COMPUTING AND DESIGN IN THE CANADIAN SCHOOLS OF ARCHITECTURE AND LANDSCAPE ARCHITECTURE:

A PROPOSED RESEARCH AGENDA FOR INTEGRATED CAD & GIS IN THE 1990'S

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ABSTRACT

Conventional computer systems currently used by architecture and landscape architecture are not addressing complex decision making, system interface, dynamic manipulation and real time visualization of data.

This paper identifies a strategy by which Canadian Schools could form a supportive network, incorporate and expand their research development. Within this larger framework schools would have better tools, a larger research base and access to funding as a group.

The following discussion is an idea of what we at the Canadian Schools need to do differently over the next five years in our research and teaching in order to make a unique contribution to our fields.

1. WHAT ARE THE PROBLEMS AND ISSUES?

Computers are useless, they can only give you answers
Pablo Picasso , 1881-1973

CACDE: Canadian Association for Computers in Design Education.
ACEDI: Association Canadienne D'education de Design par Informatique.

CACDE / ACEDI was formed three years ago in order to exchange information and gain some understanding of what computer activities were taking place at the Canadian schools and what issues were foremost in people's minds. The first meeting took place at Toronto in 1986. At that meeting it was resolved to form the association to facilitate this purpose. McGill hosted the second meeting. The third meeting was held in association with the ACADIA conference in Raleigh, N.C. in 1987 and Calgary hosted the spring 1988 meeting. Montreal hosted the fall 1988 meeting and Waterloo will host the Spring 1989 meeting. The major activity of the association has involved the networking of staff assigned computer-aided design responsibilities at most of the ten schools of architecture and five schools of landscape architecture in Canada.

1.1. Problems Faced By The Schools.

The staff that have participated have all expressed concern for their ability to cope as individuals with the rapid pace of developments in this field. The fundamental problems common to all of the schools are;

- inability of any one school to obtain adequate in-house expertise to be able to expose students to the broad range of subjects being influenced by computers and information technology.

- the technology is changing at a pace where both the knowledge of a professor and the equipment used to deliver a given course can become outmoded in as little as 24 months without updating and adaptation of course syllabi.

- the schools are also having difficulty doing credible research on their own in comparison to better funded schools in the United States and Europe. The international reputation of our teaching and research will be seen as second class unless some collaboration among the Canadian schools is established. Students that wish to specialize in the area usually have to leave the country to get an adequate education.

The association has had some success in helping to keep its members abreast of new equipment and software and in developing a collective experience with efforts to use computers in studio and support course teaching. None of the schools participating have sufficient budgets to hire computer expertise and equipment for all of the subject areas that can make effective use of computers. Some schools have strong building science people, while others are using computers primarily in selected areas of design. It is our hope to develop a proposal for the coordinated exchange of staff for lectures and workshops among the schools in the future. In the meantime, the organization has been exchanging course descriptions, tutorials, and schools profiles. In some cases, staff exchanges have been developed. In a couple of cases, software has also been exchanged.

The group has been meeting on a biannual basis and has initiated an electronic mail and conference network in order to maximize our ability to communicate and assist each other on a day-to-day basis. The electronic conference is operated through the University of Guelph and is free to access on the electronic mail network.

Our goal is to make efficient use of the resources of the participating schools through exchanges of knowledge, staff and technology.

The objectives of the organization are;

1 - to foster the exchange of ideas and experience with the use of computers in teaching design.

2 - to facilitate the exchange of teachers and course materials.

3 - to establish a collaborative strategy for research on C.A.D.& GIS at Canadian Schools.

1.2 Issues Facing Research:

1. Design and Planning schools tend to have one or two staff members assigned to the general all encompassing area of CAD, most schools are only 'one person deep' [CACDE Survey 1987].

2. A significant number of Canadians involved in design research have independently demonstrated a collective interest with the role of time and visualization in design process and experience.

3. Given common interests, equipment environments and extremely limited access to funding, the Canadian Schools actively involved in

research at this level are slowly realizing that researchers need to work in a more supportive manner

The increase in complexity and volume of information needed for responsible decision making, in response to contemporary environmental concerns, has been burgeoning over the past three decades. The automation of data processing relevant to design and planning activities has been on going. The principle advances for design have come in the development of software that facilitates the design process, in part, such as tools for analysis and production. The limitations of such software stem from the fact that they attempt to automate tasks such as drafting and map making, while ignoring the intuitive and cognitive aspects of design activities. These activities are wide ranging and can include site selection, site analysis, design conceptualization, program preparation, data synthesis,and production, etc. These activities can not always be resolved using common computational tools and approaches [Mutunayagam 1987].

The computer-aided design (CAD) and geographic information system (GIS) technology as it is presently used displays three fundamental deficiencies that we believe can be addressed effectively by the participants in CACDE. First, when one needs to examine problems involving building and site more than one scale of information necessary. However the use of both GIS and CAD technologies simultaneously is an extremely difficult if not impossible task [Lindhult 1988]. The second problem stems from limitations imposed by the static two-dimensional data representations used by most commercially supported CAD and GIS technology. Third, these conventional systems are not object oriented, but use computer graphic semantics for the classification (ie layers or polygons). This subject area has been chosen as the focus of our collective research efforts and best captures the unique collaboration of architects and landscape architects in CACDE.

2. WHY DO WE NEED A COOPERATIVE RESEARCH NETWORK?

When the cat and mouse agree the grocer is in trouble
Persian proverb

In Canadian schools the more sophisticated levels of computer activity usually occur at the universities with strong computer graphics groups in computer science departments(1). There is, however, a need for a more consolidated approach in Canadian research and practice in dynamic integrated visualization, analysis and modelling systems for architecture, landscape architecture and land planning.

The current state of the art in computer technology intended for use by these disciplines is extremely limited. The current technologies of CAD (Computer-Aided Design) and GIS (Geographic Information Systems) are ideal formats to change, store, and access static representations of environmental design and planning information. An approach is needed that draws upon these systems a base for the development of a new generation of computer tools. These tools would be aimed at supporting professionals in the determination of optimal solutions to complex environmental design problems that involve physical development, construction or use.

2.1. Goals And Objectives

Our proposed strategy is centred around a cooperative research effort (a network) among the majority of Canadian Schools of Architecture and Landscape Architecture. We propose this approach to address the challenge of this year's (1989) ACADIA agenda.

The research should focus on two fundamental contributions to knowledge. One contribution is the synthesis of research work at the participating schools to form a new generation of research tools integrated to address issues of building and site together. This will be used for the development of tools for the support of design thinking and representation. Secondly, research should take place in the form of creative professional practice using a computer system applied to positively influence decisions and designs for significant real world applications.

Project development will focus on developing and examining analytical and problem solving tools for use with CAD & GIS technology in environmental decision-making at four scales; building and structure performance,site planning and land development (land parcels, district planning, and regional analysis).

The goals are:

1. To establish an administrative and systems (software and equipment) infrastructure across the country to support collaborative research

2. The national sharing of existing resources and exchange of state-of-the-art software & expertise between the membership of the network.

3. To provide researchers outside major research facilities with state-of-the-art technology and assist them to participate in nationally significant research.

The network will allow researchers and professionals across the network to focus their time and resources on the unique dimension of their work. Researchers will not have to invest precious time and resources in the support of expensive research facilities to undertake unique and useful work.

The objectives are :

The research activities are aimed at the creation of a new generation of integrated software. This will enable dynamic interaction, modelling, and simulation of environmental design problems and establish a base for a coherent, integrated set of tools for research in both software development and the practical application of existing tools and commercial systems in design applications research. The Network's Objectives are:

1. To develop a means of data and software exchange between the various GIS and CAD systems in use and under development by the network.
2. To develop a dynamic interactive work environment.
3. To develop a set of dynamic three-dimensional shape based tools founded on architectural, landscape architectural and land planning vocabulary.
4. To develop a set of dynamic interactive analytical tools for testing the performance of design and planning projects.
5. To apply these tools in creative practice and studio teaching.

3. WHAT IS THE SPECIFIC DIRECTION OF THE NETWORK?

Researchers in design need to be able to share experience and knowledge about the rapid advances in hardware and software technology in a working research context. We believe that the fundamental research required to utilize and expand on such systems has been achieved. Some existing centres in this network have amassed an impressive portfolio of individual software tools and have applied those tools on practical design problems. However, few groups of design oriented research are capable of fully addressing the development of integrated, dynamic

technology for linking CAD and GIS technology for use in in the design and planning fields.

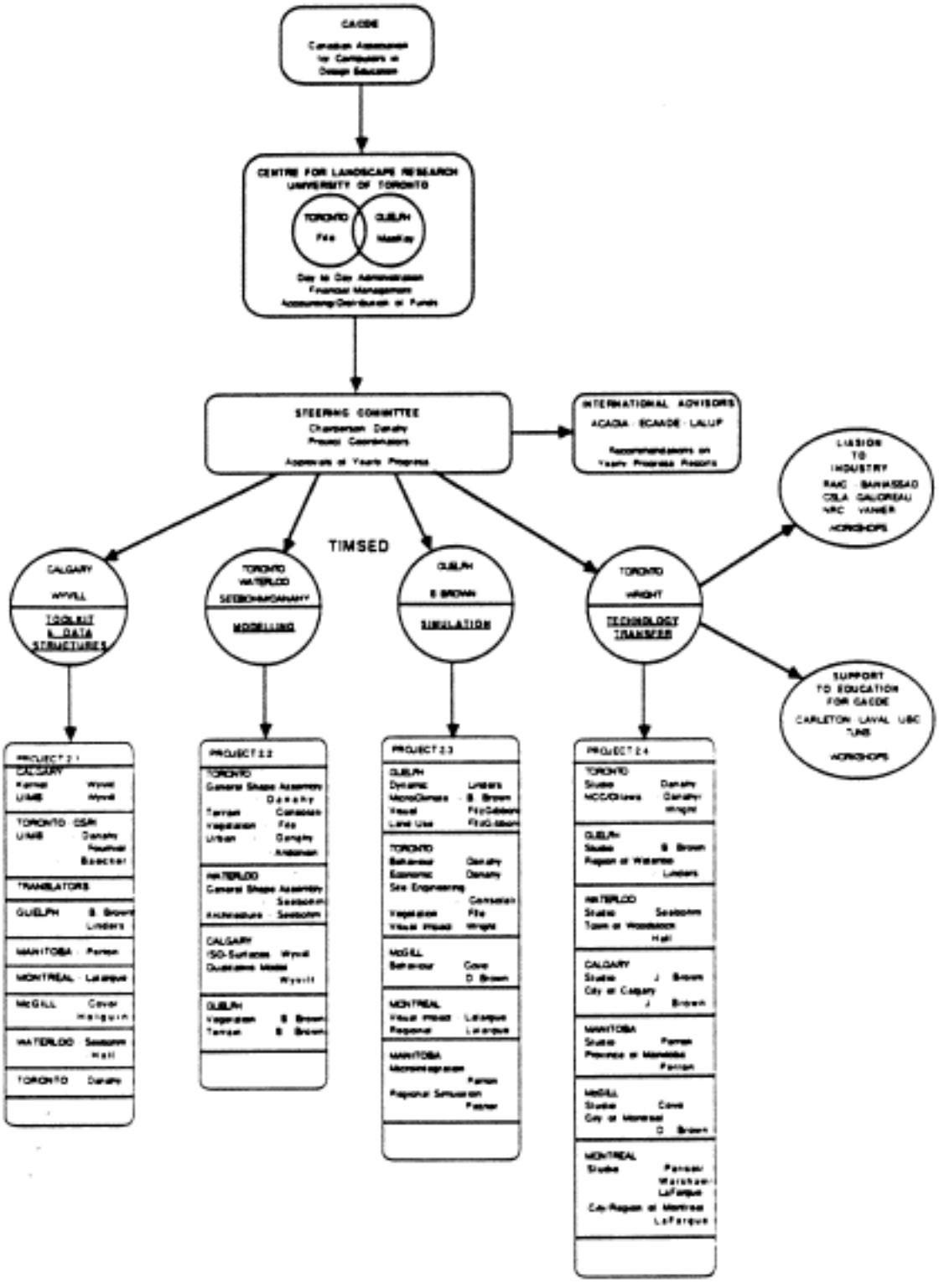
We would propose to make the software developed to date available for use by Canadian schools and professional practice (specific applications) by distribution of system packages through the network of schools of architecture, landscape architecture and environmental design and planning across the country. Further development of this research in software will extend the usefulness of CAD and GIS systems currently in use. The practical use of such a system in professional practice will serve to play a significant leadership role in the direction that commercial CAD and GIS systems will take in the future and will advance our capacity to integrate multi-dimensional spatial information at the early stages of environmental design and planning decision-making.

4. WHAT EMPHASIS SHOULD THE NETWORK PURSUE?

If I had been present at the creation I would have given some useful hints.
***Alfonse The Wise** , 1221-1284*

The joint aim of this group is to develop a set of tools that properly support synthesis and optimization of design and planning used in our physical environment.This network will bring prototype systems together into one integrated and comprehensive research and design tool. The software portfolio will serve as a comprehensive base for environmental design professionals and researchers. It will have the capacity to represent and support dynamic manipulation of physical and abstract models of the environment at a variety of scales. The basic prototypes for this system exist now at three of the participating research units.

The project will draw upon research personnel in Computer Science and Design from these three universities. The software portfolio will be used by this network as a common framework for the synthesis of environmental design and planning information. The system is composed of a a set of visualization and data presentation tools, and a common data structure which an infinite variety of simulation, analysis and modelling software modules can access. The structure will allow for importation of data from Geographic Information Systems and Computer-Aided Design Systems. The current prototype of the system imports data from existing commercial and academic modelling and rendering packages (ie. AutoCAD) and can import polygonal or rasterized data from geographic information systems (refer to figures 1 to 2).



The Dynamic Modelling & Simulation Network

Figure 1. Illustrates the type of prototypical work environment to be developed. GIS and CAD source data files could be brought together to facilitate modelling & simulation of terrain, roads, vegetation and buildings.

The research programme for the proposed network and the tools developed will be focused on four major areas.

1. Toolkit: Interaction dynamics and Data Structures (data base, UIMS)

The Toolkit project is to integrate the object oriented computer graphics system and user interface software already developed to a point where it can be easily used by the network. This system includes a high level language suitable for describing design experiments. It can also be used as a unifying tool for communicating ideas between the network.

2. 3D Modelling: Spatial Shape Assembly & Editing (in GIS &CAD)

This seeks to prototype and build a set of modelling software modules that operate within the common interaction and visualization tools currently available and being developed. These modules will permit one to model three-dimensional space and shape in real time for use in CAD and GIS applications as a support to intuitively driven and knowledge base directed design and planning modelling.

3. Simulation: Analytical Assessment Techniques (GIS to 4D Analysis)

The goal of this project is to incorporate the information storage and analytical modelling capabilities of GIS into larger scale, data intensive situations, leading ultimately to full integration into the 3-D, dynamic, real time environment of CADD. Individual researchers will undertake the development of simulation and analysis modules in areas such as pedestrian & vehicular movement, plant growth, microclimate, urban design economics, zoning, and energy.

4. Environmental Design Evaluation: Applications Testbed & Technology Transfer

A primary task in support of a sophisticated integrated computing system is to ensure that it is tested in a range of applications. This will require that a series of test situations be devised to compare and evaluate the system against predicted performances and project objectives. This type of critical review will guide effective tool building and help to devise more efficient means of technology transfer and professional feedback.

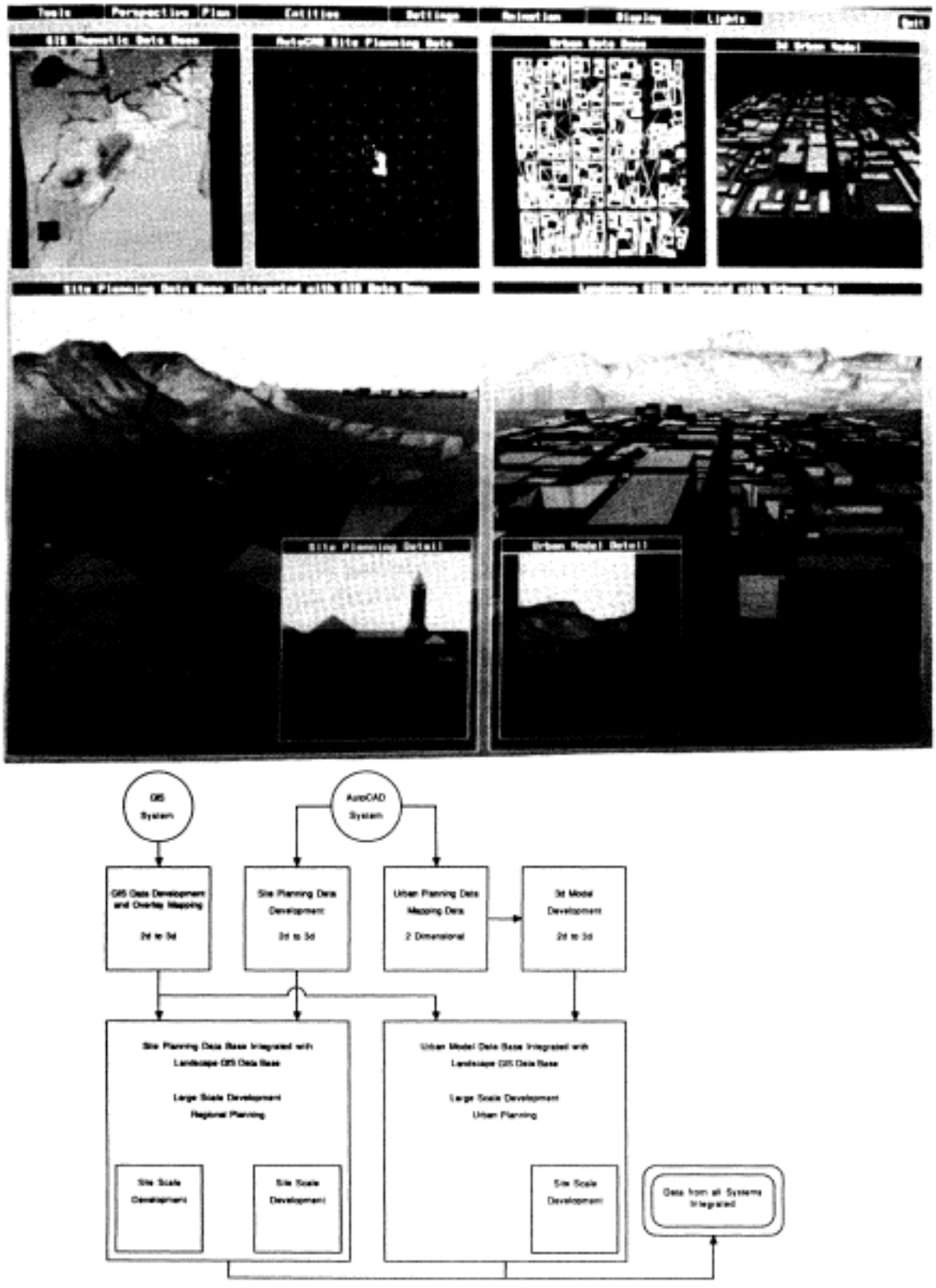


Figure 2. Illustrates the prototypical work environment to be developed. GIS and CAD source data files could be brought together to facilitate modelling and simulation of terrain, roads, vegetation and buildings. (a) The screen image. (b) The flow of data.

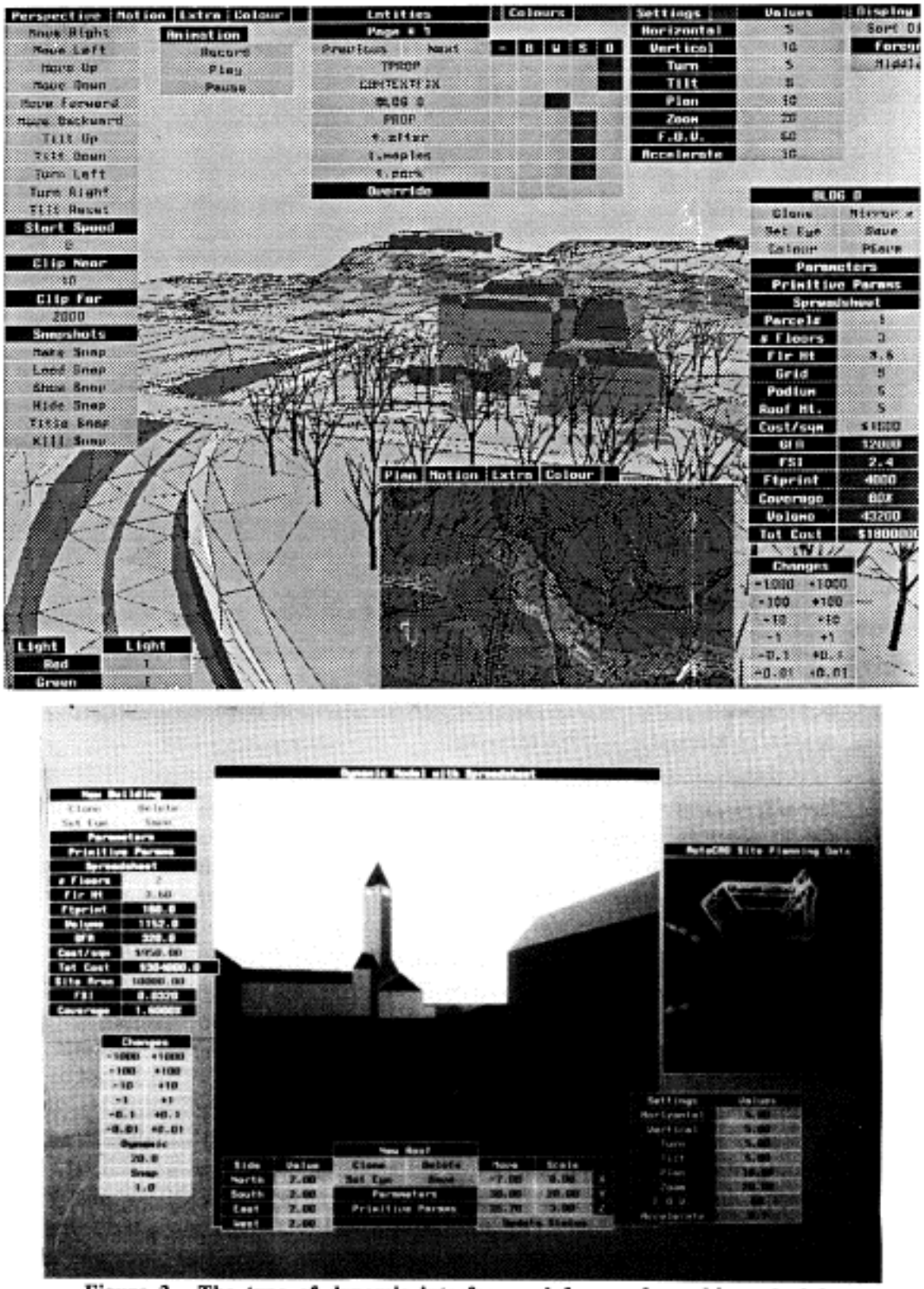


Figure 3. The type of dynamic interface and forms of graphic and alpha numeric representations available to researchers for the development of modelling and simulation modules and for applications in design studios and professional work.

5. HOW DO WE START?

I know the answer! It lies within the heart of all mankind! The answer is twelve?
I think I am in the wrong room
Charles Schulz

5.1. Structure.

CACDE has, in the last three years, acted as a proving ground for research interaction by encouraging networked electronic communications between participants. This interlinking of members has acted as a catalyst to the exchange of knowledge between researchers across Canada. It is intended to further advance this method of communication in the Network, by using it as a vehicle for the simultaneous dissemination, and assimilation, of completed software modules to all network sites.

A steering committee will be formed. The work of this group will be conducted electronically, It will be expected to act as a clearing house for ideas generated both inside and outside of the network, compiled from relevant literature and from contact with peers, both at home and abroad. This is intended to formalize the research exchange in a coherent manner.

Investigators involved in each project will be responsible for the co-ordination of the development of software modules for each component. Researchers within the network will contribute software or undertake applications testing of software under the direction of the principle investigators and report results back to the larger group.

The committee will form regional facilities for research for the transfer of methods and tools to the professions, government agencies and the building industry. Initially it will begin at the schools with the resources & personnel to undertake this role. This could take the form of a formal cooperative strategy between Toronto, Guelph and Calgary in software development effort for a comprehensive prototype system. The aim will then be to develop a research record suitable to acquire funding of the implementation of this system at all of the schools in the CACDE network. In the meantime, those schools unable to purchase $20,000 to $40,000 work stations will be invited to work as visiting researchers at the three research centres. It is hoped that these centres can help other schools get involved in this effort and eventually play a similar role for their own region.

We hope to standardize hardware and software acquisitions where feasible. This will have the twin benefits of being a more cost effective way to proceed and will also facilitate software sharing amongst members. The intent is to equip each centre with a common hardware and software platform to be used as the basic building blocks for the development of the new generation of research and production computer programs.

A major component of the project will be the integration of program modules. In co-operation with the development sites, the Universities of Toronto, Guelph, and Calgary will act as focal points for evaluating and integrating the newly developed CAD and GIS programs into self-contained software packages.

5.2 Starting Out:

The network will begin operating by;

1. Sharing software eg. (IRIS / SUN / VAX) on high end simulation.
2. Share modifications & macros in existing commercial systems that make them more useful.
3. Train people how to use the software.
4. Provide opportunities for academics at the schools with no resources the opportunity to work on projects at those schools with existing capabilities
5. Develop a coherent and complementary role for each person and school

5.3. Cooperative Involvement:

A four part categorization of projects will permit individual researchers at any of the schools to participate in the effort of:

1. systems development
2. modelling modules
3. dynamic simulation modules
4. application projects & data base development

Cooperative involvement will result in the development of basic simulation models & theory for implementation during workshops at the research hubs. It will help in the development of translators or macros in conventional systems that expedites the process of sharing on a variety of hardware systems. The CACDE membership are hopeful the network will lead to field testing and experimentation where proficient users of conventional systems undertake similar exercises to those done using the new prototypical systems to compare relative performance and critical requirements for user interface.

5.4. Network Activities:

The activities of the network may be summarized by the following points;

1. The development of a common hardware & operating system so that information exchange is possible
2. An exchange/portfolio of software tools will be made available to all participants. This will provide a comprehensive research support environment from a software point of view
3. Three hubs for simulation & high level testing will be developed, at Calgary, Guelph and Toronto the three hubs are responsible for development, dissemination and support of software to participating centres.
4. This organizational structure will insure effective communication and operational structures to coordinate research activities, apply for grants.
5. Individuals will access the hub facilities as; visiting researchers, through project participation, training, seminars and workshops. There will be at least two major symposiums a year at one of the participating hubs.
6. The network will conduct pilot projects with significant public agencies & industry to test technology transfer

5.5. Existing Research Environments

A survey of schools revealed that a common denominator in higher level computing at the participating schools was the Silicon Graphics IRIS workstation. The three schools that had active software development programmes underway

were doing the work on IRIS computers networked with Sun and Vax computing networks. These universities would provide basic research infrastructure with respect to conventional computational systems and software portfolio of GIS and CAD systems used for conventional research and professional application in industry.

5.6. Involvement of the Profession & Industry

In addition to productive internal working relationships, it is important that committee members actively maintain an on-going liaison with end user communities, be they municipal or regional governments, design establishments or the building industry. It is vital that representatives from these external groups be encouraged to act as contributors to the Steering Committee to assist it in defining research goals which are both attainable and which have practical application in the public and private sectors. Following the distribution of new problem solving tools, feedback must be garnered from users, and contact maintained at a high level.

6. HOW DO WE EVALUATE THE EFFECTIVENESS OF THE NETWORK?

I don't know the key to success but the key to failure is trying to please everybody.
Bill Cosby

The desire to apply computer technology to practical planning and design problems is increasing. The difficulty however for a wide variety of researchers has been in the cost of capital investments required for sophisticated graphic computers, specific planning and design software development, staff training and application methods. In short, technology transfer and the sharing of experience and resources.

The central task then in research based on an integrated system is to evaluate a series of user oriented projects which compares the system objectives with the systems use and brings the user and researcher together in a critical evaluation. This method of testing will have to judge the effectiveness of the computing system to respond to the translation of individual research agendas, and to be transferred to specific user groups. The latter implies an added degree of flexibility in order to fountain within diverse, organization settings and applications.

The research focus will need to evaluate the potential for the dynamic simulation of regional planning and design activities. The problem types chosen will be drawn from the "real world" ie. municipal and regional planning authorities and agencies involved in planning and design activities, such as municipal planning problems, urban design, environmental impact assessments, land assessments, etc.

The methods of such a technology transfer, the types of tools most appropriate, the level of interaction and dynamics, the basis for training and techniques of evaluation are not well defined. A research focus on applications testing will be necessary to understand the shortcomings of system configurations and to provide necessary feedback to software and user integration and provide an ideal role for schools not active in software development to participate in an important aspect of research.

7. WHAT CONTRIBUTION DOES THE NETWORK GIVE TO RESEARCHERS, PROFESSIONALS AND SOCIETY AT LARGE?

I'm astounded by people who want to "know" the universe when it's hard enough to find your way around Chinatown.
Woody Allen

The network and tools developed are aimed at making it easier to survey the vast array of digital forms of data about a problem that is currently being establish on Computer-Aided Design) and Geographic-Information-Systems across the country. Multi-million dollar investments in equipment, software, above all, data creation and archiving systems are being made by universities, municipalities, government agencies, and private developers across Canada. We believe that this investment can made more significant by providing an effective means of access to CAD and GIS data bases and to operate on that data in dramatically more useful ways for design and planning decision making.

Recent technological breakthroughs in real-time three-dimensional computer graphics technology make it possible to assemble the various prototype systems developed at Canadian Universities in a cost-effective manner. The network will propel research and professional practice in this country a quantum leap forward. It will make it possible to research a set of questions in design and systems design that have not been possible to pursue in the design and planning fields.

The prototype software systems that have been created build upon existing state-of-the-art CAD and GIS to form a set of capabilities essential for the proper use of this technology. They form the basis for a comprehensive examination of the impact on decisions about building and development in our natural and urban environments, an examination that the participating members of this network will carry out. A parallel group of researchers at participating schools will use these systems and develop decision-making methodologies for the transfer of the technology into the field.

8. SO WHY HAVEN'T YOU CALLED US YET?

We would like to invite researchers in other countries to join our effort as active participants or for information exchange and peer review. If you are interested in participating in such a network please contact CACDE.

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