A.D.A.M. - ARCHITECTURAL DESIGN APPLICATIONS MODEL

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ABSTRACT

This paper will describe ADAM, a project to explore the potential for interfacing independent graphics software for the purpose of developing a microcomputer based design system. This system will be implemented in three undergraduate design studios at the University of Illinois (Urbana-Champaign) School of Architecture. The three design studios are part of an experimental project to determine the usefulness of computers in the architectural design curriculum.

The concept used throughout the design of this system is: "make use of what already exists, but use it smoothly together in such a way that the management system is totally invisible to the user." Many low-end quality graphics software packages are commercially available. Each has the capacity to address some aspect of the architectural design process, none will do it all. The problem is a lack of compatibility between software.

ADAM is a management system designed to invisibly control and interface the use of an assembly of graphics programs and data base management systems to achieve compatibility. Because of these compatible interfaces, new and varied design tools can be created from existing software.

INTRODUCTION

Since the late 1970s, developments in the field of microcomputers have made this new technology affordable and accessible to professions, which typically have not been associated with computer automation. Although architects have been slow and reluctant to change, they have begun to appreciate the advantages of office automation. In the mid 1980s it is not uncommon to see personal computers in the smallest architecture office. Along with the new developments in microprocessors, software developers have begun to address a newly found clientele. These new clients are visually oriented people: the pictures and diagrams they use are more descriptive and easier to interpret than words or numbers. Therefore, graphics software development is now specifically addressing "visual" professions such as architecture and other graphic arts.

The Architectural Design Applications Model (ADAM) is a research project which takes advantage of the developments in both microcomputer hardware and software. The emphasis of this project is to experiment with the potential for interfacing existing microcomputer software and hardware.

The content of this text is not intended to be the complete design specification for an architectural design system, although it addresses the development and feasibility of several tools which can enhance the design
process. These new tools are the result of combining (interfacing) existing software packages, the potential for which exists in many of the commercially available software packages. We plan to continue to expand this project, and have the flexibility to change as technology changes in order to maintain an element of diversity.

This document presents a general description of the project and its components, the design procedures used to develop the project, and implications for future enhancements. The actual design specifications and implementation procedures are separate documents. They include technical information and computer code for component interfaces. Each interface is contained in a separate document and should soon be available upon request. The following is a list of these documents:

1) AutoCAD to Dr. Halo Interface
2) Dr. Halo to AutoCAD Interface
3) AutoCAD to Cubicomp Picture Maker Interface
4) ADAM Drawing Data Base
5) ADAM System Design and Implementation
6) CadCAMERA / Data Copy Digitizer

PROBLEM STATEMENT

Background Information

The School of Architecture has received a significant portion of the $2.5 million dollar Project EXCEL grant from IBM to the University of Illinois at Urbana-Champaign. "The purpose for including the architecture curriculum in this experiment is to determine whether computers can significantly improve the teaching of architecture."

There are many potential uses for the computers in the School of Architecture, and all will eventually be explored. One obvious area which presents an innovative and exciting approach to architecture design is that of computer graphics. The Design Department is exploring this possibility by installing graphics workstations in three experimental design studios. Each studio is equipped with graphic workstations which consists of an IBM AT computer, professional graphics display, and a Mouse Systems Mouse input device. In addition to the workstations, one "B" size plotter and several dot matrix printers are available in each studio. The primary graphics software being used is the AutoCAD drafting system. These experimental studios will assist in determining whether computers can enhance and stimulate the architectural design process.

While working with these studios, the primary concern of the faculty and students is the limitations imposed on them by the software. Although there is a proliferation of quality graphics packages commercially available, there is a severe compatibility problem. Each package may successfully address individual aspects of the design process, but falls short of being a complete design tool by itself. Unlike main-frame or mini-computers, entire design systems are not yet available for microcomputers. Currently, it does not appear commercially feasible to market a design system for microcomputers with a sales value equal to two to three times the price of the computer system itself.
Purpose

The purpose of A.D.A.M. is two fold. As a research project, it has significant implications for future software development. The concept of interfacing independent software packages to develop a customized system has little or no precedence in the microcomputer world. However, many of the quality software producers are now providing an input/output facility with their products to allow user interfacing and customizing.

A more immediate purpose of this project is to provide architectural design students at the University of Illinois with additional design tools. The key word is design, rather than documentation. Computer Aided Drafting systems, such as the one used in the experimental design studios, are typically tools for documenting completed designs. Accurate documentation is an important aspect of the design process, but it is one of many, and certainly not the most important.² The intent of A.D.A.M. is to provide the architectural design student with a set of tools which will enhance and stimulate the creativity of the designer as well as to provide a means of documenting the completed design. The system will provide several modes of design (sketch, hard-line, 2D, 3D) to simulate aspects of the design process. Typically the
architect thinks and draws in many design modes (see Design Modes Diagram: Fig. 1); therefore, a design system should allow drawing files to be easily transferred from one design mode to another. Initially this project addresses only particular design modes for which software exists. This project does not entail the development of new software products, but the interfacing of existing ones. Through these interfaces, the ADAM system will develop the beginnings of a design system for microcomputers.

Project Proposal

The Architectural Design Application Model is an integrated computer graphics applications model for architectural design. Using existing micro-based computer software and hardware, the interfaces for task specific programs to other programs have been developed. The intent is not to redesign what already exists, nor to design one program which does everything; both ideas are impractical. Instead, ADAM is an assembly of a select group of software packages which successfully address a particular aspect(s) of the design process, and interfaces between them. The system will have a controlling program which manages the various software packages and interface programs. The management system will be discussed and its design outlined; however, the focus of this project is the interface.

Project Constraints

Because the School of Architecture has a very limited budget and has existing investments in hardware and software, the following guidelines had to be observed:

1) The hardware to be used must be that which already exists in the design studios, or can be approved for purchase.
2) The AutoCAD drafting package has been adapted by the School of Architecture and is to be at the heart of the graphic documentation system.
3) The design system should be ready for preliminary testing during the fall of 1986.
4) Additional software to be acquired must be approved by the School of Architecture.
5) The DR. Halo paint program is currently used in the School of Art and Design. It has proven to be a versatile and inexpensive program and will, therefore, be included in the ADAM project.
6) CadCUNRA software, because of its compatibility with AutoCAD, is to be used as part of the raster to vector conversions (see Function Components, CadCUNRA).

PROJECT PLAN

Development Structure

The scope of this project required a development plan. Because this system design included many components, it had to be developed on two levels: a systems level and an interface design level. At the systems level, the design must unify the graphics programs and their interfaces, be invisible to the user, and function as one coherent system. The interface design level takes into account specific software packages (AutoCAD to DR. Halo,
DR. Halo to CadCAMERA, etc.). The general design development of this project can be categorized into four phases as follows:

1) Understanding the requirements and tools of the architectural designer
2) Software interfaces
3) Management system
4) Testing

Development Schedule

Phases 1 through 4 represent general areas of development but not the order of development. The following is a planned development schedule:

1) Research requirements and tools of the architect
2) Develop basic software interfaces
   a) AutoCAD --- DR. HALO
   b) DR. HALO --- AutoCAD
   c) AutoCAD --- Cubicomp Picture Maker
3) Design and develop drawing data base
4) Develop preliminary management system
   a) Applications display management system
   b) Batch files
5) Refine interfaces and management system
6) Customize menus of existing software
7) Customize and refine management system
8) Testing

Each development phase will overlap and lead into the design of the next. Phase 8, TESTING, will take place during all phases except phase 1. The experimental design studios will serve as test facilities. As component interfaces are completed, they will be implemented in the design studios and tested. The testing will not only reveal problems or bugs in the program, but also provide suggestions for improvements and future enhancements.

Project Priorities

Priorities have been established to assure use as the project continues to develop. The following is a prioritized list of tasks to be completed:

Highest priority: 1) basic interfaces
                2) preliminary management program
                3) basic drawing data base management system
                4) customize existing paint program
                5) customize AutoCAD functions and menus
Lowest priority: 6) customize management program

FUNCTIONAL COMPONENTS

The ADAM system is composed of selected graphics software, interface programs, and system management programs. In keeping with the design philosophy of this project (make use of what already exists), all of these
components (except the interfaces) are commercially available. The following is a list and brief description of each of these components:

1) AutoCAD Computer Aided Drafting System
2) DR. Halo Paint Program
3) Picture Maker
4) Application Display Management System
5) CadCAMERa
6) D-Base III
7) Data Copy Digitizer
8) Interface programs
   a) AutoCAD --- DR. Halo
   b) DR. Halo --- AutoCAD
   c) AutoCAD --- Picture Maker

AutoCAD

AutoCAD is a professional computer aided drafting package for microcomputers. It was designed for use by architects and engineers. It contains the drawing and editing functions necessary to produce accurate construction or presentation drawings. Although AutoCAD physically operates on modern raster display technology, its logical operations are those found in a vector environment. Entities are displayed, stored, and edited using vector commands. The constant updating required to store this information, although necessary, causes the program to run slowly. AutoCAD has the potential to store a large amount of data, most of which relates directly to graphic information, but some of which can be attribute (non-graphic) information. For this reason, and because of the versatile file input output facilities of AutoCAD, it will be at the heart of the ADAM system.

DR. Halo

DR. Halo, a professional paint program for use on microcomputers, was originally developed for artists. Because it contains no data structure for storing vectors, the response time is minimal. It has the potential for 255 colors (dependent on the graphics card), and color bit manipulation is easily implemented. The program is user friendly and works much like an artist's sketch pad. There is a great deal of freedom in the manner in which this program can be used. The inherent limitations with a paint program are those dealing with scale and accuracy.

DR. Halo operates in a raster environment rather than the vector environment of AutoCAD. Initially, the DR. Halo paint program will be used for two purposes: that of color rendering and conceptual sketching. The interface between AutoCAD and DR. Halo allows a drawing created in AutoCAD (vector program) to be rendered in DR. Halo (raster program). The DR. Halo to AutoCAD interface (via CadCAMERa software) allows a conceptual sketch created in DR. Halo to be formalized in AutoCAD.

Picture Maker

Picture Maker is a modeling package developed by Cubicomp Inc. It provides 3D solid modeling, color rendering, multiple light source simulation, and
object animation. Picture Maker operates in two environments as does AutoCAD. Physically it operates on a modern raster technology, but logically it creates, stores, and edits vectors. The AutoCAD to Picture Maker interface provides a method of accessing two dimensional AutoCAD drawings and editing them into three dimensional Picture Maker files. (Because this interface is a project of significant size and complexity, it will not be formally addressed in this project, but is being undertaken by David Ligon, MCS student, University of Illinois.)

Applications Display Management System

ADMS is a systems management software package marketed through the IBM Corporation. Its intent is to provide a consistent and foolproof method of entering user information through the use of screen menus with predefined input fields.

At the time of this project, ADMS had just been released and very little information was available concerning its use. The original intent was for the ADMS system to assume control of ADAM and make the individual programs and interfaces invisible to the user. After researching this product, it was determined that a simpler approach would be more appropriate during the development stages of this project. Rather than using ADMS, several batch programs and pascal programs will be used to display menus and prompt the user for input. In the future, however, ADMS may become a more effective method of controlling the system.

CadCAMERA

CadCAMERA is a raster to vector conversion program developed by AutoDesk INC. It is 100% compatible with AutoCAD software. CadCAMERA was originally intended to be used with a Data Copy digitizing camera for the purpose of digitizing existing hard copy drawings into AutoCAD compatible files. CadCAMERA converts all drawing elements into either lines or solids, and places them on the respective layers named line and solid. The ADAM system will use CadCAMERA to convert a DR. Halo drawing file (raster) into AutoCAD drawing file (vector) as well as for the purpose of digitizing hard copy drawings.

D-Base III

D-Base III is a data base management system for microcomputers. It provides a set of tools to organize and manipulate data. These tools are found in a versatile programming language unique to D-Base III. From within this data base management system, a customized data base can be designed.

This drawing data base will be used in conjunction with the Multi Halo graphics display drivers. The data base is a relational data base which associates attributes with drawing names. A drawing or group of drawings can therefore be queried by any number of user specified attributes. The drawings to be displayed from within this data base are actually AutoCAD drawings converted into DR. Halo drawing files (see Data Base Design diagram: Fig. 2). The advantage of displaying drawings outside of AutoCAD is the ability to page through queried drawings very quickly. Only the
The drawing data base will contain commonly used construction details and pertinent attribute information. These details have been organized into sixteen categories based upon the Construction Specification Institute and recommendations from the Construction Technologies faculty at the University of Illinois. Only one or two categories from within the sixteen are being addressed at this time (see Data Base Organization diagram: Fig. 3), but their design will set the precedent for the development of the remaining categories.

AutoCAD to DR. Halo Interface

The AutoCAD to DR. Halo interface is the link between AutoCAD's vector environment and DR. Halo's raster environment. There are two methods used to convert an AutoCAD drawing into a DR. Halo file. The first involves using the output drawing exchange facility of AutoCAD (See Sample DXF File: Fig. 4). In essence, this interface program reads each vector in the AutoCAD DXF file and converts it into a raster image. This image is then stored in a DR. Halo file format. The second method simply reads each pixel from an AutoCAD display (display buffer) into a DR. Halo file. Specific circumstances dictate the use of one method over the other. This
information can be found with the technical specifications document for this interface.

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Note: This is one section of an AutoCAD DXF file. This section describes the method used for storing vectors (lines, circles, etc.).

DR. Halo to AutoCAD Interface

The DR. Halo to AutoCAD interface is the reverse operation of the previous interface; it is a raster to vector conversion. This type of conversion is time consuming and computationally intensive. A conversion may take anywhere from 5 minutes up to 1 1/2 hours depending on drawing size and complexity. The CadCAMERA software developed by AutoDesk INC. does all of the actual raster to vector conversion. However, the DR. Halo picture file which CadCAMERA is to read must first be formatted. A Pascal program performs all formatting tasks and sets up the desired color transfers. Because CadCAMERA is a monochrome conversion, several runs or passes are required for color transfer. Each run can mask specified colors and produce a separate file. The files are then combined with AutoCAD, and assigned unique layers and colors (see DR. Halo to AutoCAD Conversion diagram: Fig. 5); however, very sophisticated renderings would be hard copied directly from DR. Halo. To return to AutoCAD only takes place in special cases.
**Fig. 6**

**SYSTEM DATA FLOW**

AutoCAD to Picture Maker

The AutoCAD to Picture Maker interface will not be developed in this project, but it will ultimately be part of the finished system.

**Component Data Flow**

As seen from the Systems Data Flow Diagram (Fig. 6), three main arteries of data flow exist. The AutoCAD drafting system is either the starting or ending point of all data flow. AutoCAD is at the heart of this system because its drawing files contain a large amount of information, and because it has a versatile input/output facility.

The Sketch to AutoCAD data flow path begins with a sketch that has been created using the DR. Halo paint program. A 512 x 512 (resolution of screen display) bit map file is extracted from the display buffer and stored in a binary file. A short pascal program reads this file and performs the task of formatting the file to CadCAMERA specifications. CadCAMERA software originally developed for use with Data Copy camera equipment can now access the bit map file and convert the raster drawing to a compatible AutoCAD vector file.

**Fig. 7**

**SYSTEMS MODEL**

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The AutoCAD to DR. Halo data flow path begins with a drawing created in AutoCAD. This drawing is a standard AutoCAD vector file. At this point one of two conversions can be used. First, from within the interactive drawing editor, a command (DXFOUT) can be executed to output an ASCII Drawing Inter-change File (see Sample DXF File: Fig. 4). The file contains among other things a listing of all vector related drawing entities. Using AutoCAD to DR. Halo interface, these vectors can be redrawn and saved in a bit map. Finally, this bit map can then be accessed and displayed by the DR. Halo paint program. The alternative method is to first read the display buffer containing the AutoCAD image, then, using Multi-Halo graphics primitives, each pixel element in the AutoCAD image can be transferred to a DR. Halo file format. The latter conversion is raster to raster interface, while the former is a vector to raster. The raster to raster conversion would be preferred for very complex drawings due to the extremely large size of the AutoCAD DXF vector files.

The AutoCAD to Cubicomp Picture Maker interface also uses the AutoCAD drawing inter-change file (DXF). This file is used to reference individual vectors and polygons. A three dimensional editor then allows the user to apply a z (3-D) coordinate to a line object or polygon. (For a detailed description, see AutoCAD to Picture Maker documentation by David Ligon).

As seen from the System Data Flow Diagram (Fig. 6), the ADAM drawing data base does not directly interface with AutoCAD. The drawings stored in the data base are drawing files which have been converted through the AutoCAD to DR. Halo conversion prior to being installed in the data base. However, these drawings are referenced by name to the original AutoCAD drawings for access from within AutoCAD.

SYSTEM MODES

The Architectural Design Applications Model consists of a series of commercial graphics programs (AutoCAD, Picture Maker, DR. Halo, CadCAMERA), as well as informational applications programs (see Systems Model Diagram: Fig. 7). The system allows the user to transfer files between programs, therefore accommodating several modes of design. When transferring from one program to another, specific graphic or attribute information is transferred through the file interfaces. This system operates in three different environments or modes. The first and most obvious to the user is the graphics mode, followed by the informational and management modes.

Graphic Modes

The DR. Halo paint program provides the user with an excellent design tool for quick idea generation in both an abstract and real environment. Using the edit and draw commands, geometrical forms can be created, transformed, and studied. The ability to inverse the images allows for imaginative figure ground studies. Because the sketch program operates in a raster environment, response time to each command is minimal. Sketches created in DR. Halo can later be transferred to AutoCAD via the DR. Halo to AutoCAD interface. Once in AutoCAD, scaling and attribute information can be applied.
As well as being a sketch tool, the DR. Halo paint program can be used for color rendering or color studies. AutoCAD drawings, if converted through the AutoCAD to DR. Halo interface, can be color rendered in the DR. Halo paint program. Again, because DR. Halo is a raster program, colors can be applied and manipulated faster and with less effort than in the vector environment of AutoCAD. Unlike AutoCAD, the raster paint program does not store any information other than the pixel configuration to display the image; i.e., "what you see is what you get." The raster image is nothing more than dots on the screen.

In contrast to the DR. Halo paint program, AutoCAD drawings do contain vectors. Each vector is an accurate and measurable graphic element. It can be scaled, rotated, dimensioned, and printed using a pen plotter. Because of these capabilities, AutoCAD is most efficiently used as a design documentation tool, or more formally referred to as a Computer Aided Drafting System (CAD).

The final graphic facility in the ADAM system is the Cubicomp Picture Maker. The AutoCAD to Cubicomp interface under development by David Ligon allows two-dimensional AutoCAD drawings to be converted to three-dimensional Picture Maker files. The Cubicomp Picture Maker System can be used as an alternative to manually drawing perspectives of building models. With either drawings or models the product is restricted; the former by having only one vantage point, the latter in that realistic views are difficult to obtain. Picture Maker can generate multiple views from a variety of view points. These views can then be combined into animated walkthrough sequences. The sequences may simulate the approach to a building, the entrance to a room, or an aerial flight around a building. Drawings can be created using wire frame or solid modeling techniques found in Picture Maker. Other features include multiple light source representation, dynamic rotation, frame animation, and color shading.

Informational Modes

Currently the only informational facility available in the ADAM system is the drawing data base. Using D-Base III, a graphic relational data base is designed to provide the user with architectural design and construction information. There are sixteen topic headings found in the main menu of the data base with each containing sub-topics. Each sub-topic then contains a more specific data base category. For example, the main topic heading of PARTITIONS contains three sub-topics named WALLS, GLASS, and DOORS. Each of these sub-topics then contains specific attribute information that is used to query the data base (see Data Base Organization diagram: Fig. 3). The drawing data base was originally intended to be used from within AutoCAD. Ideally, the user could access the data base without leaving AutoCAD, and return to AutoCAD automatically upon exiting the data base. Unfortunately, this idealized situation is not yet feasible. The AutoCAD command "SHELL" which makes the execution of external programs possible, does not release a sufficient amount of memory to accommodate the execution of the data base. Future releases of AutoCAD may, however, enhance the SHELL command to release additional memory. For now, the drawing data base must be used externally and independently of AutoCAD.
A typical work session using the data base might include the following sequence of events:

1) The user types in ADAMDB to enter and start the drawing data base.
2) The main menu appears: it includes the 16 categories, a quit function, and a function for data base maintenance.
3) The user selects category 6, INTERIOR PARTITIONS.
4) The Interior Partitions Main Menu appears.
5) The user selects Wall Partitions.
6) The wall partitions data base is activated.
7) The data base prompts the user with several questions:
   select construction material
   select fire hour rating
   select STC rating
   select cost range
8) The data base locates drawing files which meet the above criteria.
9) The drawing names and their attributes are listed on the text screen.
10) The user can page through the drawings as they are displayed on the graphics screen.
11) Other data base queries can be performed or the data base is exited.

The drawing data base is to be one of many informational programs available to architecture students. Currently several programs are being developed to aid the architectural designer. The following is a list of current and future projects to be included in this system:

1) Elevator design
2) HVAC duct sizing
3) Cost estimating
4) Scheduling
5) Lighting design layout
6) Spatial requirements for HVAC, switch gear, etc.

Management Mode

Ideally, the ADAM management facility should be invisible to the user. However, this is not altogether possible at this time. Due to memory requirements, some software can not be used simultaneously with other software. For example, as previously stated, the drawing data base can not be executed from within AutoCAD. These and other programs may be resolved with future improvements in hardware and software.

Because of the limitations described above, the management system is designed as a simple but temporary solution. For the time being, the management program consists of several pascal programs which display menus, and prompt the user for a menu selection (see System Management diagram: Fig. 8). Upon completion of a file conversion, the converted files are automatically copied to the necessary directories, and control returned to a menu selection. There are also several batch programs which provide a means of executing several programs in a designated sequence. The Applications Display Management System which was originally intended to be
used as the control system was determined to be inefficient for the purposes of this project. The pascal and batch programs provide a simplified control system which can easily be revised or enhanced as the ADAM project continues to develop.

PROJECT IMPLICATIONS

The raster to vector and vector to raster interfaces have provided a link between two very different forms of computer graphics and further exploited the potential of AutoCAD as well as other graphics programs. The ADAM
project is not revolutionizing architecture nor the way architects design, but it is helping to improve the visual communication skills which are so important to architects.

"Through their pictorial drawings and rendering, architects attempt to visualize a building in its environment. These drawings are also used in an attempt to help clients visualize the architect's design solution. The drawings which present a static viewpoint are the only tangible means a client or architect has to visually represent a design."

Computer graphics can enhance the design process as well as improve the method of presentation, thus resulting in a more accurate and valid design solution. An element of realism, a higher degree of precision and a dynamic method of presentation can be achieved. These are areas of development which have not specifically been discussed in this project, but which have been made possible because of it.

1) Prior to entering into the schematic design phase of a project, an existing site can be photographed and video taped from various angles and different times of day. The photographs or video frames can be captured into a paint program such as DR. Halo. Within the DR. Halo program, conceptual sketches can be studied in direct relation to the actual site and from actual views to the site. The conceptual sketch can then be converted to an AutoCAD drawing using the DR. Halo to AutoCAD Interface. Within AutoCAD the drawing can be accurately scaled and formalized. The AutoCAD design drawing can then be transferred back into DR. Halo using the AutoCAD to DR. Halo interface. The image is then overlayed on the image of the site. Here the building as well as the site can then be rendered for presentation.

2) The AutoCAD to Cubicomp interface can provide a dynamic visualization of a site and building. A sequence of views can be edited on to video and displayed on large screen television. An entrance to a building can be visualized as would be seen by a person walking up to the building, or another sequence may depict a 360 degree walk around the building.

3) Extensive image analysis and image editing is also possible because of the use of raster paint programs such as DR. Halo. An aerial map of a town can be analyzed by the objects contained in specific color ranges (i.e., vegetation, roads, buildings, etc.). Using CadCAMERA and the DR. Halo to AutoCAD Interface, portions of the map can be transferred into AutoCAD as a basis for preliminary design.

These examples are not describing revolutionary computer graphics techniques; most have already been achieved on main-frame or mini-computers. However, these examples are describing processes or techniques which can now be used with microcomputers and microcomputer software.
CONCLUSION

Throughout the development of this project, much knowledge has been acquired regarding the potentials of raster graphics on microcomputers. Some of these discoveries related directly to the research of this project; others sparked ideas which proved the feasibility for future enhancements. Because this project spanned three disciplines within the University of Illinois, many people have contributed ideas and suggestions. The School of Architecture, the School of Art and Design, and the Department of Computer Science have all assisted in some capacity. The School of Art and Design has made significant contributions in the form of equipment and alternative design solutions. The use of their Electronic Imaging Laboratory (EIL) in conjunction with the development of this project has led to some fascinating discoveries relating to computer image animation, video presentations, and image analysis. Currently, research and development is being undertaken in all of these areas, each of which has direct implications for future architectural applications, and all of which are now more feasible because of the interfaces developed in the ADAM project.

There are some obvious limitations of this project as a commercial product. However, it could become a commercial product with additional refinements. At this point in time, it is the ideas behind it that are most important. These ideas are important to schools of architecture, schools of art and design, small or medium size architecture offices, or to anyone who uses microcomputer graphics workstations. They are important because graphics interfaces can greatly increase the capabilities of a microcomputer graphics workstation.

The ADAM project started out with several independent graphics software packages. Each could be used in some sense in design and could contribute to the design process, but limited by its own environment. For example, the paint program could not accommodate accuracy, scale, nor the storage of attribute information, but it featured an excellent sketch and color rendering facility. AutoCAD, on the other hand, provides a high degree of accuracy, and all the features of a professional computer aided drafting tool, but it lacked the ability to work abstractly both with forms and color. These two programs are nearly direct complements of each other; instinctively one could recognize a desired relationship between the two. ADAM relates these two programs as well as others by means of interfaces and thus increases the power and usefulness of each graphics program, and the system as a whole.

Fully integrated computer graphic design systems are still a rare commodity in the architecture profession. Several exist, but they are very expensive and are main-frame or mini-computer based. Microcomputer users typically have not enjoyed the luxury of integrated design systems. The concept employed in ADAM, however, is approaching that goal with the philosophy; "use what already exists, but make it work together."
FOOTNOTES


2. Original Grant Proposal to IBM by Professor Donald E. Bergeson, Director: Project EXCEL, School of Architecture, University of Illinois, Champaign, IL.

3. Interview with Professor Bruce Hutchings, Chairman of the Design Committee, School of Architecture, University of Illinois, Champaign, IL, January 11, 1986.


8. Ibid. p. 5.


10. Ibid.

11. Ibid.

REFERENCES


Data Copy Reference Manual.


