27. Computer image by Klas Eckerberg*

An interesting hybrid software is Piranesi by Informatix (named after the seventeenth century Italian master illustrator). Although a pixel-based program, it stores depth information. Painting tools can thus be applied to separate geometric planes in the image. Artistic effects can be used to take the image "beyond photo-realism" (Figure 25). Filters emulating traditional manual methods can be found in most image processing software, such as Adobe Photoshop. These are far from prefect though.

*[A]rtistic filters in Photoshop though, they don't work. I've spent hours, trying to get an image like that, for example [hand-made color pencil drawing], of a 3D model, and it just seems they're not sensitive enough, the pencil tools, I've tried every kind of pencil width and I can never get it to do what I want it to do. So, they need a bit of more work. But we're getting there. Definitely, that will happen in the future.* (IS 2)


*Figure 28. Computer image, courtesy of Informatix.*

Modern illustration and CAD software has the ablity to combine different digital sources – line art (vectors), "pixel art" and photographic images – into one presentation. Figure 29 on next page shows an aerial view, where 3D CAD has been combined with a photograph.

There is also the possibility to mix computer-aided and manual techniques. A common method is using 3-dimensional cad wireframe models as base for manual drawings. Instead of elaborate manual perspective construction, a computer model is printed out, overlaid with tracing paper, and a drawing is produced using lead or color pencil, ink or watercolor. The image can also go through an additional step – after scanning, the manual drawing can be enhanced by use of image software.

This "post-processing" of computer-generated images can perhaps solve the problem of using images that are too exact, or perhaps too revealing.

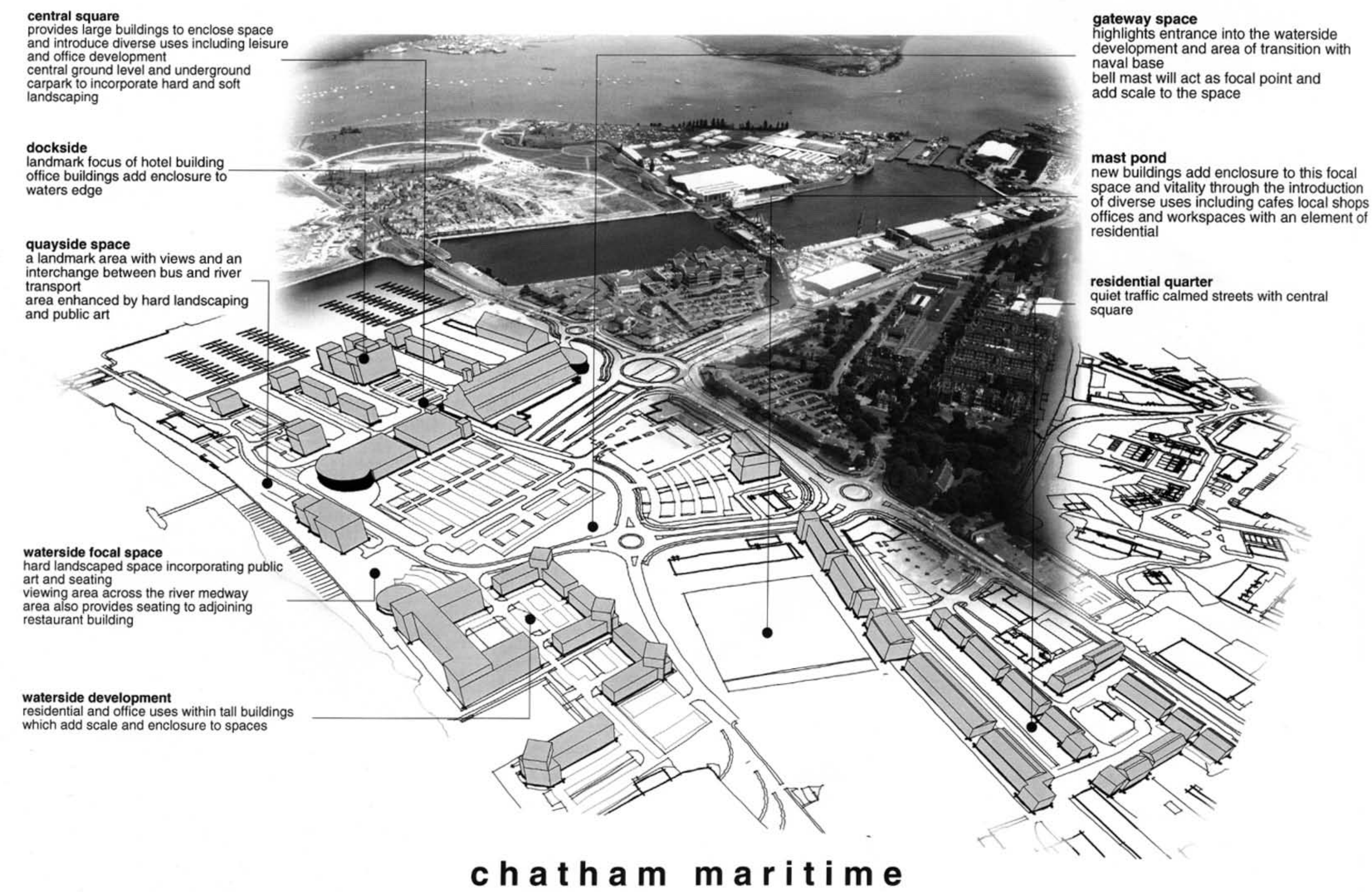



*Figure 29. Aerial presentation, courtesy of Klaus Faulhaber.*

Desktop Publishing

Presentation material, in the shape of pictures and text, can be combined using software for desktop publishing. Instead of gluing pictures and text on a board, the computer can be used to produce large printouts. The software can also be used for in-house production of leaflets, brochures, and even books. The most popular software in this field is PageMaker (Adobe), followed by Quark Express (Quark) and Corel Ventura (Corel).

Desktop publishing can be useful for producing composite drawings. Material from CAD, imaging software, and hand-made images can easily be arranged to form a more expressive type of presentation than the standard 2-dimensional plan drawing.

Multimedia

Presentations can also be made in the shape of multimedia shows, where video, images, drawings, text, and sound are combined. Using software such as Microsoft PowerPoint, Adobe Première, or Macromedia Director, highly interesting and informative work can be produced.

These tools are seldom used by landscape architects, although IS 2 as quoted earlier finds them very important. The generation now being educated will perhaps change this situation. They are to a greater extent "brought up" with moving images in music videos and computer games. The techniques will be introduced in courses, and from there spread to the profession. However, the learning threshold is rather large for this kind of software.

## Drafting

In working with Bygghandlingar 90 Del 7, the Swedish recommendations for landscape construction documentation, one criticism received was that the drafting technique was too CAD oriented, leading to ugly drawings. Ugly drawings result in ugly constructions, according to one critic.

The benefits and graphic capabilities of CAD use in the design process were discussed at some length under Technology. The computer as a tool in the conceptual stage is still debated. However, its use as a drafting aid is now widely recognized. If carefully made, the quality of modern CAD drafting is not far from good manual technique. In graphic precision, it is superior.

The real issue in the criticism of CAD drafting lies in the drafting philosophy – the purpose of the drawings – not in the technique used to produce them. The current Swedish recommendations – Bygghandlingar 90 – has a clear view on drafting.[1]

At least the first part of this philosophy is neutral in respect to the drafting technique. A simple and coordinated manner of drafting has advantages in itself. If the work is done in a computerized environment, the benefits are even larger. Information can be reused, and easily moved between the phases of the project and between the parties involved.

If, however, the designer decides to use the old, illustrative manner, the computer still is inferior to the skilled manual drafter. This problem is most evident in the Anglo-Saxon countries, with their tradition of "pencil squibbling". Modern CAD software tries to mimic this method, so far with moderate success. Nevertheless, the difference between British, American, and Scandinavian CAD applications is evident. This is probably part of the explanation why the American AutoCAD application LANDCADD did not succeed in penetrating the Scandinavian and British markets a few years ago.

*1. Bygghandlingar 90 Del 7 recommends a simplified drafting technique compared to the one used today by many landscape and site designers. There is an old tradition that the documentation should be illustrative. Older documents could be pure works of art, thoroughly drafted and colored.*

*The rule today is that the documentation is simplified as far as possible, and that the appearance and symbolic language is coordinated with other disciplines. The drawing as such is also getting a new role. Design is increasingly moving towards product modeling, where the drawing is a projection of a digital database (Dahlin and Eckerberg, 1996, p. 9)*

As the CAD software develops, these regional and national characteristics will become more evident. On the other hand, the difference will perhaps exist only on drawings used solely for illustrative purposes. The standardization efforts within the AEC/FM industry is a factor weighing in the other direction, trying to make construction documents international in their appearance.

Again, we will see many types of compromises between these attitudes. In every drawing, the drafting technique will reflect the type and size of the project; the nationality, age, and personal preferences of the designer; the purpose of the drawing; and whether or not a computer was used to produce it. No matter how advanced and well-established computerized product modeling will become, drawings will continue to be produced in a large number of ways.

*If you look at the drawings of the landscape architects who we look up to, like Jeffrey Jellicoe, they're all scribbles, pencil scribbles. Very, very nice drawings, but unfortunately, a lot of people think that's the way things ought to be done. And the computer can't do it, so therefore computers aren't right for landscape drawings. I just think that what we haven't yet discovered probably is… it's a new aesthetic which has to be evolved. We don't have yet a computer drawing aesthetic. We still judge computer drawings on the same aesthetic criteria as we do manual drawings. I think, you know, that a computer style is evolving, but it's a long way from being generally accepted. […]*

*All CAD drawings look the same. And they were characterized mainly by the software they were using to produce it. So, for example, if they were using LANDCADD, then it would look like a LANDCADD drawing. They were using all the same tree symbols. And the same with KeyScape or whatever it is. And so the drawings were characterized not by whose practice but by the software they were using. One of the things I was quite interested in doing was saying, "Well, we don't want to do that. We want our drawings to look like our drawings." So we spent a long time developing our own style, producing our own tree symbols, our style of lettering and layers, which was similar but not exactly the same as the manual style. It was identifiable as least, as being something different from the rest. That sort of ethic has continued. (IS 2)*

# Chapter 4
# Results, Conclusions, and Further Studies

In this final chapter, the results from the interviews are related to the propositions formulated in the beginning of the paper. Some conclusions are drawn from reflections and interpretations of the interviews. Finally, some thoughts concerning further research work are expressed.

## Results and Conclusions

In Chapter 1, four propositions were formulated. In this chapter, the results will be summarized under the following headlines, inspired by the propositions:

❊ IT in Design
❊ Effects on the Professional Role
❊ New Fields
❊ Factors Affecting IT Use.

### IT in Design

*Proposition:*
*The tools and methods made possible by information technology gives the landscape architect opportunities to concentrate on the design process. The use of it minimizes routine tasks such as administration and cost estimation.*

Perhaps the use of new technique can truly give access to new possibilities, not just for data mining, information processing, and presentations, but also for the very design of open spaces that landscape architects engage in. For centuries, the two-dimensional plan drawing has been the dominating method of expressing design ideas. By using three-dimensional digital modeling, new ideas can be expressed using new methods. Perhaps these new tools can even change the way landscapes are seen and perceived.

The question of the impact of IT use on design – perhaps the most interesting one for a landscape architect – could not be thoroughly investigated in the small group of interviewees used in this first part of the study. Apart from being small, the group was non-representative of the profession. It is interesting to note, however, that in spite of the interviewees being far more experienced and skilled than the average landscape architect, their opinions and predictions concerning computers in design are rather vague and diverse – sometimes even contradictory.

❊ Software will improve, e.g. CAD applications will have better graphic capabilities for producing presentation document.
❊ Software will become more complex and difficult to use. Many will be forced to specialize in one field, such as 3D modeling. The landscape architect will know the capabilities of the software, but most of them will leave the actual computer work to others.
❊ Some of the software will have large impact on the design process. Great expectations are held especially for GIS in planning and site design, and computer modeling as a base for animated presentations or virtual reality. GIS will enhance decision-making; multimedia will improve presentation of ideas and designs.
❊ Proficiency in the use of computer-aided presentation gives more weight to the argumentation in design issues.
❊ The technique used for presentation is not of prime interest. More important is the designer's level of confidence and skill with the tools used. It is important to enjoy the work!
❊ Computer tools for communication and administration are yet too new for their impact to be evaluated in depth. E-mail and Internet-based cooperation will shorten time schedules, as did the introduction of the fax machine. The likelihood that this will increase the time spent in designing in low. Instead, the total amount of project time will be lower.
❊ Improved access to data from governmental and local authorities will raise the quality of the planning process, and shorten the time needed for background research.

As it appears, computer support has not yet had a significant impact on the techniques used in every-day design. 3-dimensional digital modeling is so far seldom used in actual design, but rather in final presentations. Conceptual design continues to be mainly a manual task, using paper and soft pencil. CAD software is by some used early in this process, as a means of testing ideas, and providing accurate grounds for further studies.

*The proposition does seem to be wrong.* Enhanced tools for administration and communication leads to faster, and perhaps better cooperation within project groups. The possibility to work in geographically scattered groups has increased somewhat, leading to greater efficiency in large practices. However, administration and communication continues to fill a large portion of the day. This situation will probably not change radically in the years to come, even as the technical level continues to get higher.

The landscape architect will always need to gather information and opinions from a large number of sources. The day is yet far away, when he or she is sitting by the computer all day, designing in virtual space, seamlessly finding data and information as it is needed. This may seem a scary thought today, but the tools for virtual cooperation that information technology will give, might ease this anxiety. Human interaction on the Internet will increase to an extent hard to imagine.

For the designer, this increased interaction will perhaps be confusing and irritating, but also important and stimulating. The effects this will have on the architect's possibilities to design – to reflect, to be creative, to dream – only time and experience can tell.

## Effects on the Professional Role

An increased use of product modeling would shift the balance in the construction business. Today, with the often highly schematic drawings produced by the designer, many decisions are in fact made at the construction site. If the design process was to result in a more or less complete computer model of the proposed project, then more responsibility would lie at the designer. Controversial as it may be, this would strengthen the role of the landscape architect.

*Proposition:
By using information technology in a conscious and systematic way, the landscape architect can strengthen his or her professional role. The tasks can be shifted to earlier stages of the design process – from "making it green" when everyone else is finished, to an actual involvement in principal decision-making.*

Superior skills in IT use is by itself not sufficient for staying ahead of the competition. Some landscape architects have definitely found a niche in e.g. visualization, but for the profession as a whole this is marginal.

The costs of IT is today one of the largest budget item – for many, it is larger than the office rent. In this sense, information technology has raised the stakes. Smaller companies are afraid to lag behind their competitors unless they start using CAD or other technologies. The economic effects on such a decision are hard to forecast, which increases the hesitation.

Since demands from customers still are moderate, most landscape architects therefore tend to hang on to the old roles. If they do invest in computer support, it is often done half-heartedly, and is not allowed to change the tasks in any major way.

Consultant offices aiming at being in the lead, have put more effort into implementing an IT strategy. This is of course not a miracle cure. In order to maintain a successful role in planning and design, the talents and skills of the employees is still the most important ingredient. As the market matures, this fact becomes more and more evident. Today, flashy computer presentations can perhaps act as the Emperors new clothes. In the long run, the professional knowledge of the landscape architect decides how important roles he or she will be able to play.

In Chapter 3, several examples were given showing that landscape architects have been successful due to computer know-how. The interviewees are good examples of this. They have shown how their IT skills has increased their influence in the design process. I also have personal experiences supporting this fact. *For this group of landscape architects, the proposition is correct.*

## New fields

*Proposition:*
*The professional role of the landscape architect has moved from being a "gardener" to being a part of a variety of processes in the society. The use of it can give possibilities to move into new fields – unheard of today or established by others.*

GIS Uses

When discussing the future, Karen Hanna expresses interesting views concerning the role of GIS. By itself, it will neither cause conflicts between computer-aided and manual approaches to decision making, nor make the designer more successful. However, clever use of GIS will make the work more accountable. Landscape architects put a pride in being generalists; in their ability to evaluate data from many different fields. GIS can help them to this in a systematic way, easy to follow for others.

If the profession grabs this opportunity, the computer can actually assist in integrating different interests, making it possible to analyze and find patterns in a broad variety of data. Perhaps the use of GIS can truly change the way different professions cooperate in planning and design processes. Landscape architects can be in the center of this development.

The interviewees share this view. GIS seems to be the area of IT use were the highest hopes are put. In all the interviews, GIS was considered an increasingly important field for landscape architects to engage in. None of them had however had much personal experience with it. All of them expressed the problem of data access as one major obstacle.

Environmental Issues

The use of GIS has been remarkably slow in acceptance among landscape architects. There still appears to be a lot of confusion as to the uses of the tool. The practices that have started utilizing GIS often limit the use to producing "intelligent maps". Using the tool for more complex issues, such as environmental monitoring and assessment, seems to be a logic step to take.

Planning on the Internet

Another interesting aspect of GIS use is the possibilities for Internet communication. Landscape architects, with their all-round knowledge, should be well suited for this kind of task, acting as a mediator between the public and the politicians.

Facility Management

Facility management and maintenance can also be greatly aided by the use of computer support. A landscape architect, with IT skills combined with education in management and economics, should have no trouble finding large and interesting fields of expertise in facility management at different levels.

Visualization

Increased specialization will most certainly result in landscape architects engaging in practices with specific IT profiles. Some of them will be able to act as free agents on the market; others will be incorporated into larger companies. All three of the interviewees are much used as "visualizers", producing images to present schemes designed by other architects. With growing experience, this role can be highly influential and rewarding.

*The investigation strongly supports the proposition*. Increased IT competence can strengthen the profession of landscape architects.

## Factors Affecting IT Use

*Proposition:*
*The most important factors influencing the use of tools and methods are found in the environment of the landscape architect. Changing processes and new demands result in new tools, which are put into use when the organizations find them appropriate.*

The forces behind changes in the professional field of the landscape architect can broadly be classified into inner and outer. The inner forces are based in the properties of the individual – the needs, wishes, knowledge, skills, capabilities, ambitions, dreams, and so on. The outer forces consist of pressure, rewards, and other emotional influence of the social environment; economical realities; family situation and so on.

In this first part of the study, many of these aspects have only been hinted at in the interviews. Alas, most of the literature read so far barely notices the complexity of the introduction of computer support in design professions. This area will be the primary focus of the completion of the study. However, some results and conclusions can already be described.

After completing this first part of the study, I am more strongly convinced than ever that the effect of the use of information technology is largely up to the individual users. The environment obviously provides the landscape architect with new tools, some of which are commonly used – CAD software, fax machines, e-mail correspondence. However, the effects are so far limited to the area of communication and administration. The core task of the architect – the design process – has not yet been transformed in any substantial way.

The success of a planning organization, a landscape architect's office, or an educational institution, rests in the hands of the employees, and their interests and motivation. The organizations employing landscape architects must be aware of this fact. The managers must understand how technology will influence the employees, and try to reduce the anxiety caused by these possible changes. Support, education, and motivation are essential.

It is easy to be overwhelmed by the many possibilities of information technology. With the ever-increasing rate of change, it is often wise to step back, and try to picture the new tools as trivial parts of everyday work. Only the truly beneficial software and technological gadgets will move from being "revolutionary" to becoming integrated parts of our lives.

The situation is today improving. Just some ten years ago, the primitive software interface scared many designers and planners from using computer support. A small minority of the landscape architects, including myself, found the technique so fascinating that we tried to penetrate through the rough edges. The amount of success of course varied greatly. Not only did we need a special interest in the technology – the basic design skills remained as important as for colleagues using manual methods.

It takes more than computers and software to solve complex problems. The user needs a number of personal qualities and attitudes to successfully apply computer-aided techniques to problem solving:

❋ Technical proficiency and working knowledge in planning or design methodology.
❋ Open attitude towards innovative tools for problem-solving.
❋ Capability to generate the information needed in the process.
❋ The ability to link software to the preferred method of problem-solving.

❄ The experience and intuition needed to interpret and assess the accuracy and validity of results generated by the computer.
❄ The confidence not to be intimidated by the power of the computer, or to be discouraged by hardware and software shortcomings and imperfections.
❄ Sensitivity to the partnership between the human and the machine. (Partly from Mutunayagam and Bahrami, 1987)

These high ambitions are, according to Mutunayagam and Bahrami, to be cultivated into "a kind of instinctive philosophy for using equipment and software judiciously[1]". The landscape architect that manages to combine all of these skills will be able to practice a powerful and versatile planning or design philosophy. By using creativity and innovation, every limitation encountered will be overcome. Thus the computer user will ensure a competitive edge in professional practice.

*1. Wisely; with sound judgment.*

However, most landscape architects would hesitate in front of this kind of description of their future-to-be. Merely keeping up-to-date with the technological advances is a hard task for anyone. Often, problems encountered in everyday practice would require computer programming, in order for the software to solve it. Landscape architects are not used to an active role in this field, burdened as they are by all the other skills to keep alive and active. Also, economic realities put a restrain on the time to put aside for education and experiments.

The introduction of information technology has been relatively slow in planning, construction, and facility management, mostly due to the complex and variable nature of this "industry". So far, the impact of IT has not changed everyday life for the landscape architect to any greater extent. Some individuals are prospering because of their computer skills; some are frightened of it, or simply do not care; most toddle along, slowly adapting to new demands put on them.

Many practices and organizations are trying to plan for the future by composing IT strategies. Although this has not been the primary object of study, it does seem as if the impact of these documents is low. As noted above, they are – or rather, they could be – very important indeed. In order to be successful however, they must be dynamic documents, engaging all employees in their everyday tasks.

The immature use of information technology in the sectors where landscape architects are active also results in moderate customer demands. To put it bluntly: new techniques and methods are introduced not by need or demand, but by the mere possibility of using the novelty. My own experience of the introduction of CAD was that the initiative came from us consultants. Eventually, the customers demanded it from everyone – not so much for using the digital material in any new way, but initially because it seemed modern and exclusive.

This attitude of course changed quickly, since the advantages of computer-aided design was evident. Presently, this insight is growing among facility managers. The big change will come when market pressure forces the consultants to cooperate around a digital product model, useable in design, construction, and management. When this day comes, the market will force changes upon the landscape architect.

Simular pressure will perhaps also come from new demands in planning. The public will increaslingly demand the use of new technologies to access data, and to be given better opportunities to influence the planning process.

*As of today, however, the proposition is not correct.*

# Closing Word

As shown, the development of information technology has in many ways changed the conditions for the landscape architect. Put together, these changes are strong predicaments for the use of IT strategies – individual as well as on the organizational level.

Acquiring the ability to evaluate computer support, and to use it in a professional situation, is largely up to the individual. The parties surrounding the landscape architect provide the framework in terms of possibilities and expectations.

However, since the choices of methods and tools have a large bearing on how individuals can and will function in planning and design systems, the choices must in the end be made individually.

If these strategic decisions are based on knowledge and insight, they can increase the possibilities for the profession to adapt to a changing society, and enhance its role as an active and creative part of this process.

# Further Studies

The aim of this first part of the study has been to give a theoretical and historical background to the subject, and to make a few pilot case studies. The most important aspect of continuing studies is obviously to make the case study wider as well as deeper.

The further studies should concentrate on the following areas:

❊ Broaden the case study, to encompass landscape architects of different sex, age, and professional background.
❊ Increase the quality of the study, i.e. make the hermeneutic interpretations more thorough.
❊ Investigate the complexity of the introduction of computer support in design professions – personal attitudes vs. corporate IT strategies.
❊ Study to which extent IT proficiency is used for marketing purposes among landscape architecture practices.
❊ Study the flow of information from design and construction to maintenance – is this improved when IT is used?
❊ Examine the discrepancy found in my 1993 survey, that landscape architects tend to view IT more important for other practices than for their own.

As for techniques, the most interesting issues are:

❊ The reasons to the slow acceptance of GIS among landscape architects.
❊ The use of three-dimensional modeling in design.
❊ The use of new techniques – particularly Internet communication – in physical planning.

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# Appendix A
# Interview Manual

The main purpose of the interview is to make the IS to describe which techniques, methods and roles he/she uses today, and thoughts concerning the reason for this. Also thoughts dealing with what the future might bring, as well as reflections on historical influence.

| **Subject** | **Questions** | **Note** |
|---|---|---|
| Professional experience | | Also apart from landscape architect |
| Present work | Tell me something about your present work. How many landscape architects? | |
| Work tasks | Ongoing projects? Most common tasks? What kind of customers? | |
| Professional interests | Dream tasks to work with? Hinders to achieve this? | Dreams on how things could be. |
| Tools and methods | Go through the points below (not necessarily in that order!) | Go through all of the tasks the IS has. Ask is to show material, describe work methods, motivate techniques (personal interest, talent, praxis? What does IS think about other techniques? Important to find out is:s thought about why he uses these methods and techniques - own ideas and alents, taught from school, from other, "forced on" by others in the process? |

| | | |
|---|---|---|
| ❖ *Information* | Type of information being handled? Sources? Purpose? Who governs? | Work through this and the following subjects for each typical task. |
| ❖ *Technique* | Which techniques are used? What/who governs choice of technique? Which tools are used - sketches, drawings, images, plans, texts? Computer aid at problem solving, sketching, early stages? What/who governs choice of tools? Other ways of solving the tasks? Tried? Does others do differently? Are they better or worse? Does the choice of tool affect decision making? | |
| ❖ *Data structure* | How is data structured? Electronic-ally or more traditional? CAD layering? What/who governs? Ad-hoc organization, or same system and rganization every time? Ready-made forms for quality assurance? Computerized work-flow programs? | |
| ❖ *Role* | What roles do you have in different kinds of projects? What/who governs? Is the ole affected by methods and tools used? | |
| ❖ *Communication* | Which other parties do you communicate with? What/who governs? Tools for communication? | |
| ❖ *Result* | Properties of different kinds of result? In which ways is the result affected by tools and methods? How does the recipients experience the work? Is this influenced by the techique used? | |

| | |
|---|---|
| Technical interest | Opinion on technical gadgets - tools, computer? Education on spare time in computing? Read manuals? |
| Computer experience | Is it fun to work at the computer? Self confidence in front of it? Read computer magazines? Computer at home? Others in the family us it? Work at home? Use Internet for fun and/or pleasure? |
| IT strategy | Does the company have an IT strategy? If not, is it discussed? Are you interested? Does the strategy affect daily work? |
| IT in the future | How will IT affect work in 5-10 years? Interested in the IT debate? Concept knowledge: EDI, product modeling, IAI, bandwidth? |

# Appendix B Case Study Analysis and Interpretation

This section describes the steps taken in the analysis and interpretation of the primary case study data, i.e. the interviews.

## Grounded Theory

Transcribe the recorded interviews into text files. Move the files into the NUD*IST software, where the structure of the report and the system model are used as a base for structuring the data.

Every relevant statement made by the interviewees must be classified and "tagged" in the software. As new categories are found, using a intuitive method of finding patterns in the data, the structure of the data should be adjusted. When all the data is classified, make queries into the data in order to find different views, new ways of grouping answers, and hereby new perspectives on the problems discussed.

## Hermenuetical Interpretation

Follow the four levels of interpretation:

1. "Single" hermeneutics: try to find and describe *the individuals own interpretation* of their subjective and inter-subjective cultural reality.
2. "Double" hermeneutics: analyze *my own efforts to understand* this reality.
3. "Triple" hermeneutics: try to define the *structures and processes* that affect the studied subject's as well my own interpretation of its situation and research themes respectively.
4. "Quadruple" hermeneutics: question, or even ridicule, the three previous steps, showing their ironies and inconsistencies.

The fourth level must not be overly emphasized. The main effort should be to move between the levels, using a *reflexive* method, where the interpretations are reflected in each other, as well as in themselves. This must as often as possible be applied to all references to case data.

Use the table below for reference:

| **Element/level** | **Focus** |
|---|---|
| Interaction with empiric data | Statements, own observations etc. |
| Interpretation | Underlying meanings |
| Critical interpretation | Ideology, politics, social reproduction |
| Self critic and lingual reflection | Own text, claims of authority, selectivity |