

INVESTIGATION OF AN  
INTEGRATED COMPUTER  
SYSTEM  
FOR ARCHITECTURAL DESIGN

by

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MASTER OF SCIENCE IN ARCHITECTURE STUDIES

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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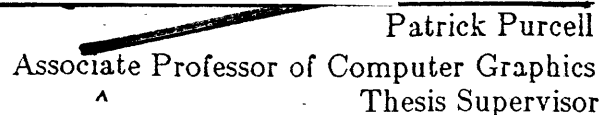
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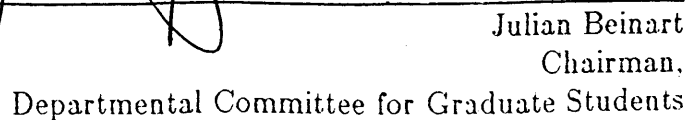
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Julian Beinart  
Chairman,  
Departmental Committee for Graduate Students

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INVESTIGATION OF AN INTEGRATED COMPUTER SYSTEM  
FOR ARCHITECTURAL DESIGN

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Therese Vien

Submitted to the Department of Architecture on June 14,  
1985 in partial fulfillment of the requirements for the degree  
of Master of Science in Architecture Studies.

**Abstract**

The objective of this study is an attempt to define a new design method merging the introduction and continuous development of computer technology in the field of building construction. The project will introduce an integrated computer system based on current state-of-the-art technology and implementation of it through two case studies which illustrate different applications. In addition this thesis will demonstrate the potentials of the system as an analytic tool and a drawing aid for teaching architectural design as well as for the professional practitioner. The proposed system combines essentially a drafting system, a data base processing system and a visual information system, which together furnish cross-referenced graphic and numeric information of any entity (buildings, sites, technical specifications, land use information, etc.). More than a design aid, the system proposes through suitable information sources, retrieval and visualization of images stored in a relational data base, using state-of-the-art emerging video and computer technologies.

Thesis Supervisor: Patrick Purcell  
Title: Associate Professor of Computer Graphics

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## INTRODUCTION

Computer technology has improved enormously in performance, especially in the world of microcomputers and software development. It seems clear that these trends will continue. Past hostility among architects to the idea of incorporating computers in the design process was caused in part by ignorance of the potentials of computer technology, but the fundamental reason undoubtedly was an economic one. Earlier Computer-Aided-Design (CAD) systems required investments far beyond the means of most architectural firms. Only the largest firms could afford to invest in the expensive equipment and wait for the extended payback period.

The situation, however changed largely because of the emergence of very small, cheap, and powerful microcomputers. Moreover, basic research conducted over the last decade established some important new theoretical foundations for the use of computer technology in the process of architectural design as well as in the practice of architecture. The improvements in microcomputer hardware and the development of software have opened a powerful potential for the field of architecture. Two factors have contributed to the emergence of this potential :

1. First, an increasingly broad range of performing software in CAD/CAM is designed to be flexible enough for use by architects.
2. Second, the rapidly decreasing cost of software and hardware due to a very competitive market has made their technology available for even the smallest architectural offices.

Nevertheless there is still no integrated software available on the market directed specifically for architectural design. Facing this "computerized architectural" phenomenon, the architecture profession should consider strategies

that will incorporate this technological development in an optimal way. One of these strategies will be the object of this thesis. Such a strategy should target at two objectives:

1. A new way of thinking and teaching architecture, as well as merging the architectural design process with the computer aided design rationale.
2. Awareness of the potential and limitations of current software in terms of architectural applications.

There is an obvious need for an integrated system which will use off-the-shelf software but will be designed to be more suitable for architectural practice. The study will attempt to define a new system of hardware and software for architectural applications. It will present an integrated computer system based on current state-of-the-art technology and it will illustrate its different applications in two case studies.

Chapter I gives a general summary about the impact of the new technology in the field of architecture. Chapter II describes the system components and explains the reasons why those elements are selected to be part of an integrated system. Chapter III presents two case studies : one in the context of building systems design and the other in the context of planning for developing countries. Chapter IV develops the potential of the system and suggests paths for future development.



## Chapter 1

### FUNDAMENTAL CONCEPTS:

#### Design in terms of integrated computer system.

##### 1.1 Impact of State-of-the-Art Technology on Architectural Design.

There has always been a healthy scepticism among architects about computer-aided-architectural design (CAAD). Architects tended to think that because computers are wholly numerate and logical, they represent the antithesis to creativity and therefore a likely constraint on design freedom. Pioneering integrated computer system have been used successfully in the UK since the 1960's. Computer-aided-design systems are most likely to have their greatest immediate impact on industrialized building system where repetition, economy and speed of construction are emphasized. Comprehensive integrated systems developed so far have some basic requirements such as:

From the building side:

- Design rules for location of components.
- Design rules for location of spaces, adjacencies, etc.
- Building description data base related to components, assemblies, sub-assemblies.
- Evaluation and optimization criteria.

From the computer side:

- A graphic representation
- A data base structure which has efficient data factoring for ease of access and multiple levels of access.

- A high capacity for storage of building descriptions.

The integrated computer systems which have been developed so far such as CEDAR 2 & 3 and CARBS (developed by the Liverpool University Computer-Aided-Design Center), OXSYS and HARNESS (Applied Research of Cambridge), SSHA (Edinburgh University CAAD Studies) are stand-alone computer systems. They all encounter a major difficulty: managing the complex and large data base that a complete building description requires. Data retrieval and processing used to require considerable CPU time. Therefore it is a relatively slow and expensive process.

State-of-the-art computer technology, especially through the means of optical videodisc technology<sup>1</sup> combined with microprocessors will allow a new approach for handling such problems. In terms of data management issues, "data factoring" is usually used to eliminate irrelevant repetition in different record fields of a building description. For example, each element in a facade would have a fairly large amount of data associated with it. It would be uneconomical to repeat this detailed description when such an element is inserted one hundred times in a facade. It would be more efficient to store one detailed description and just a list of locations of instances which occur in the building. The concept of data factoring analog to the mathematical term "highest common factor" can become extensively a "data sharing resources". In other words, the combination of a microprocessor with the videodisc will provide the two computer capabilities with substantially limited computer power, such as:

- A large amount of data can be stored on the disc (the equivalent of 1000 floppy diskettes: 360 Megabytes).

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<sup>1</sup>cf 2.4. Principles for use of an optical videodisc

- A relatively rapid random access to that data, which is made possible by the disc format.

Furthermore since this data base is terminal and computer system independent, it is possible to have a portable system or shared resource system. For example, a building system description can be accessed by different computer systems.

## **1.2 Microcomputers and Their Capabilities**

The evolution of computer technology is characterized by successive cycles which are generally referred to as computer generations. Every new generation is accompanied by the emergence of new component technologies, new types of software, and new system designs (in terms of computer architecture ). The first generation began in 1951-52. The hardware was operating at a relatively slow speed, low reliability and a limited memory capacity as well as limited software. The second generation began around 1959. The significant change in hardware configuration resides in replacing the vacuum tubes that the previous generation of machines were using with, transistors. Use of transistors reduced the physical size, cost, power consumption and air-conditioning requirements for the machinery. More software was also developed with a significant increase of memory. The third generation started in 1965. Miniaturization of electronic circuits was improved by replacing individual electronic components with electronic circuits. The fourth generation, which started in 1971-72, is characterized by the interconnection of numerous computers to form a large-scale computer network , and the introduction of relatively small and inexpensive minicomputers and microcomputers. A major factor in the development of microcomputer technology is the development and refinement of techniques for manufacturing miniature electronic silicon circuits.

Microprocessor technology has reached the point *"where tens of thousands of electronic components can be fabricated upon a chip less than a quarter of an inch square, at a cost of a fraction of a cent per component"*<sup>2</sup>. Parallel to hardware development, software development has evolved even more rapidly to the point that shrinking costs seem to constitute the trademark for the computer business.

This analysis of current software development will focus on three main areas of application:

- Computer-Aided-Design
- Data Analysis
- Computer Graphics and Image Processing

### **1.2.1 Computer-Aided-Design**

The development of computer-aided-design started in the early 60s and has been rapidly adapted to various fields such as civil, electrical, mechanical and industrial engineering. The architectural application of CAD was largely derived from applications in engineering. In the US, discussions of the potentials of CAD began to be published in the early 1960's. Significant contributors were Dawson in 1961, Eberhard in 1962, and Christopher Alexander in 1964, who published "Notes on the Synthesis of Form". Alexander's book, the result of a PHD thesis, presented a futurist computer-based method in architectural design. In 1970, Negroponte's URBAN5 was designed to be an "Experimental Urban Design Pattern"<sup>3</sup>. The concept of URBAN5 is related to the close interaction between the urban designer and a machine. Therefore the technology of URBAN5 is based to a large degree on

---

<sup>2</sup>"Computer Architectural Design" W.Mitchell 1977

<sup>3</sup>cf Computer Graphics in Architecture Design, edited by Murray Milne. Published by the Yale School of Architecture

Artificial Intelligence. URBAN5 is designed so that the user can communicate with it in simple English. The system would have the intelligence of asking for users' input, checking input errors and generating architectural graphics. URBAN5 was one of the pioneering CAD system for architectural design implemented at MIT (Architecture Machine Group), which is fundamentally concerned about man-machine interaction.

Unlike pure engineering, the architectural design process has complex criteria such as cultural and aesthetic criteria which are as equally important concerns as structural, mechanical or technical specifications. However the design of a building is based much more on informed decisions made on measurable or "quantitative" criteria as on subjective decisions or "qualitative" criteria. A computer system is undoubtedly the most appropriate means to deal with "quantitative" criteria. Furthermore software development is more and more oriented now for designing "expert systems" which is characterized by *"the symbolic nature of the tasks it performs, a broad and robust intelligence, an ability to rationalize and justify its behaviour, a capacity to expand its range of capabilities and refine its skills, and an ability to solve important problems involving complexity and uncertainty."*<sup>4</sup>

Improving performance and decreasing the cost of computer systems, both in terms of hardware and software, has made the world of CAD accessible to routine architectural practice. Chart 1, 2, 3, 4 & 5 give a summary of the CADD software, the basic hardware system required and the pricing as of March 1985.

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<sup>4</sup>"Building Expert Systems", edited by Frederick Hayes-Roth, Donald A. Waterman, Douglas B.Lenat".

Company Name	Product Name	Primary and Secondary Application	Graphic Software															Non-Graphic Software		Basic System Hardware		Hardcopy Other Than Pen Plotters		Workstation Design					Pricing		Market Data																		
			2-D Drafting	2-D Wire Frame	2-D Solid	Solid or Surface Shading	Perspective Viewing	Macro Programming	Attribute/Agency Model	2-D Piping	Paper Plan Menu	Reflected Ceiling Menu	Visual Masking Studies	Civil Engineering	Structural Engineering	AV/C Engineering	Electrical Menu	Landslide Menu	Interior/Exterior	Interactive Space Plan	Arch. Production Draft	Hierarchical Database	Relational Database	BOM or Specifications	Facilities Management	Project Management	Drawing File Management	Host Manufacturer	Method of Backup	CPU Bit Size	Operating System	Standard Core Memory	Standard Disk Memory	per Workstation	Electronic Plotting	Screen Hardcopy	Color	Black and White	Tablet	Mouse	Light Pen	Joystick	Master Tube	Storage Tube	Separate air Screen	Screen Size (inches)	Screen Resolution	Configuration 1	Configuration 2
* ARCAD Design Graphics Software, Inc. 811 West Seventh St., Suite 800 Los Angeles, CA 90017 213/627-1427	AIDS	1. Arch./Engineering 2. Space Planning/ Facility Mgmt.																								DEC	VAX/VMS, MICRO/VMS Tape, Floppy	32	1-2MB									19"	1280x1024	30,000	60,000*	1983	85	N/A					
Accugraph Corporation 50 Garvnia Drive, Suite 204 Toronto, Ontario, Canada M3C 1Z3 416/441-2211		1. Basic Drafting 2. Corp. In-House Eng. Dept.																								Hewlett Packard/DEC	Reel Tape (DEC) Streamers (HP)	32	2MB 30MB									19"	640x480	30,000*	120,000*	1982	110	N/A					
* Artec, Inc. 2441 Impala Dr. Carlsbad, CA 92098 619/438-3355		1. Civil Engineering 2. Basic Drafting																								Sun Microsystems	UNIX Streamers	32	1MB 86MB									19"	1280x1024	30,000	89,000	1985	N/A	N/A					
* Auto-trol Technology Corporation 12500 N. Washington Denver, CO 80202 303/452-4919	Advanced Graphics Workstation	1. Heavy Engineering- Plant 2. Architecture																								Apollo Computer	AEGIS, AUX, VMS Streamers, Floppy, Disk	32	1-4MB 34-158MB									19"	1024x1024	47,000	185,000	1973	1500	300					
* Autodesk, Inc. 2658 Bridgeway Sausalito, CA 94965 415/331-0356	AutoCAD	1. Architecture 2. Engineering																																								2,000*		1982	12000	N/A			
* Bruning CAD AM International 1800 Bruning Drive West Itasca, IL 60143 312/351-2900	SPECTRA II	1. Architecture 2. Basic Drafting																									Proprietary (MC68000)	Modified HP PASCAL Tape, Streamers, Floppy	16/32	2MB 14.5MB									19"	1024x768	41,900*	81,900*	1981	1000+	150				
* Cascade Graphics K.T.I. 1000 S. Grand Ave. Santa Ana, CA 92705 714/558-3316		1. Facilities Mgmt. 2. Architecture																									Cascade	UCSD PASCAL Floppy & Tape	16/32	1/2 MB 10MB									19"	1024x798	30,000	42,700	1980	60	20-25				
CLM/Systems, Inc. 3654 Gandy Blvd. Tampa, FL 33611 813/831-7090	CLM UNIFIER	1. Civil Engineering 2. Site Engineering																								Stride Micro	P-505 Streamers or Floppy	32	1024KB 10MB									14"	1024x1024	20,000	32,000	1984	200+	40+					
* CalComp 2411 West LaPalma Ave. Anaheim, CA 92803 714/821-2000	SYSTEM 25	1. Architecture 2. Corp. In-House Fac. Mgmt.																								MASSCOMP	UNIX BERKELEY 4.2 Floppy 1/2" Reel or 1/4" Streamers	32	1MB S12KB									20"	1024x780	65,000	128,000	1978	541	198					
* Carrier Corporation United Technologies PO. Box 4808 Carrier Pkwy. Syracuse, NY 13221 315/432-6838		1. Basic Drafting 2. Architecture																								HP	PASCAL 3 1/2" or 5 1/4" Floppy or 1/4" Cartridge	16/32	15MB									19"	512x390	54,000*		1982	300	240					
* Computer-Aided-Planning, Inc. 169C Monroe Ave. Grand Rapids, MI 49503 616/454-0000	CAP 2.0	1. Interiors 2. Corp. In-House Fac. Mgmt.																								IBM PC/XTor PC/AT	MSDOS Floppy	16	640KB 10-20MB									13"	320x200	18,000	36,000	1981	180	60					

Figure 1-1: Chart 1







Company Name	Product Name	Primary and Secondary Application	Graphic Software													Non-Graphic Software					Basic System Hardware		Hardcopy Other Than Pen Plotters		Workstation Design					Pricing		Market Data												
			2-D Drafting	3-D Wire Frame	3-D Solid	Solid or Surface Shading	Perspective Viewing	Macro Programming	Alimony/Adjacency Model	3-D Piping	Floor Plan Menu	Reflected Ceiling Menu	Visual Massing Studies	Civil Engineering	Structural Engineering	HVAC Engineering	Electrical Menu	Interior/Furniture	Interactive Space Plan	Arch. Production Drawg.	Hierarchical Database	Relational Database	ROM or Specifications	Facilities Management	Project Management	Drawing File Management	Host Manufacturer	Operating System	Method of Backup	CPU Bit Size	Standard Core Memory	Standard Disk Memory per Workstation	Electrostatic Plotting Screen Memory	Color	Black and White Tablet	Mouse	Light Pen	Joystick	Resistor Tube Storage Tube	Separate w/o Screen	Screen Size (inches)	Screen Resolution	Configuration 1 Configuration 2	Color Only-3 Software Only-4
* SKOK Systems Incorporated 222 Third Street Cambridge, MA 02142 617/868-6003	Artech	1. Architecture 2. Professional Facilities Mgmt.	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		Hewlett-Packard HPBASIC Floppy, Streamer	32 2MB 1.2MB-14.8MB	•	•	•	•	•	•		•		19" 1024x780	29,900 91,900	1978	450 300					
Starflo Engineering Starflo Corp. 4740 A Interstate Drive Cincinnati, OH 45246 513/874-4499	Code Petro Draft	1. Corp. In-House Engineering Dept. 2. Basic Drafting	•			•															•	•			DEC or IBM PC DEC VAX IBM MS-DOS Floppy	16 1MB 5MB				•							13" 640x400	N/A 30,000*	1983	6 1				
SummaGraphics Corp. 777 State Street Extension Fairfield, CT 06430 203/384-1344	ICON	1. Basic Drafting 2. Civil Engineering	•	•		•							•												Data General DEC RDOS Floppy	16 512KB 15MB	•	•	•	•					•		19" 1280x1024	51,500 105,000	1978	300+ N/A				
Summit CAD Corporation 5222 FM 1960 West, Suite 102 Houston, TX 77069 713/440-1488	Auto CAD/Plus Summit CAD Upgrade Package	1. Architecture 2. Engineering	•	•	•	•		•																	IBM MS-DOS 2.7MB Floppy or tape	16/32 640KB 15 or 20MB	•	•	•	•							12" 640x400	12,000* 32,995*	1984	140 50				
* Sys Comp Corporation 2042 Broadway Santa Monica, CA 90404 213/829-9707	Sys Comp Eng. Program Library Easinet CADD System	1. Civil Engineering 2. Structural Engineering	•	•	•	•																			Data General Corp. Data General ADS/VS Magnetic Tape	32 2MB		•	•	•					•		15" or 19" 640x480 1024x1024	N/A 65,000	1983	14 200+				
Systemics, Inc. 2161 NW Military Hwy, Suite 214C San Antonio, TX 78213 512/344-4154		1. Architecture 2. Corp. In-House Architecture Dept.	•	•		•		•																	Digital Equip. Corp. RSX-11M X" Tape Cartridge	16-32 1MB 35MB								•			13" 512x386	49,900 N/A	New New New					
Technique Architectural Software 443B Valencia Ave. North Vancouver, BC, CN V7N 4B1 604/980-5353	#9.3B for wide range of machines	1. Architecture 2. Space Planning	•	•	•	•		•	•								•	•	•	•	•	•			MS-DOS		•											2,000*	1984	50 15				
* T & W System, Inc. 7372 Prince Dr., Suite 106 Huntington Beach, CA 92647 714/847-9960	VERSACAD 4.0	1. Basic Drafting 2. Architecture	•	•		•											•								MS-DOS					•								2,000*	1981	5000 1,800				
* Tonias Engineers Tonias Engineers, Computer Applications Consultants 65 West Broad Street, Suite 702 Rochester, NY 14614 716/232-6995	CEDRA	1. Civil Engineering 2. Struc. Engineering	•	•		•						•	•												Prime PRIMOS Tape	32 1MB 34MB	•	•	•	•			•	•			19" 1280x960	70,000 72,000	1982	16 8				
Tittek Vision Systems 4710 University Way NE Suite 1512, Box C56789 Seattle, WA 98105 206/632-2125	EXECADD		•	•	•	•																			IBM PC, XT, AT													1,500*	1984	N/A N/A				
* VLSystems, Inc. 2691 Richter, Suite 118 Irvine, CA 92714 714/660-8855	VANGO (Ver. 4.2)	1. Civil Engineering 2. Surveying/Mapping	•			•						•													DEC VMS or RSTS/E Reel Tape	22 to 32 5 to 4MB Varies	•	•	•	•	•			•			14" 768x293	35,000+ 43,000+	1980	450+ 35				

Figure 1-4: Chart 4

Company Name	Product Name	Primary and Secondary Application	Graphic Software																Non-Graphic Software						Basic System Hardware		Hardcopy Other Than Pen Plotters		Workstation Design					Pricing	Market Data														
			2-D Drafting	3-D Wire Frame	3-D SOLID	Solid or Surface Shading	Perspective Viewing	Macro Programming	Alt/Trim/Associativity Mode	3-D Panning	Floor Plan Menu	Reflected Ceiling Menu	Visual Mapping Studies	Civil Engineering	Structural Engineering	HVAC Engineering	Electrical Menu	Landscaping Menu	Interiors/Furniture	Interactive Space Plan	Arch. Production Drawg.	Hierarchical Database	Relational Database	BDM or Specifications	Facilities Management	Project Management	Drawing File Management	Host Manufacturer Operating System	Method of Backup	CPU Bit Size	Standard Core Memory	Standard Disk Memory per Workstation	Electrostatic Printing		Screen Memory	Color	Black and White	Tablet	Mouse	Light Pen	Joystick	Raster Tube	Storage Tube	Separate an. Screen	Screen Size (inches)	Screen Resolution	Configuration 1	Configuration 2	Color Only-3
*McDonnell Douglas AEC Information Systems Ca McDonnell Douglas Information Systems Group P.O. Box 516 St. Louis, MO 63166 800/325-1551	Building Design System/General Drafting System (BDS 12.2/ GDS 4.2)	1. Architecture and Engineering 2. Facilities Mgmt.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Digital and PRIME Digital VMS, PRIME PRIMOS Reel Tapa, Streamer	32 2MB N/A			•	•	•	•					19"	13"	1280x1024	640x480	67,750	153,350	1973	837	229		
Manufacturing & Consulting Services, Inc. 9500 Toledo Way Irvine, CA 92718 714/951-8858	ANVIL-1000MD	1. Basic Drafting 2. In-House Eng. (Mechanical)	•																							PC DOS														2,995*			1971	N/A	N/A				
*MEGA CADD, Inc. 401 Second Avenue South Seattle, WA 98104 206/623-6245	Design Board Professional	1. Architecture 2. Interiors	•	•	•			•									•									NEC-H03 MS-DOS Floppy	16 512K N/A							13"	640x496	N/A	20,500*	1983	500	350									
*Micro-Installations, Inc. 419 Park Ave. S., 12th Floor New York, NY 10001 212/889-6684	MICAD	1. Architecture/ Interiors 2. Prof.-Corp. Facilities Mgmt.	•		•												•									MS-DOS, XENIX, & Compatibles														3,000*			1980	33	30				
PSI Systems Corp. P.O. Box 21 Pittsburg, KN 66782 800/351-9121 Toll Free 316/231-5208 in Kansas		1. Basic Drafting 2. Word Processing	•	•	•	•													•							Wicat Systems MCS Floppy	32 512K 15MB					•						14" & 19"	800x600	31,500*	N/A	1983	123	9					
*Personal CAD Systems, Inc. EDS Division 981 University Ave. Los Gatos, CA 95030 408/354-7193	CADPLAN 1.45	1. Corp. In-House Facility Mgmt. 2. Corp. In-House Engineering Dept.	•	•	•	•		•									•									MS-DOS														1,600*			1983	N/A	N/A				
Point Line Company 2435 Polk Street San Francisco, CA 94109 415/474-0548	Point Line CADD #2007	1. Architecture 2. Corp. In-House Engineering Dept.	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	NEC APC CPM/86 Floppy	16 256K 1MB							12"	640x475	22,780*	50,060*	1983	100	80+									
*Prime Computer, Inc. Prime Park Natick, MA 01780 617/655-8000	Architectural Design Rev. 2.0	1. Architecture 2. Corp. In-House Arch. Dept.	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Prime Computer PRIMOS Reel. Streamer, Cartridge	32 1-4MB 58MB							19"	1280x1024	82,000*	139,850*	1982	N/A	N/A										
*Resource Dynamics Inc. 150 East 58th St. New York, NY 10155 212/486-9150		1. Corp. In-House Facilities Mgmt. 2. Professional Facilities Mgmt.	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	MASSCOMP UNIX Streamer & Floppy	32 8MB + Virtual 80MB up to 474MB							19"	832x600	76,290	147,120	1981	N/A	N/A										
*Sigma Design, Inc. Corporate Headquarters 7306 S. Alton Way Englewood, CO 80112 303/773-0666	The Sigma III	1. Architecture/Civil and Structural Engineering/HVAC 2. Pro. & Corp. In- House Fac. Mgmt.	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Sun Micro Systems UNIX Streamer cartridge or 1/2" Track	16/32 RAM 84MB							19"	1000x800	65,000	N/A	1979	250	250										

Figure 1-5: Chart 5

### 1.2.2 Data Processing

Parallel with the development of the CAD system, a comprehensive integrated computer system should also develop a systematic method for symbolic description of a building. Data processing includes data base management and different subroutines using this data as input file. Both procedures imply two types of data:

- A non-project specific type of data which refers for example to libraries of parts of a building system structure or a catalogue of standard design details . We will refer to this type of data as the Library Data Base. An example of such can be a catalogue of structural components, or fixture elements from a manufacturer.
- A project-specific type of data which refers directly to the project such as a body of data which describes a proposed building. This second set of data constitutes the input data file for data processing subroutines such as a bill of quantities, cost estimates, structural analysis, etc.

Organization of data involves a clear distinction between physical and logical structure. The physical structure is concerned with the data storage media (such as core memory, disks, magnetic tapes, videodiscs etc.). It actually describes the pattern of data in computer memory and its representations by means of physical devices. The logical structure refers to relationships between data (stored as sets of entities: e.g. files, records, fields.) which determine the different ways records can be accessed by using the facilities of a programming language or a data base management system. The logical structure requires relationships between attribute categories at different levels of hierarchies and subsets. For example, a building can be considered in a functional level as a set of functional entities (types of rooms in an apartment in a building) or in a structural level as a set of subcomponents. From one case to the other, different types of information have to be retrieved.

A major concern for data base storage relates to the size of the data base .The Library Data Base (e.g. Sweet's catalog) tends to be larger than the project data base. The requirements for a data base management system must be the ability to store data records in the system, the ability to retrieve them on demand, and the ability to update them when necessary.

Merging videodisc technology and computer capabilities has made feasible an innovative data base management system combined with an information retrieval system which utilizes prestructured image disks that are controllable from a computer data base system. Using the optical laser disk as a storage media is a powerful innovation for several reasons:

- high-capacity of memory storage
- independence of physical structure and logical structure
- capability of computer graphics and image display

The later point will be discussed in the next section.

The project data base requires a different way of thinking for building description data. It is necessary to conceive of the building as a collection of discrete elements in order to develop a method for symbolic description. Different categories of attributes have to be defined, according to the relevant application program for which these data serve as input. For example, these attributes may be:

- Geometric: e.g., records would store informations on size, location, etc.
- Physical: e.g., weight, conductivity, structural tolerance, etc.
- Economic: e.g., cost, availability, etc.
- Image Processing: e.g., frame addresses on videodisc.

### **1.2.3 Computer Graphics and Image Processing: the notion of interactive data image file**

Architects are especially interested in computer graphics techniques for architectural drafting, the production of perspectives, sections, axonometries or mapping. The animation of perspective scenes generated with computer graphics have been developed in other fields such as engineering. The Architecture Machine Group (MIT) has implemented an interactive video for real-time simulation of aircraft and spacecraft landing and ship docking.

The basic components of an interactive computer graphics system are, according to Newmann and Sproull (1974):

- Input devices which provide data and control commands
- Application routines which execute the application data structure
- Output routines which extract the necessary data in order to display the – right pictures
- Transformation and clipping routines and the concatenation routines which combine to execute the required transformations
- The display generator which converts the transformed and clipped information into signals to drive the display
- The display itself which physically generates the picture

A closely related field of application is image processing, which means the computer analysis of visual materials such as photographs. Typical applications of image processing technology are analysis of earth satellite photographs to extract data about land use, mineral deposits, etc.

A new application can be mentioned as the basis for a data image management which will combine image storage in videodisc and image retrieval

through a computer graphics package. Linking a videodisc with a microcomputer creates a new visual dimension which constitutes a valuable architectural visualization tool during the design process. It is no longer limited to final presentation, but can help to optimize design decisions in all stages of the architectural and design process. It will enable the architect to proceed simultaneously with optical simulation (image processing with the videodisc) and electronic simulation (computer graphics generation with CAD system). The first simulation allows the user to view an animation sequence prestored on the videodisc whereas the second simulation allows the user to generate various perspectives and manipulate them interactively through a device such as a light-pen or a mouse.

Additional use of a digital decoder will enable the system to process the images stored in videodisc. In that case not only slides of an actual built environment or standard libraries can be part of the data file but also vector drawings can be stored on the videodisc and downloaded to the local computer system for manipulation. The user, for example, will be able to build up a floor plan using standard parts of any building construction manufacturer, stored as vector drawings in the videodisc. The computer's memory can be filled from the disc in any place in order to control specific sequences as viewer-movie interaction unfolds.

### **1.3 Definition of Needs**

The merging of video technology and computer capability has opened up a new path for research in the field of potential application in architectural design. Improving performance and decreasing the cost of micro-based computer systems have made this current generation of microcomputers the most appropriate applicable computer-based environment for architectural practice and education.

Nevertheless there is not any software even in a micro-based environment which is specifically designed for architectural applications. Response to this can be undertaken at two levels:

- **In education:**

So far there is no clear structure of academic curricula which relates and integrates computer techniques with teaching architectural design, although the subject reflects an increasing development importance with its appearance in university curricula, and a proliferation of conferences and workshops.

- **In professional practice:**

As a professional group, architects still do not constitute a large or important enough group of users for the software market in comparison to engineering and scientific groups. Therefore, in currently available off-the-shelf software there is not a single package which could handle computer-aided-design, data analysis and processing, designed and marketed for the specific purpose of architectural design.

The basic needs in the process of architectural design will be established in this chapter. As a first step in the analysis of the practical application of computers for architectural design, it is useful to break down the design process into different tasks and functions which can be related to the rationale of a computer system. There are basically three paths an architect should follow in a continuous interactive way:

- The ability to generate graphic representation
- The ability to manage a data base
- The ability to do spatial visualization and simulation

This section is not intended to provide a theoretical basis for establishing a

design methodology which is seen as a discipline in which the methods, procedures and the techniques would be understood as the conceptual preparation of activities. It is only an attempt to decompose the architectural design process in a way in which computer-aided-design techniques can be effectively introduced. The building design process can be viewed as an information process task. The information which is expected to be provided should be both graphic and alphanumeric. The information processing involves the performance of various functions and procedures which require data as input and will produce data as output based on certain rules and assumptions. Examples of functions might be the design of a building system, the generation of a site plan, the making of a bill of quantities or cost estimates, etc.

Traditional design procedures are labor-intensive and tasks are executed with simple equipment. Tasks are performed separately, for example, the architect will design a project by working more on the qualitative criteria than the quantitative criteria. The graphic representation phase is not concurrent to the quantitative evaluation of the proposed project. Performance and cost analysis for example are only performed once the schematic design synthesis is finalized. Continuous feed back from one phase to the other is rarely performed. An alternative to the performance of such functions by using a computer system can produce higher quality results at a lower cost with higher speed. An integrated computer system could link the graphic representation to the numeric data by using the appropriate program, as well as, perform for example a cost analysis for each design sketch.



## **Chapter 2**

# **DESCRIPTION OF THE INTEGRATED COMPUTER SYSTEM.**

### **2.1 Principles of the system components.**

The concept of such an integrated computer system is based on the interface of modular components, using principally off-the-shelf software and micro-based equipment. The fundamental requirements of the system for the process of architectural design are the ability to generate graphic representation, store and compute numeric information in a data base structure, and visualize contextual images.

#### **a) Representation**

A CAD system with an extensive library of drawing functions will allow the user to generate graphically plans, elevations, sections and details. These entities can be represented on the screen and manipulated in terms of different configurations, elements or space combinations.

#### **b) Computation and Data Processing**

Actual construction work needs a detailed description of the proposed building or building system to be designed. This description generally is presented as a database of numeric informations (for example: related to a bill of quantities, technical specifications, cost estimates, structural analysis, and the like.)

#### **c) Visual Information System**

The visual information system uses the relatively new technology which allows

an image file to be stored on a videodisc. The major advantages of such a system are :

- High-capacity of memory:

It is possible to store more than 2 gigabytes (2 billion bytes) of digital data on each side of a videodisc. The storage capacity of both sides is equivalent to 5000 double-density floppy disks.

- Capacity of storing real-life images:

These images can be still (slides), moving pictures (videotapes), vector drawings, computer graphics, collages, or simulations. In addition two sound tracks allow the insertion of music, comments or instructions associated with the display of the images.

Combining these three features, the proposed integrated system becomes a powerful tool, tailor made for architectural education and practice. Such a system will allow the user to work simultaneously on generating graphics, data processing as well as spatial visualization. By combining the powerful microprocessor technology with the videodisc's high-capacity of storage memory (which doesn't require the computer power), the system offers great opportunity, being relatively inexpensive. The system integrates AutoCad (as a CAD system) and Lotus123 (as a data processing system) because both are versatile enough to allow interchanging files with other programs.

Graphic and numeric data will be entered once in the AutoCad environment (CAD system). A library of graphics data will be stored in AutoCad as drawing files. Eventually as the project develops, this library of graphic data can also be stored as vector drawings on videodisc and downloaded (through means of a data decoder) to AutoCad for geometric manipulation. The videodisc is used because of its high-

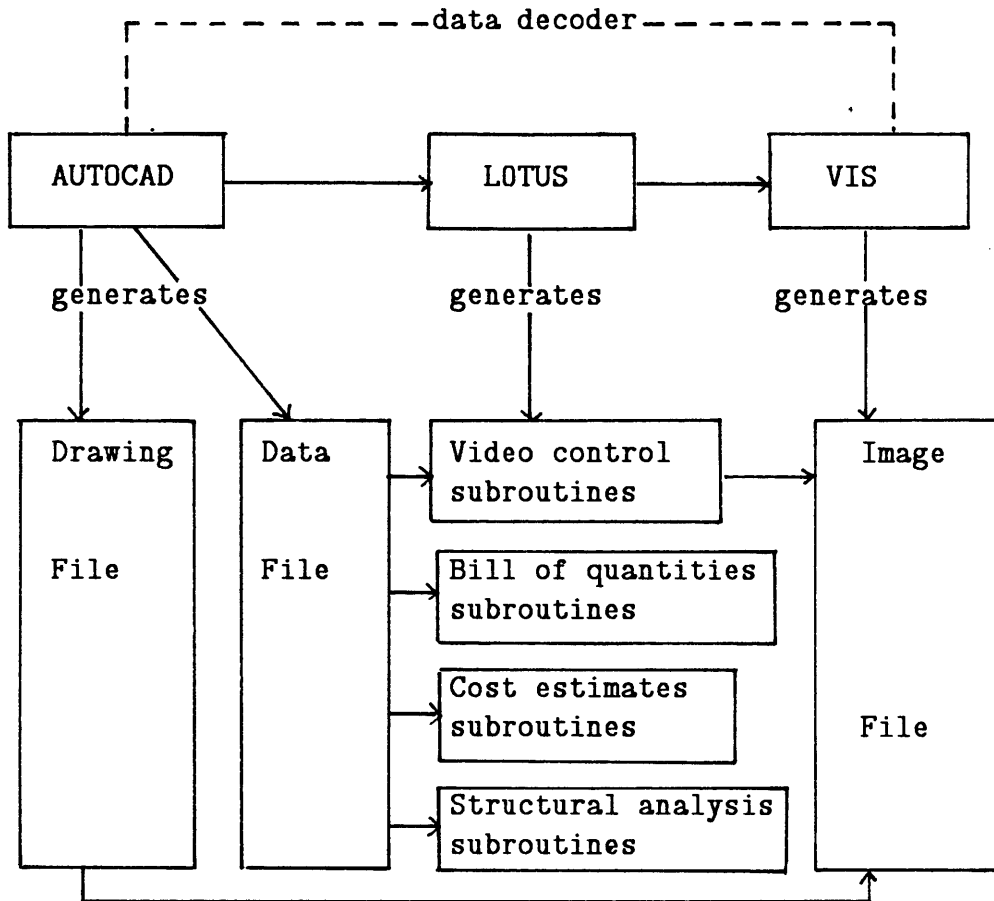
capacity memory (approximately 300 megabytes).<sup>5</sup>

Numeric data associated with each drawing file will be extracted and transferred as a data file in a spreadsheet environment, Lotus123. This information can then be manipulated through programs to provide video control subroutines, bill of quantities, cost estimates and even structural analysis subroutines.

Interfacing with the image file stored on videodisc can be performed from AutoCad or Lotus123, separately or simultaneously. The interface program to the videodisc player can be written in the Lotus123 environment -which will play the role of video control subroutines within the integrated system environment. The input data necessary for the interface program is generated at the same time as drawings are created in AutoCad. The interface structure can be shown schematically in the following chart:

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<sup>5</sup>More detailed description of the videodisc technology is explained in section :Principles for use of an optical videodisc player



Such an interface will allow the user to simultaneously design a project while viewing on a TV monitor an array of images associated to a library of parts, in order to decide which component he is going to use. In other words, the CAD system will also let him access an image data file. The video control display program will also allow him to view an animation sequence accompanied with narrative instructions at the speed he chooses; e.g., to stop on any image he is interested in; to play back the sequence, etc.

The hardware configuration of the system has 4 major components:

1. A user input device, i.e. keyboard and digitizer (or mouse)
2. An IBM PC-AT (512K RAM) working with the operating system DOS version 3.0, a digital memory and storage system, with:
  - Asynchronous Communication Port 1 (to be connected with the

digitizer)

- Asynchronous Communication Port 2 (to be connected with the videodisc player)
  - Parallel port 1 (to be connected to a printer)
  - 2 monitor adapters
  - 2 video displays
3. An optical videodisc player which acts as an image and sound storage system containing analog memories of images (SONY LDP- 1000A)
  4. A videodisc display, a cathode ray tube TV

The software requirements are:

1. Dos version 3.0 operating system
2. AutoCad, AutoDesk, Inc.
3. Lotus123, Lotus Development, Inc.
4. Wordstar (or any other text processor)

## **2.2 Principles for use of a CAD system**

Before explaining more extensively the CAD system features, one has to put forward the criteria based on which candidate CAD systems are chosen to be integrated. In a micro-based equipment, the system should have an extensive set of drawing primitives which allow flexibility and ease for use (for example it should provide "macros" for customizing menus according to specific needs). It should also provide the possibility for attribute definition and drawing interchange file capabilities which make it potentially capable of being interfaced with other systems.

AutoCad, from AutoDesk, Inc. meets perfectly these criteria. The following is

a brief overview of AutoCad capabilities<sup>6</sup>. AutoCad, as a drawing tool, provides a set of drawing entities such as a line, circle, text string, etc. The user enters commands to tell AutoCad which entity to draw. The user control with AutoCad is implemented through:

- the keyboard, by typing the commands
- a light-pen, by digitizing the tablet
- a multi-button pointing device, by selecting from a screen menu

Besides drawing entities, AutoCad provides also a set of functions which allows the modification of the drawing by: erasing, moving, or copying to form repeated patterns. A list of functions available is provided in the AutoCad user's manual. An AutoCad drawing is a file of information which describes a graphic image. The drawing entities are positioned according to the cartesian coordinate system. The drawing can be stored in a form which can be processed by user-written programs for interchanging files with other computer systems.

A drawing created with the basic drawing entities can be stored and manipulated as a unit (block) in a drawing file. Such a block can be inserted in another drawing so that the user can interactively construct a new drawing file using the previous block as a drawing part. This feature allows the user to build up his own library of parts.

AutoCad also has the layering capability which allows the user to view and plot related aspects of a drawing separately or in any combination. The layering concept is similar to the transparent overlays used in architectural drafting.

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<sup>6</sup>More extensive literature is found in the AutoCad users' guide, Sept.1984

### **2.3 Principles for use of a data processing system**

In practice, data processing refers to any kind of an analysis program which uses the alpha-numeric information associated with the graphic representation. It usually includes straightforward applications of the report generating facilities of the data base system. This section will discuss the issues of data base management and data analysis in the context of a given data processing system, which is in the case of the proposed integrated system, a Lotus123 spreadsheet.

#### **Data Base Management System**

Different techniques are to be considered in a data base management system: techniques for encoding, structuring and storing in computer memory.

The world of Lotus123 is characterized by its graphical format: a worksheet which is similar to a financial ledger sheet ruled into rows and columns. Each of the spaces of the worksheet (called "cells") can store a piece of information: a number, letters, words or an instruction to calculate a value.<sup>7</sup> The simplest definition of a 123 data base is a list of information stored in a range of cells that spans at least one column and two rows. Certain terms such as records and fields have specific meanings in the language of a data base. A record is an individual item in a list. The most common example is in the case of a phone directory, each listing (name, address, phone number) is a record. In the case of a building description, any element of the building treated as an ensemble of systems and subsystems, is a record; e.g., windows, doors, panels, etc. In Lotus123, a record is a row and a field is a column. Each record (row) is made up of one or more cells. Each cell is also a part of a field (column). Every field in a 123 data base must be

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<sup>7</sup>More extensive literature about the hardware configuration and user's interface with the software can be found in the Lotus123 user's manual, edited by Lotus Development, Inc.

given an unique name. All field names are entered in a single row across the top of the data base.

Besides the fact of being already a data base management system, Lotus123 also has the capability of sharing data with other data base management system, such as DBaseII for example. This facility is very useful because Lotus123 in fact is not as good as DBaseII in storing fairly large data base but Lotus123 is definitely more flexible in processing data. There are situations where primary data should be stored in DBaseII and only selected portions of the data base should be moved to 123 for various types of analysis and experimentation.

### **Data Base Analysis**

The range of types of analyses that might be carried out at the feasibility study stage of an architectural project are of course virtually unlimited and rather diverse. Since different tasks on a project are undertaken by appropriate specialists, the design which results is not the product of a single mind but of the contribution of many. According to each user's viewpoint, different types of analysis have to be carried on. For example, a structural engineer would be interested in structural analysis programs whereas others might be more concerned with doing cost estimation or bill of quantities. The capability of Lotus123 for implementing structural analysis programs still must be explored. But it is definitely appropriate for doing other types of analysis similar to cost estimation because Lotus123 has a fairly large amount of built-in functions which could do basic calculations as well as sensitivity analysis. The fact that Lotus123 is represented by a huge matrix or spreadsheet facilitates the implementation of mathematical relationships between the various elements of the matrix. Sensitivity analysis is the process of evaluating the changes to the results of a model which is previously designed. For example in the case of cost estimation, once a set of mathematical relationships has been built



into the worksheet between the different data of a building, in terms of cost and quantities, the worksheet can be recalculated for different sets of assumptions (meaning in fact new input data) with amazing speed.

## **2.4 Principles for use of an interactive videodisc**

The most important function in an interactive video system is random access of data. This is the ability to access any segment of a pre-recorded video program with speed and accuracy. The standard video disc commands include searching to a specified frame #, playing successive frames forward or backward at specified rates, freezing on a single frame, etc.

An optical (laser-based) video disc can store an enormous amount of information in a small space. It is possible to store more than 2 gigabytes (2 billion bytes) of digital data on each side of a video disc (appr. 54,000 images). To put this phenomenal storage capability in perspective, it would take approximately 5000 double-density floppy disc to store 4 billion bytes, the amount of data that fits on both sides of a single video disc. It offers both motion and freeze-frame reproduction. It also has high-speed random access and the advantages of two sound tracks. The optical reflective videodisc system operates by aiming the output of a small laser through a lens at a mirror which redirects the light to a precision objective. The precision objective focuses the light at a small pit etched beneath the transparent surface of the disc. The light is modulated by the pit and is returned by the same pathway where it is read by means of a photo detector. Each pit is smaller than a particle of dust. The videodisc system being used in this project is an industrial videodisc player such as a SONY LDP-1000.

In addition to this substantial information storage and retrieval capabilities, the videodisc offers other benefits to users of interactive video systems. Interactive

training allows users to learn at their own pace, skip over irrelevant material, and repeat instruction as often as necessary without disrupting a class or group of trainees.

The SONY LDP-1000 videodisc player reads video signals from a disc with a beam of laser light rather than a tape head or stylus. It has the ability to access any one of up to 54,000 frames per side in an instant (appr. 3 seconds). It has also an RS-232C communication interface providing easy and flexible connection to external computers. Because it has a built-in Z-80 microcomputer, the LDP-1000 can be programmed to communicate with any external computer without any external interface equipment for computer hookup, a feature not found in most of the video disc players. User control is implemented through a key board or a mouse.

In summary, lower cost hardware, clear single frame display, fast access time, reverse motion, and durability are the major advantages of the videotape. Random access and frame-by-frame selection of video imagery will allow unprecedented technical control and automation of instructional presentations. The proliferation of video-computer applications can be expected to include inexpensive portable devices and interactive TV networks.

#### **2.4.1 Functioning of a videodisc**

Three video disc systems are available in the world:

1. *The Laser Vision*. Developed by N.V. Philips in Eindhoven, the Netherlands, and MCA Inc. of Los Angeles, California. The Laser Vision is an optical pickup system with a silvery, grooveless surface that covers and protect the information-bearing layers underneath. In operation, a laser shines through the surface layer onto the inner layer, where data is

stored as either reflective areas or opaque pits. When the laser strikes the inner layer, the beam is then reflected to a photodiode that detects the presence or absence of light (such as binary OS and IS) and converts this reading into electric current. (this is the video disc system we have chosen to work on in our project.)

2. The Capacitance Electronic Disc (CED.) The CED was developed by the RCA lab in Princeton, N.J. For playback, a diamond touches the grooves as the disc spins. (Consequently, they are subject to the same wear and tear as phonograph records.)
3. The High-Density Disc (VHD.) The VHD is being developed by the Victor Co. of Japan (JVC) and is not on the market yet.

A common feature in all three systems is that they all use a plastic disc rotating on a turntable. In each system, the player picks up information stored on the surface of the video disc, and then converts it into signals for a television set. Therefore the characteristics of a video disc player are determined by the nature of the video disc upon which video programming is recorded.

Since our project will only use the laser optical video disc, this discussion will focus on this system. In order to compare the video disc with the audio disc, we could say that as a 12" diameter LP audio disc rotates at 33 revolutions/mn while making only 990 revolutions, a 12" diameter video disc rotates at 1800 revolutions/mn while making 54,000 revolutions. This high recording density is made possible by the use of a laser beam that is focused to form a spot of approximately 0.00004 inches wide.

A schematic of the disc player system is shown in Fig.(2-1)<sup>8</sup>.

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<sup>8</sup>Frontiers in Education Conference. Miller 1978

### VIDEO DISC PLAYER BLOCK DIAGRAM

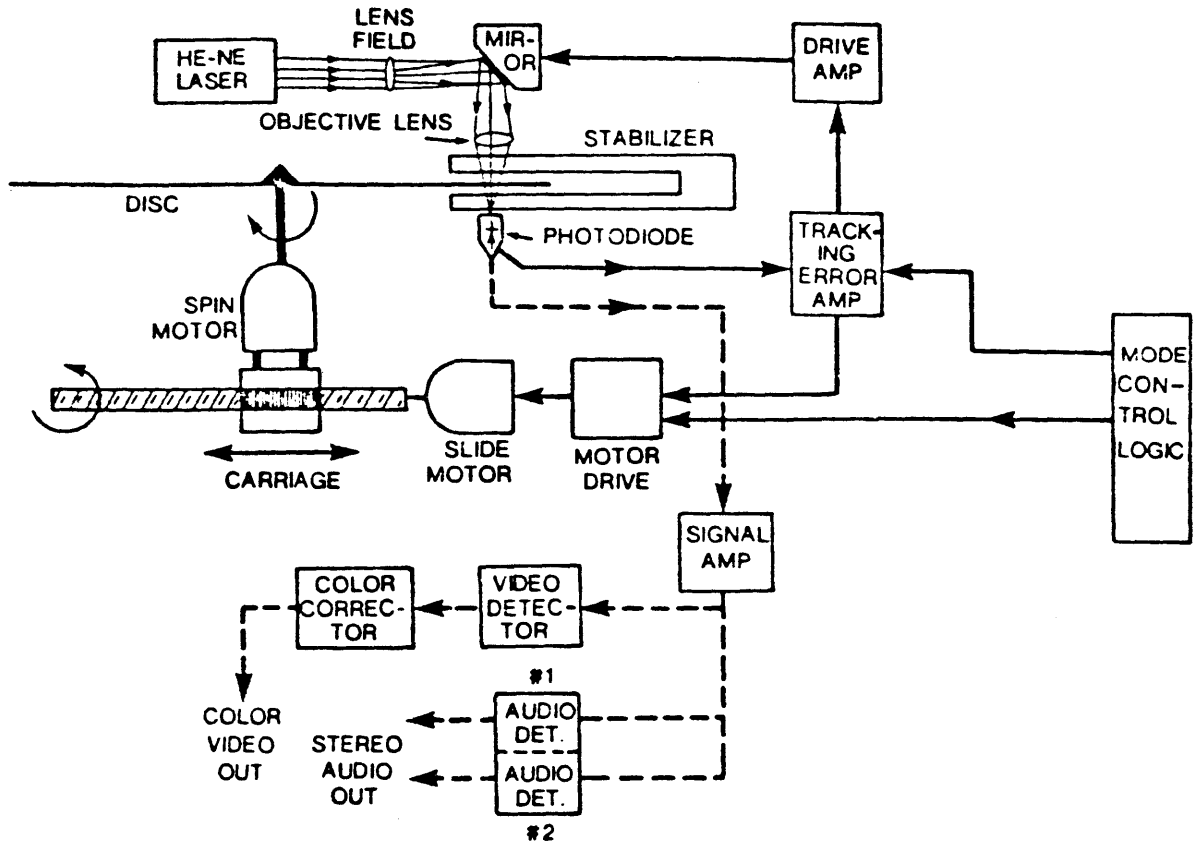


Figure 2-1: Video disc player block diagram

The recorded information consists of an NTSC Standard color video signal and two independent high fidelity audio signals.

As previously mentioned, a video disc can hold up to 54,000 still pictures corresponding to the 54,000 frame addresses. Each frame is provided with a digital indexing tag, recorded in the brief interval between frames that occur once each revolution of the disc. This tag is being placed while manufacturing the master disc.

When a microprocessor is combined with the videodisc, the obvious goal is to provide the two computer capabilities with substantially limited computer power, such as:

1. large amount of data that can be stored on the disc (the equivalent of 1000 360 Kbytes floppy discs);
2. relatively rapid random access to that data that the disc format makes possible.

#### **2.4.2 Production of a videodisc**

Producing a videodisc is done in 3 steps:

- preparing a premaster videotape;
- mastering a disc;
- making replicates of the disc.

Premastering is taking the assortment of source materials (slides, film, graphic art and videotape) and editing them onto a one-inch helical videotape. Single sides must be recorded on single frames of tape, and all titles and captions must be added. Special encoding is required to allow access to individual videodisc frames.

The premastered tape is then sent to a videodisc manufacturer. The process of making a videodisc is called mastering. Common to the three videodisc systems

is the process which a program from a magnetic tape is recorded onto a master metal disc. Plastic discs for the Laser-Vision optical pick up system are coated with metal on one side, the recorded surface, and subsequently two discs are bonded with the metal inside for protection.

For the CED and UHD system, carbon is added to discs to make them conductive. A lubricant for smoothing the pick up and reducing wear is added to CED disc. Fig.(2-2)<sup>9</sup> is a summary chart of these three systems.

Fig.(2-3) shows a representative film based premastery system.

From this glass plaque master, video disc replications are made for use on the video-disc player.

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<sup>9</sup>IEEE spectrum, March 1982

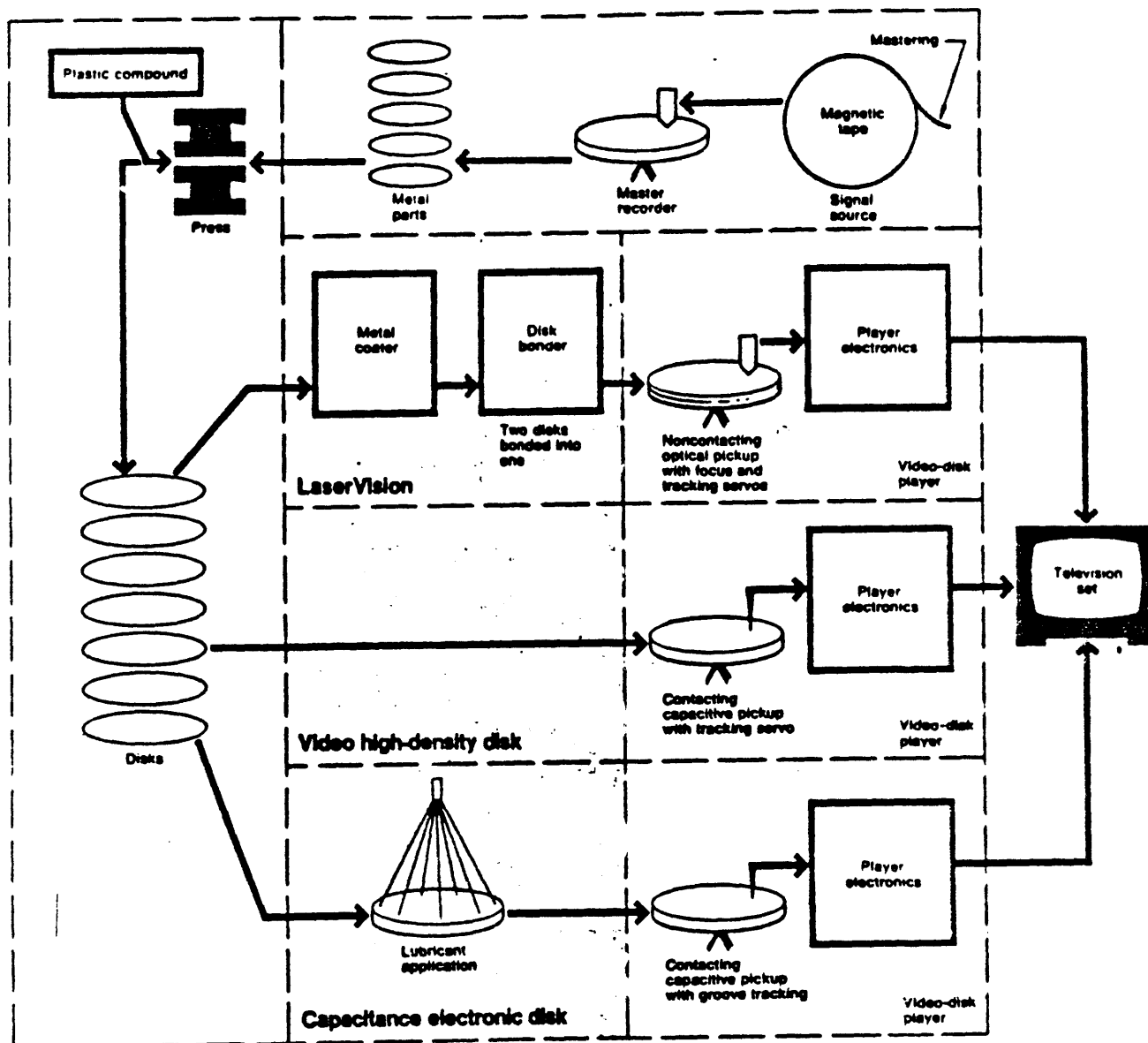
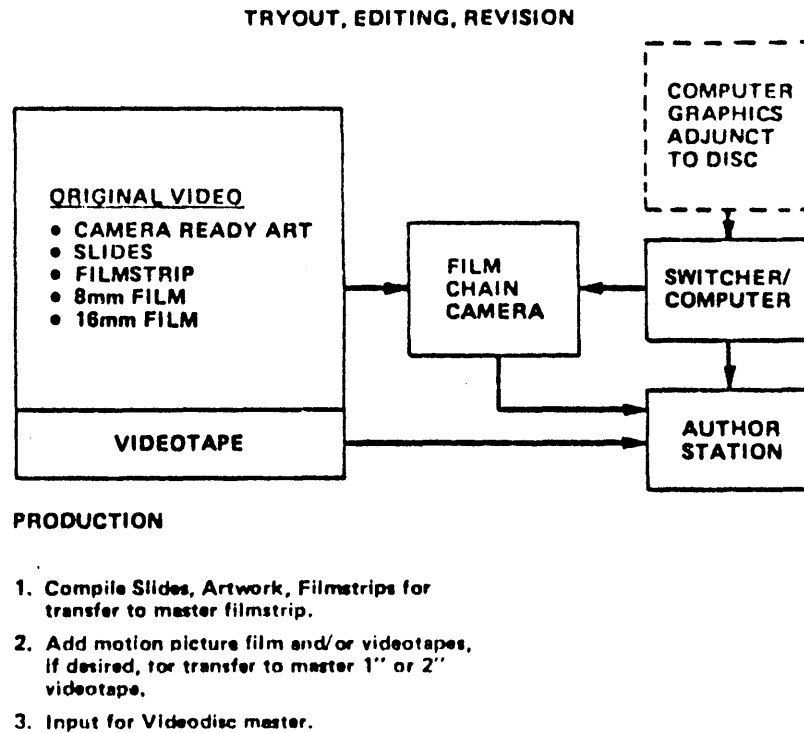


Figure 2-2: Video disc: 3 choices



**Figure 2-3:** Production sequences



## Chapter 3

# IMPLEMENTATION: CASE STUDIES

### 3.1 Building Systems Design

#### 3.1.1 Uses in Classroom

The proposed integrated computer system can be used as a teaching tool in a building systems design studio. The CAD system (AutoCad) is simplified so that the novice can use the program without difficulty. Within a given structural system, the program presents the different steps through which the student should proceed.

#### **Basic Concepts**

The building may be seen as an assembly of subsystems consisting of the following elements:

1. Structure and/or Support (Primary System);
2. Enclosure and/or external envelope. Partitions and space dividers (Secondary System);
3. Service infrastructure, including conduits, ducts, and other networks (Tertiary System); and
4. Supplementary elements (stairs, elevators, etc.).

As discussed in Chapter 1, the designer of a building faces two basic problems:

- **The problem of specification** (i.e. the nature of the system); and
- **The problem of coordination** (i.e. the rules of the system).

The nature of the system relates, for example, to the choice of the material

and type of construction, the technology used, the sequence of assembly. And the rules are derived from the nature of the system. These rules can be translated in terms of design criteria, as functional and technical coordination.

### Assumptions

1. Primary System or Support elements. The primary system is defined by those elements of a building which are permanent, and structurally required. The nature of the building system presented in this case study is based on some simplified assumptions on the structural system, principally its use of prefabricated columns, beams and floor slabs.
2. Secondary System or "Infill" elements. The secondary system is defined by those elements which, over the life of the building, may be subject to change. It includes the non-structural external envelope, interior partitions and dividers.
3. Tertiary System or "Service" elements. The tertiary system could be seen as a subsystem of the "Infill". It refers to the service infrastructure. It is defined by elements such as mechanical, HVAC, electricity and plumbing.

Each of those above cited systems is determined by a set of rules, in terms of positional coordination. In practice, for the CAD user, these rules can be translated as different options for positional grids. The rules would, for example, state that the building system would only allow spans of 8'x 8'; 8'x 12' and 12'x12'. AutoCad, by itself, will not prevent the user from accidentally placing a structural column every 4' or 2', an obvious mistake. In this instance, the proposed computer system would display different options of positional grids which are the combinations of the allowable spans. And the user will not be able to place any structural elements in a position which is not acceptable within the technical specifications of the structural

system.

### **3.1.2 Step-by-Step instructions for use of the system**

The proposed computer integrated system introduces a new way to help the novice to use the system in building design. In a certain way, the computer program is designed to make AutoCad "transparent" so that the user will be led by a step-by-step menu-driven process. The structure of the menu is based on the criteria stated in section 3.1 (the problems of specification and coordination). It is also related to the different steps a student would follow in practice. Basically, he would work on interactively in three different graphic modes:

- Plan
- Elevation
- Axonometric

The visual information system integrated to the overall computer system allows a fourth category of graphic expression. This later is referred to as VIDEO on the menu. It relates to two issues:

First, a student usually has to face the difficult deadline for project reviews. He can get nervous and might forget to show different points in front of the jury. This part of the menu allows him to store a pre-set up demo for the purpose of presentation and review. He can, for example, present an "*automatic*" demo of the construction process he has gone through while designing his building.

Second, another feature of this menu allows the user to control directly the videodisc display by pointing to commands such as :

FSLOW (to play forward the videodisc)

FSTEP (To play forward in a very slow mode)

FSCAN (To scan through the images of the videodisc)

STILL (To stop on one image)

INDEXON (To display the frame address)

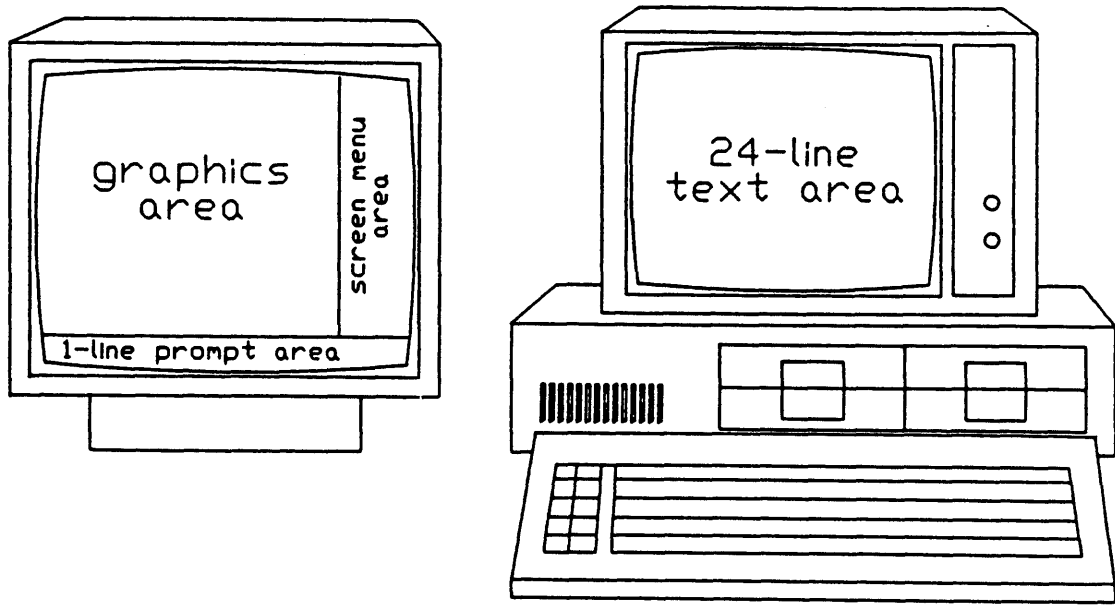
INDEXOFF (To turn off the display of the frame address)

RPLAY (To play reverse)

RSLOW (To play reverse in a slow speed)

RSCAN (To play in a very slow speed)

In short, these commands allow the user to view the contents of the videodisc in an interactive mode. These commands are placed on the screen menu area which is shown in Fig.(3-1).



**Figure 3-1:** Typical Dual-Screen configuration

### The Setting

When the student sits in front of the terminal (see Fig.(3-2)) and starts to work on one of the graphic modes (Elevation, Plan, Axonometric) -- let's say he chooses the Plan option -- a new menu pops out on the screen and gives him the option to work on (see Fig.(3-6)):

- The primary system
- The secondary system
- The tertiary system

Usually he would like to start designing his building by determining the primary system. So he chooses the "Primary" system design option by touching the screen through a pointing device (mouse or digitizer on a tablet). By choosing this option, he would see on the screen menu (see Fig.(3-7)):

PRIMARY FLOOR PLAN MENU

GRID

LIBRARY

SESSION

exit

quit

UPDATE

SECONDARY

TERTIARY

LASTMENU

SYSTEMS

ROOTMENU



**Figure 3-2:** View of the workstation

The GRID command lets him access to a choice of grid options which define the positional rules set up by the structural system. The LIBRARY command lets him access to the library of components of the structural system drawn in plan.

If at that point, he would like to finish, he has two options. If he wants to save the current drawing file, he points to SESSION then exit. If he doesn't want to save it, he points to SESSION then quit.

The UPDATE command is explained further on . Basically, it replaces sketch drawings with more sophisticated drawings at a final stage of design.

The SECONDARY command lets him access to the menu for designing the SECONDARY system.

The TERTIARY command similarly lets him access to the menu for designing the TERTIARY system.

The LASTMENU command returns to the previous menu options.

The SYSTEMS command brings him back to the top level of the SYSTEMS menu.

The ROOTMENU command lets him access the AutoCad drawing functions.

For ease of use, the last three commands always appear in every submenu.

If he would like to keep on working, he would have first to choose the desired grid in order to position his structural system. The GRID submenu gives him the different grid options that the structural system allows him to work with. He would see on the screen:



PRIMARY SYSTEM

GRID Options

GR812

GR8812

GR81212

SETSCALE

GRID ON

GRID OFF

LIBRARY

PRIMARY

LASTMENU

SYSTEMS

ROOTMENU

SETSCALE allows him to select the scale in which he wants to work at, according to the level of details he wishes. The function of the command will basically set the drawing limits according to the scale of a site plan ( $1/32"=1'$ ); of a large building ( $1/16"=1'$ ); of an apartment ( $1/8"=1'$ ); or of a room ( $1/4"=1'$ ); of a construction detail ( $1/2"=1'$ ).

GRID ON and GRID OFF commands allow him to turn the positional grid on and off as desired.

The PRIMARY command lets him jump back directly to the level of PRIMARY floor plan menu. The deeper the user goes in the tree structure of this menu, the more useful this command is in order to bring him back to the top level of the branches. The chart at the end of this section shows clearly the tree structure of the SYSTEMS menu with all the possible cross-references between

branches. (see Fig.(3-3)). Fig.(3-4) shows the two sub-branches of the GRID option.

It is assumed that the user has no idea what the grid named GR812 is. So he points to it in order to discover more about it. Informations about GR812 are displayed as:

GR812

HELP

VIEW

SELECT

QUIT

GRID ON

GRID OFF

SETSCALE

LIBRARY

SYSTEMS

ROOTMENU

The HELP command will display on the drawing editor the characteristics of the grid GR812 and instructions for use of the grid (see (Fig.(3-5))).

The VIEW command will search for an image file stored on videodisc, and display it on the TV monitor. This image file can show more extensive instructions about the grid. At a further stage of the development of the project, this command will search for a vector drawing file, display it on the TV monitor and can be downloaded to the user's drawing editor. The VIEW command prompts on the command line :

Type "Y" and "SELECT" in the screen menu or "N" and "QUIT".

This prompt tells the user that if he wants to select the grid he has been

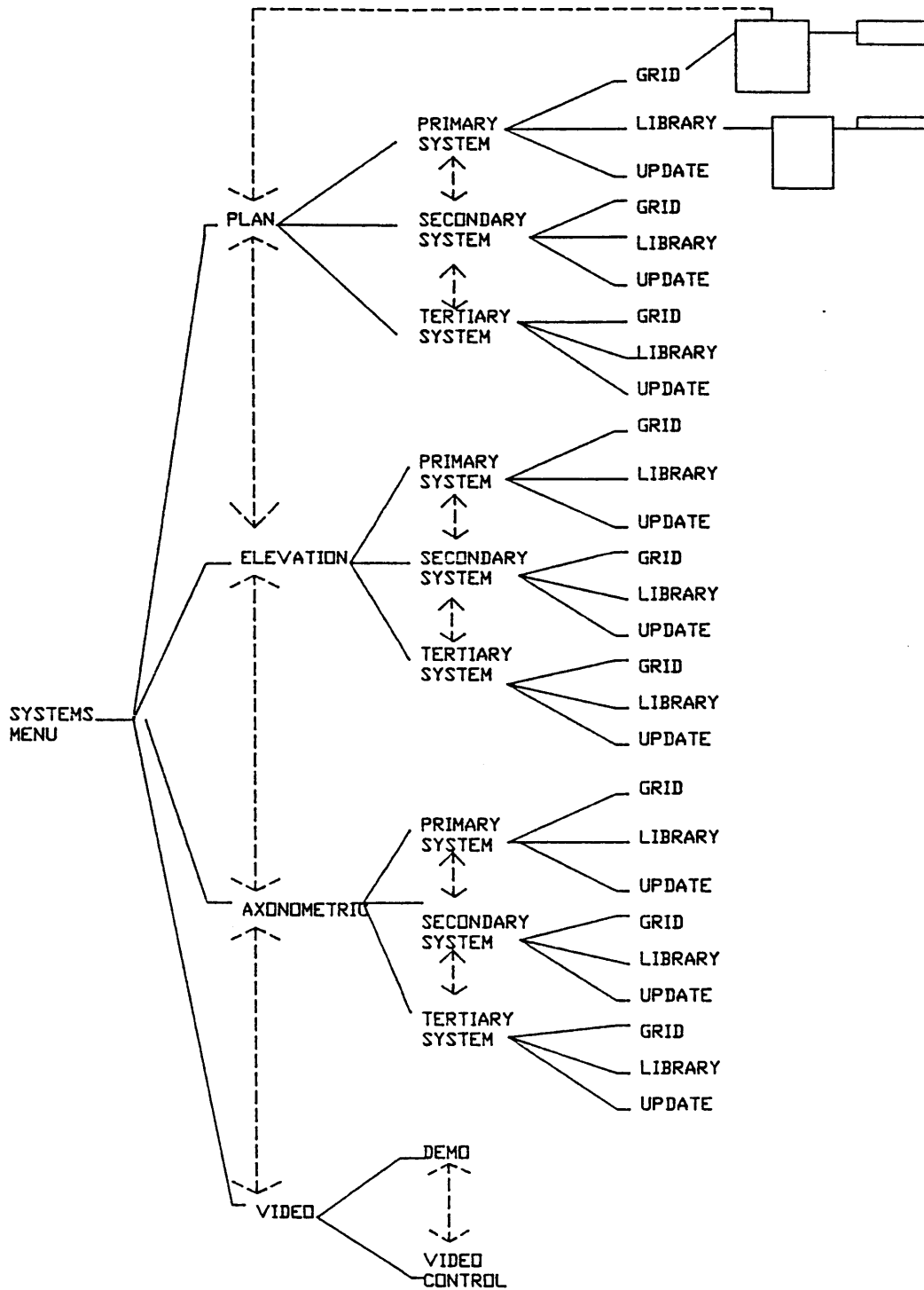


Figure 3-3: Tree Structure of the SYSTEMS menu

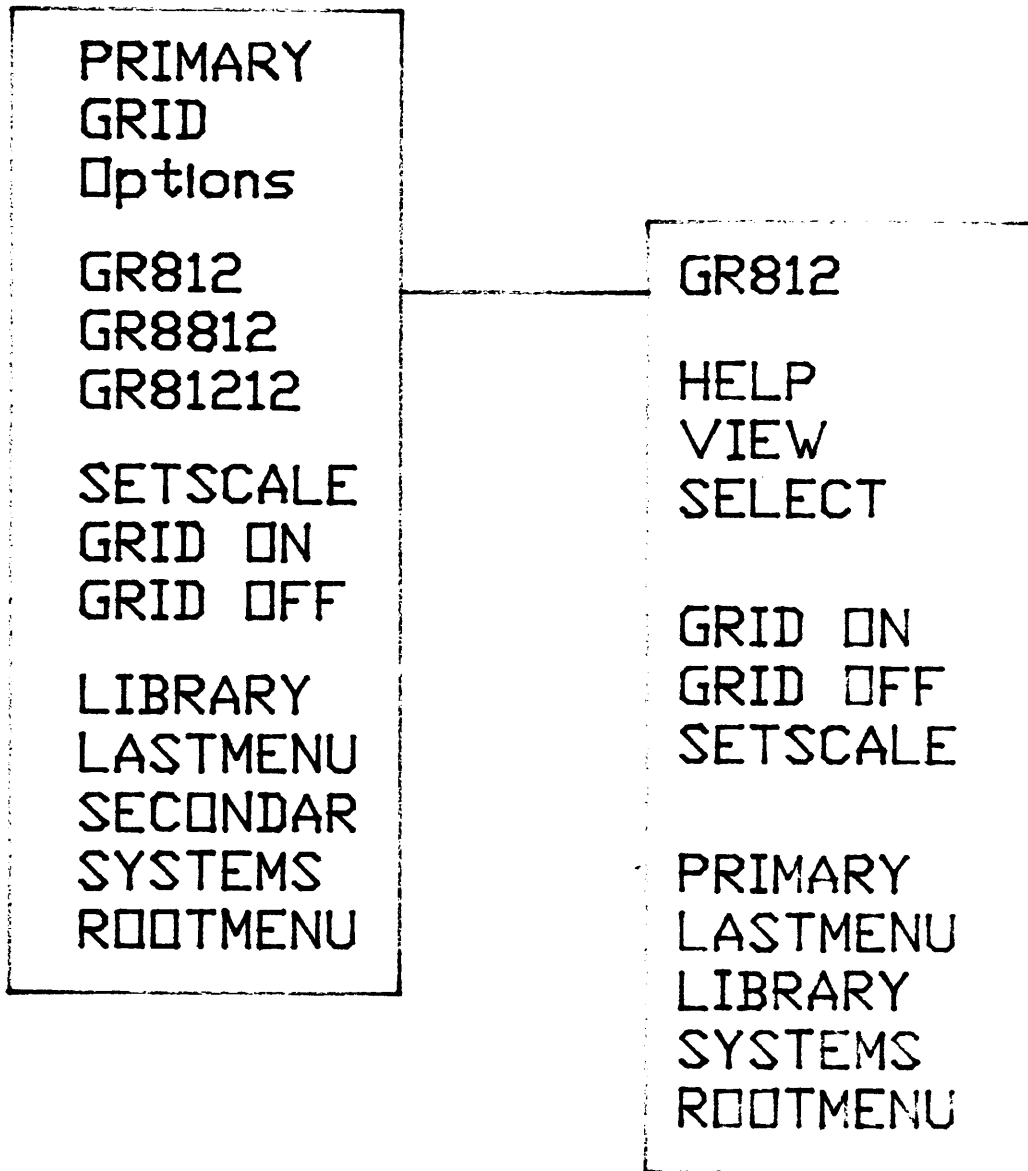
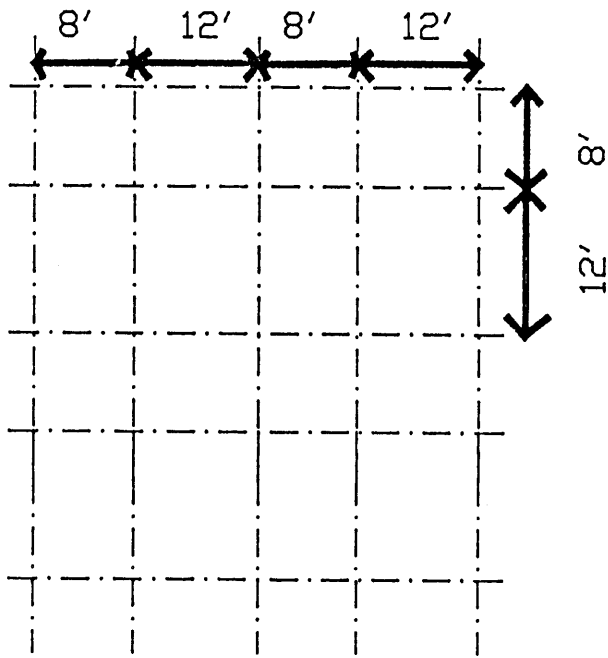


Figure 3-4: Subsections of a typical GRID option



GR812

STRUCTURAL ELEMENTS CAN  
ONLY BE PLACED AT  
INTERSECTION OF LINES

**Figure 3-5: GR812 HELP**

viewing to work with, he points to SELECT on the screen. The desired grid will then be loaded on the drawing editor. If he doesn't want to select this grid, the "QUIT" command will bring him back to the different grid options, so that he can keep on viewing more grids and finally chooses that one he feels more appropriate to the design of his building.

The GRID ON and GRID OFF, the SETSCALE, and the PRIMARY commands are also available at this level of the menu for the user's convenience. After he has chosen the desired positional grid, he would point to "LIBRARY".

LIBRARY command will bring him to the library of parts (drawn in plan) in the structural system. The screen menu will display a list of component names. The screen menu is (see Fig.(3-12)):

PRIMARY SYSTEM LIBRARY

Co6

Beam12

F1812

F1128

F11212

GRID

SETSCALE

SESSION

exit

quit

PRIMARY

LASTMENU

SYSTEMS

In order to choose either of these components, the user would proceed in the same way as before. Pointing to either one of the library parts lets him access to the same mode for choice as for the grid options.

The HELP level for each library part will display on the screen a drawing which indicates the insertion point of the element.

After he has finished placing the structural elements, he would go back to the level of floor plan menu and start over, using the same process for placing the elements of the secondary system. Finishing the secondary system, the student goes to the tertiary system menu and proceeds in similar fashion.

After his floor plan is done, he will move on the elevation menu, which has a similar structure with different grid options and library parts (drawn in elevation). Similar instructions are displayed at the AXO. menu. Library parts are, of course, drawn in an axonometric mode.

The system has also a very useful command, UPDATE, at the level of each graphic mode submenu (ELEV, PLAN, AXO).(cf. Fig.(3-24)). This command is used in case the student wants more sophisticated drawing features for the library parts, such as different types of HATCHING. Such features take a lot of computer memory in order to regenerate the drawing, and also are time-consuming. At a sketch level, the student wouldn't want to spend too much time waiting for the system to regenerate the hatches of 100 partitions inserted in his floor plans, for example. This command, used at the end of each session, allows him to update all his inserted components with a more sophisticated level of detail.

The following figures give some samples of the different sequences the user goes through during the work session.

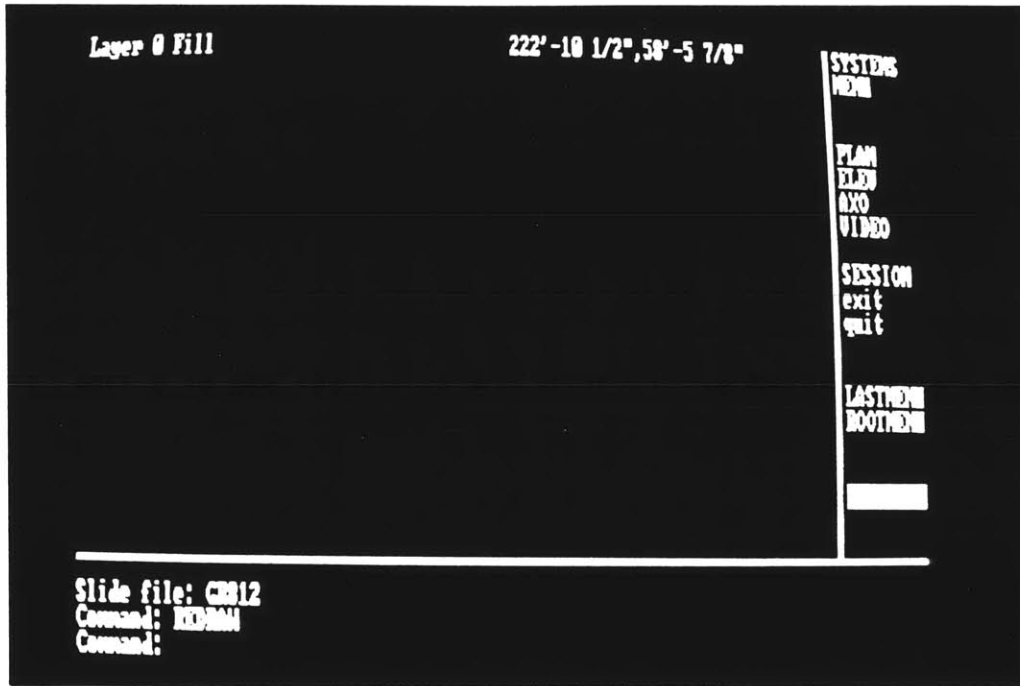


Figure 3-6: Screen display of the Top level of the systems menu

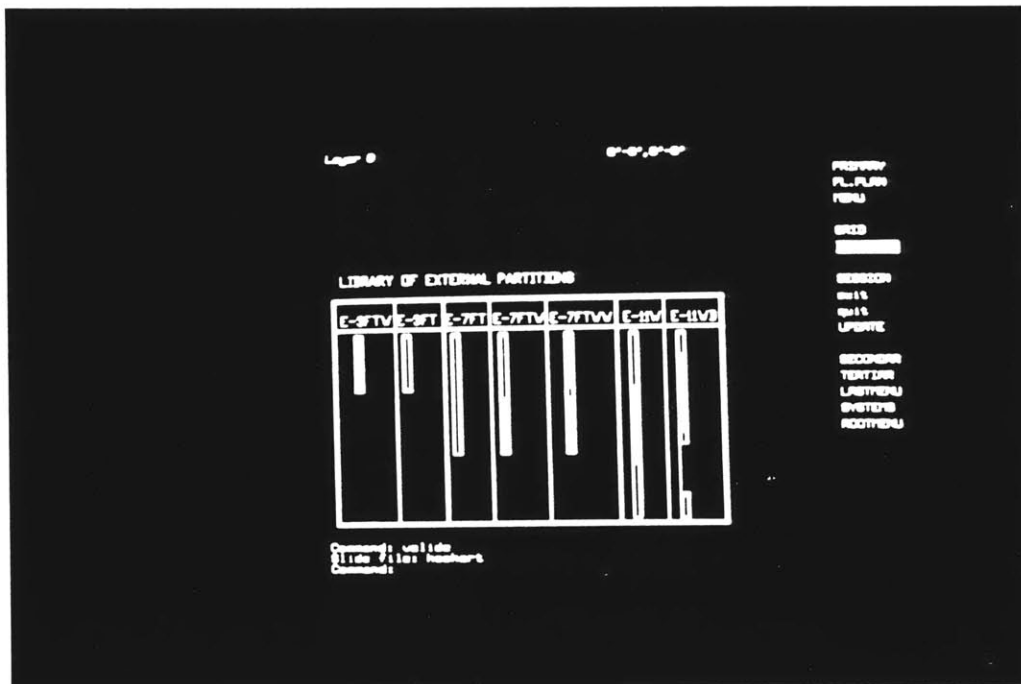
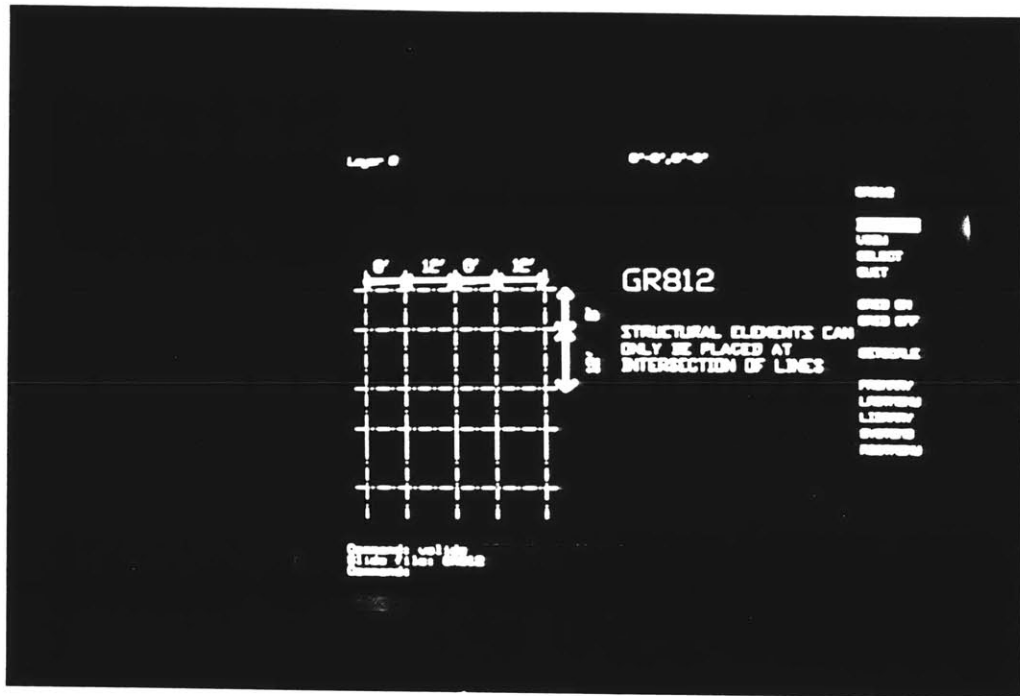
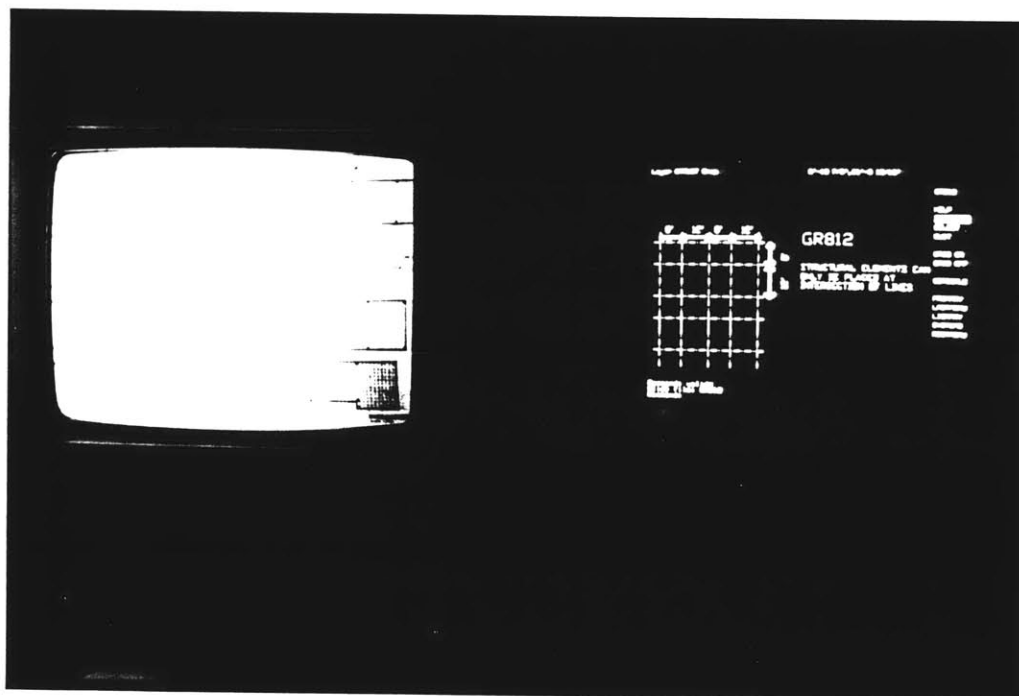


Figure 3-7: Screen display of the Floor Plan menu





**Figure 3-8:** Screen display of the HELP command in the GR812 menu



**Figure 3-9:** Screen display of the VIEW command in the GRID menu

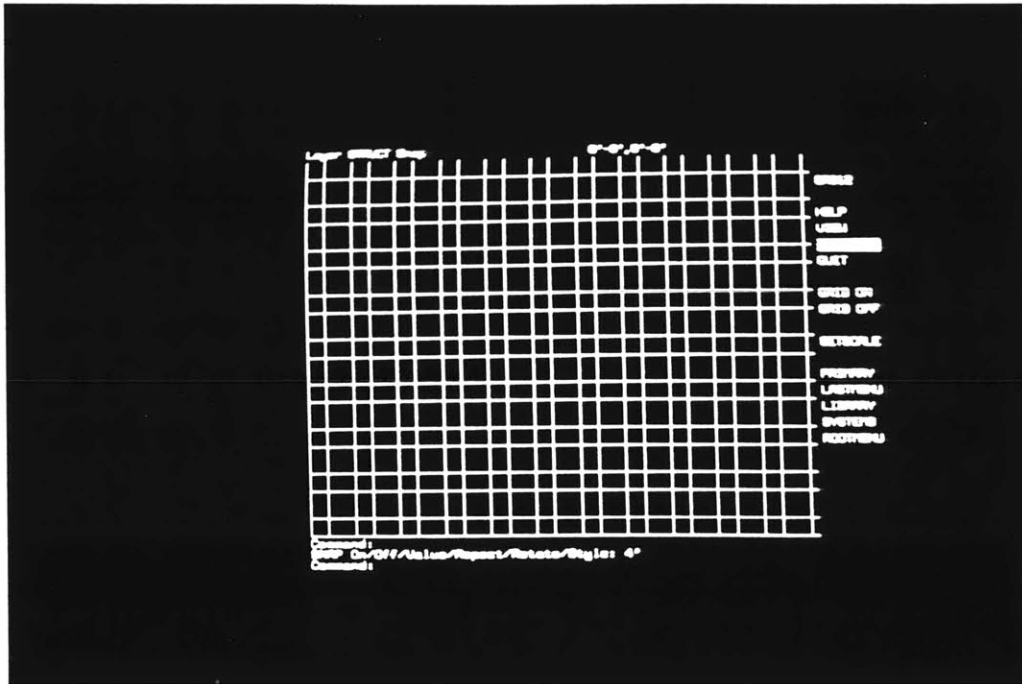


Figure 3-10: Screen display of the SELECT command in the GR812 menu

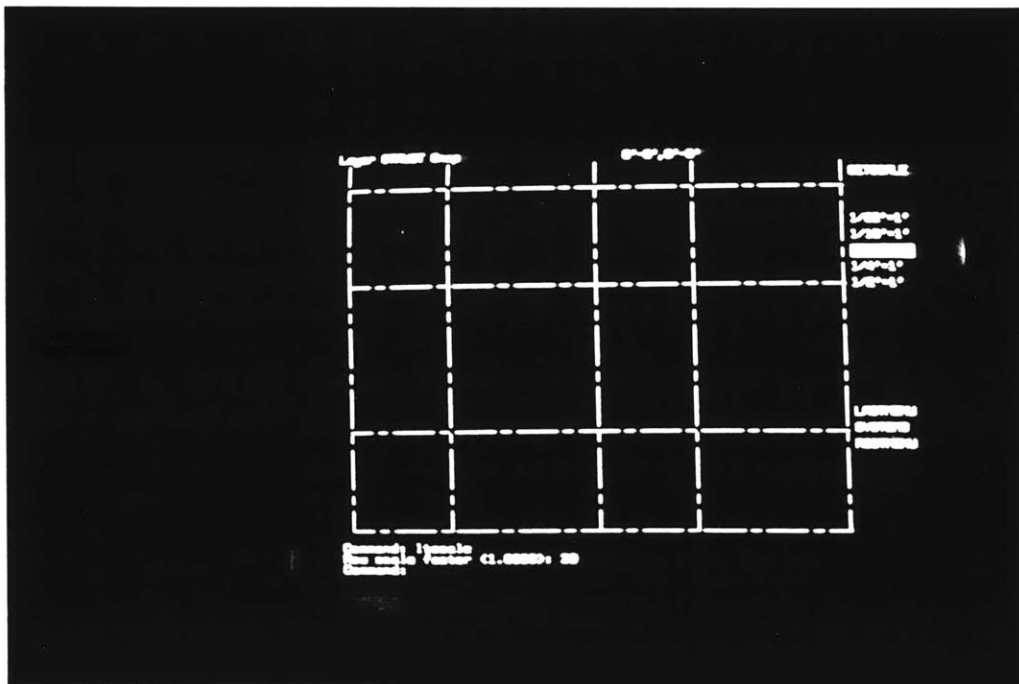
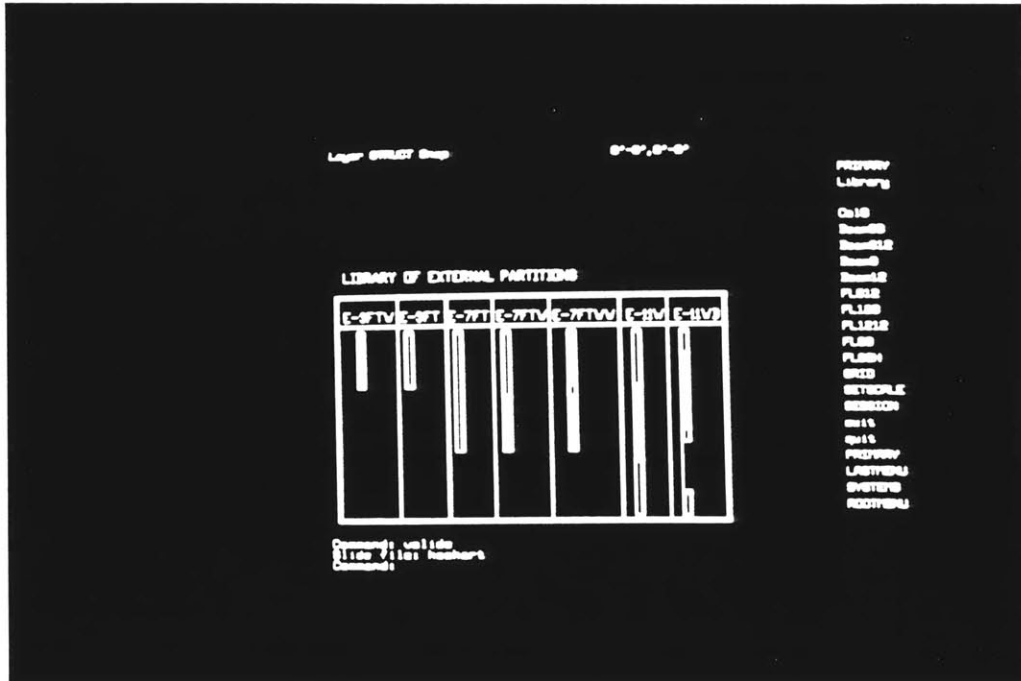


Figure 3-11: Screen display of the SETSCALE command when the grid GR812 is selected



**Figure 3-12:** Screen display of the LIBRARY command

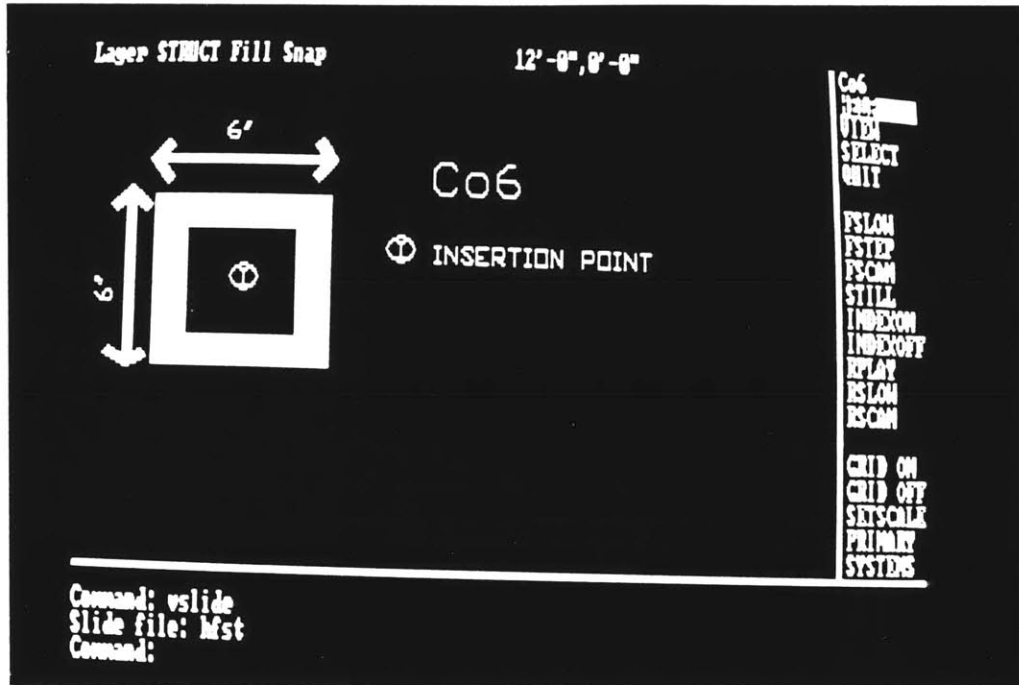


Figure 3-13: Screen display of the HELP command for one structural column

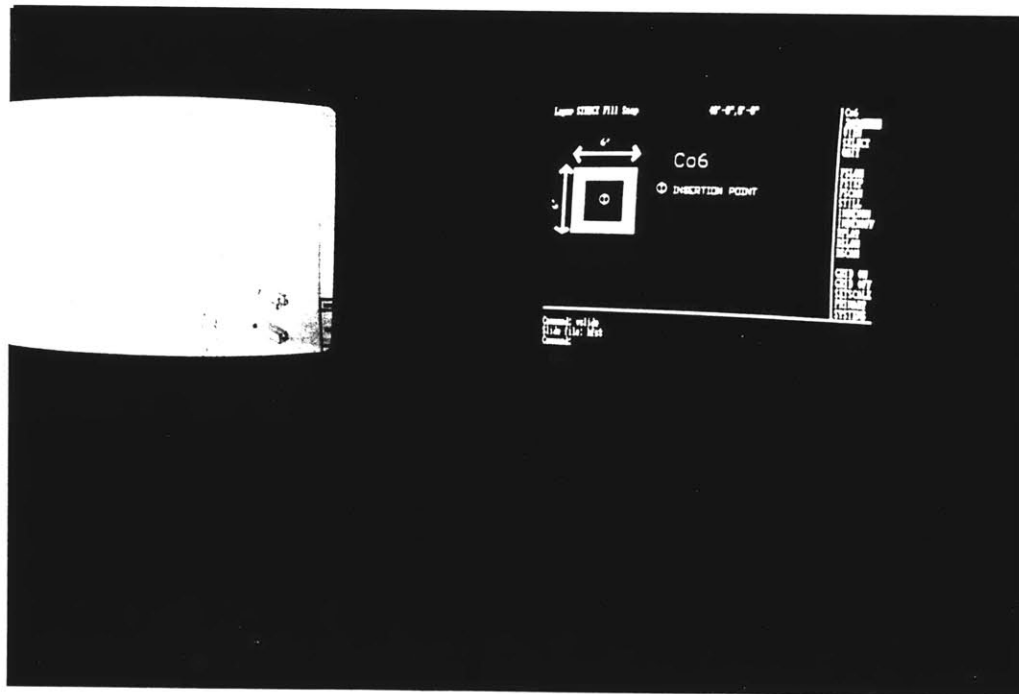


Figure 3-14: Screen display of the VIEW command for the previous element

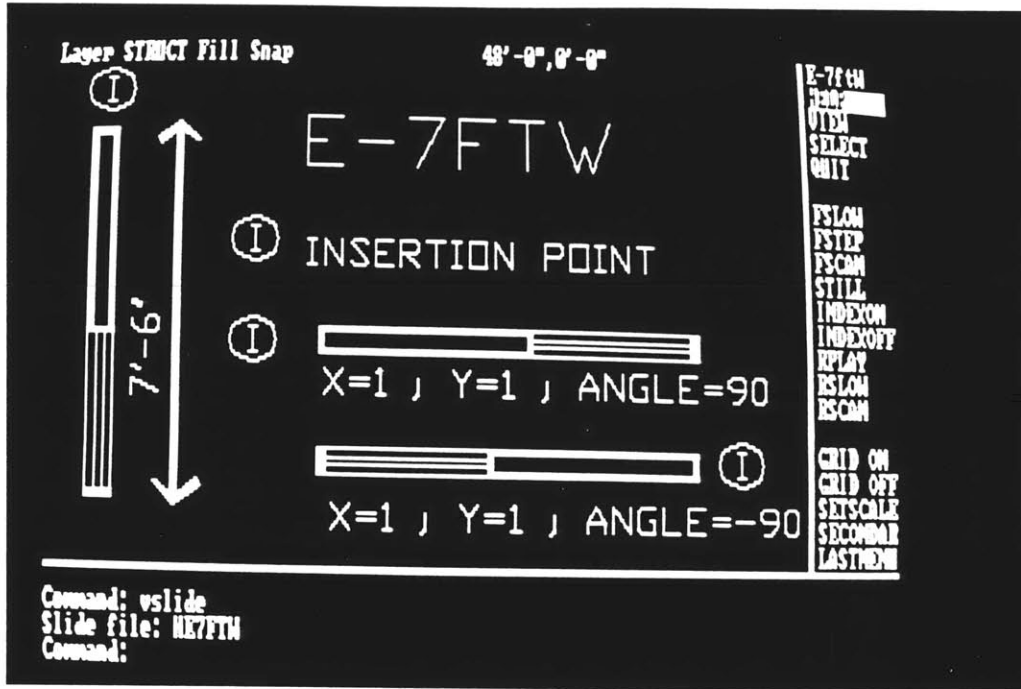


Figure 3-15: Screen display of the HELP command for one external partition

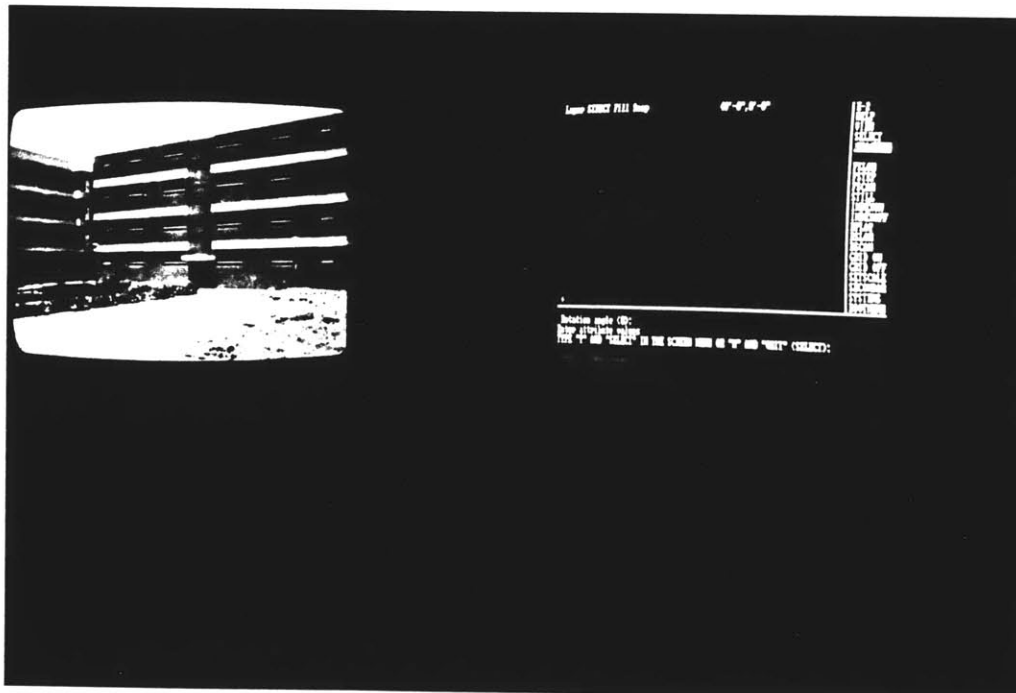


Figure 3-16: Screen display of the VIEW command for the previous component

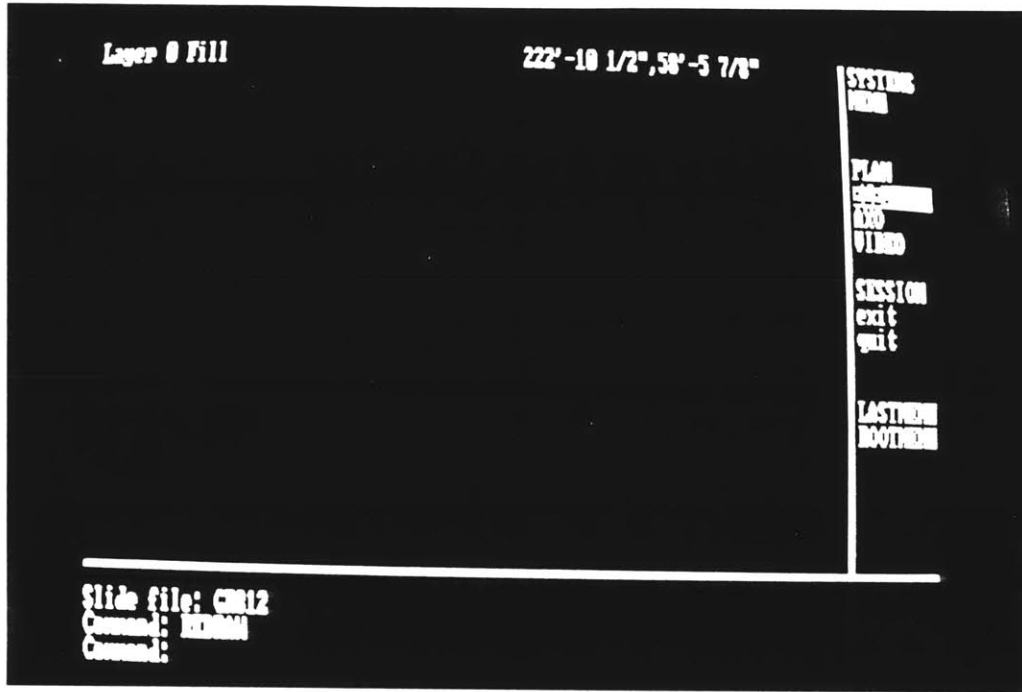


Figure 3-17: Screen display when choosing the ELEVATION graphic mode

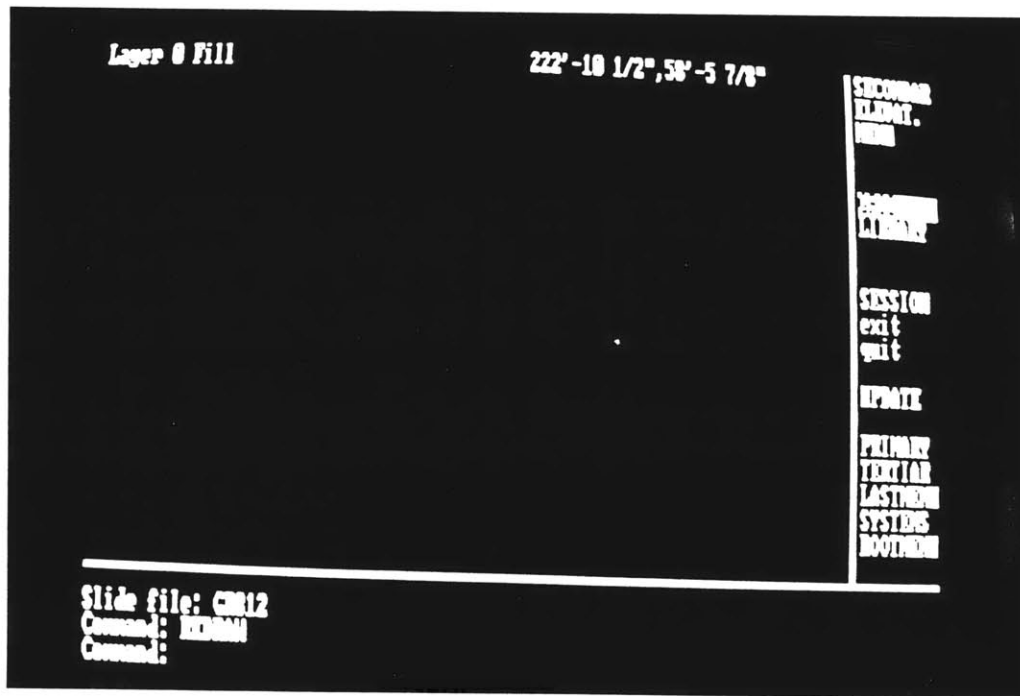


Figure 3-18: Screen display when choosing the SECONDARY system in the ELEVATION graphic mode

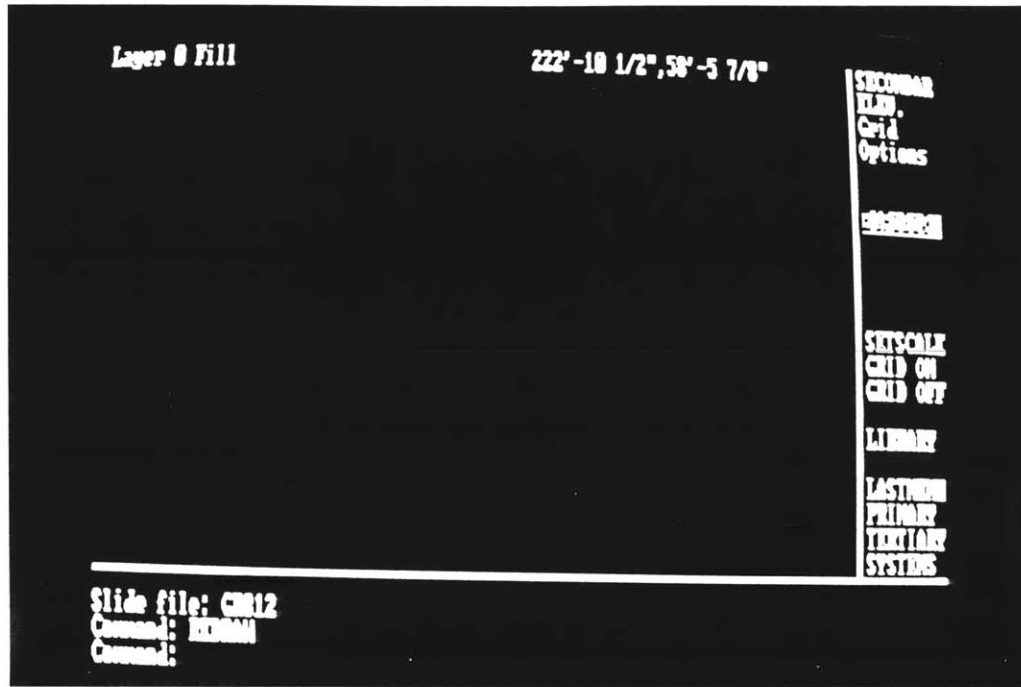


Figure 3-19: Screen display when choosing the GRID option

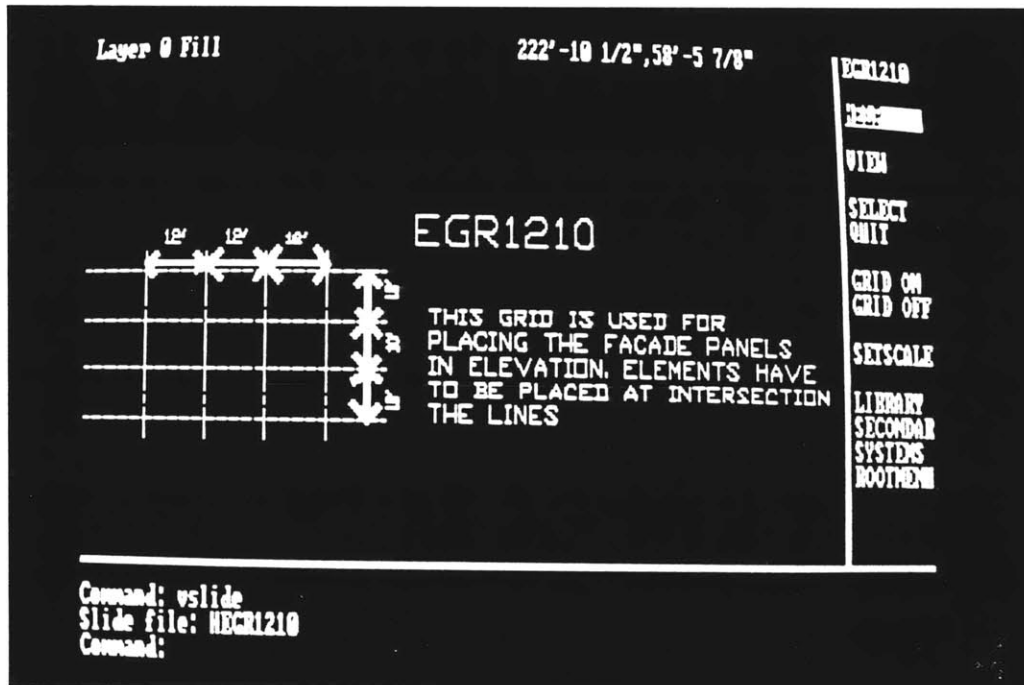
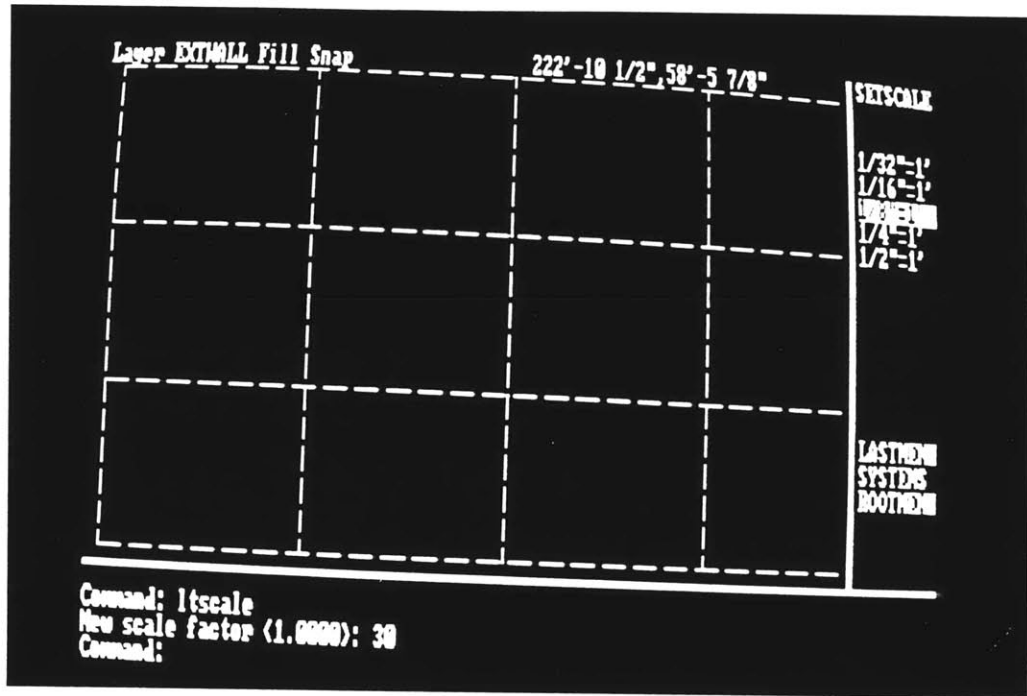
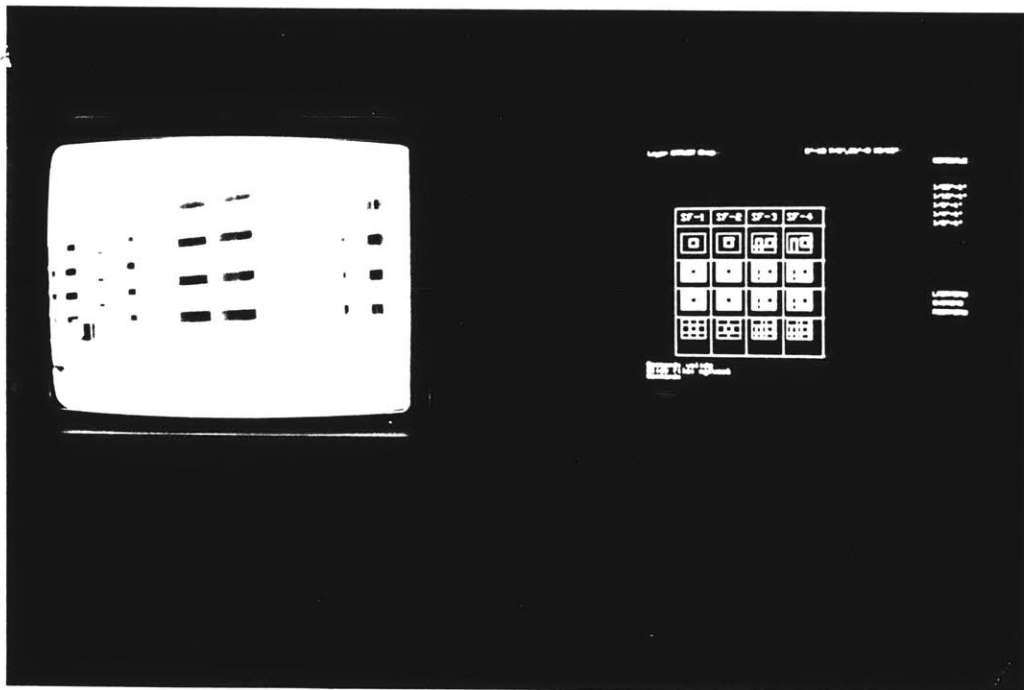


Figure 3-20: Screen display of the HELP command in the EGR1210 option



**Figure 3-21:** Screen display when selecting SETSCALE 1/8"=1' for the grid EGR1210



**Figure 3-22:** Screen display when viewing the library parts



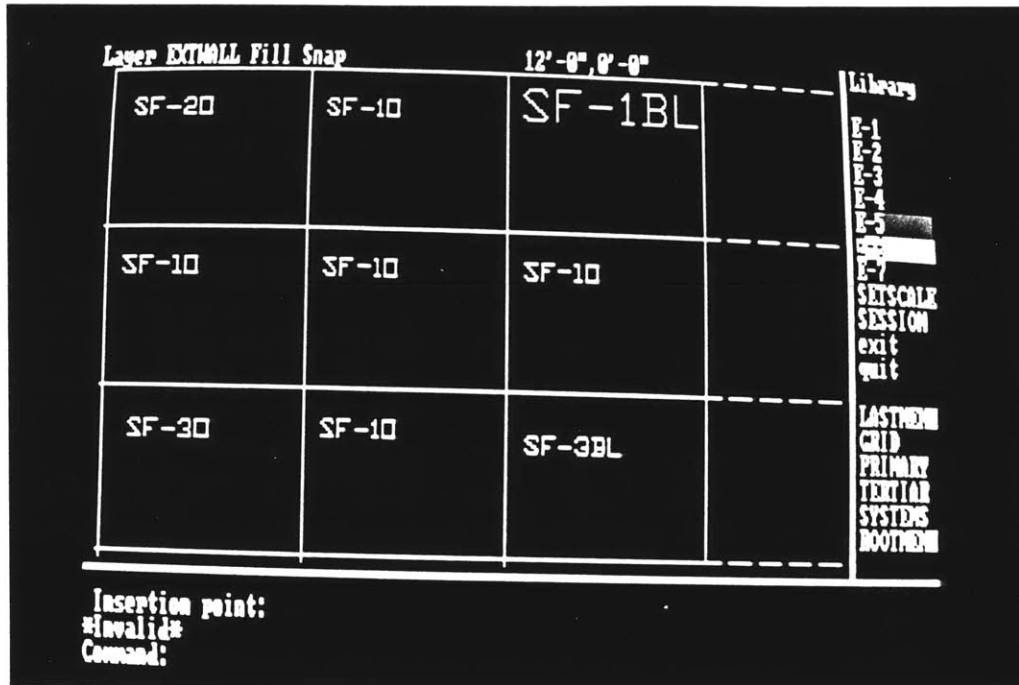


Figure 3-23: Screen display when inserting sketches of the library parts

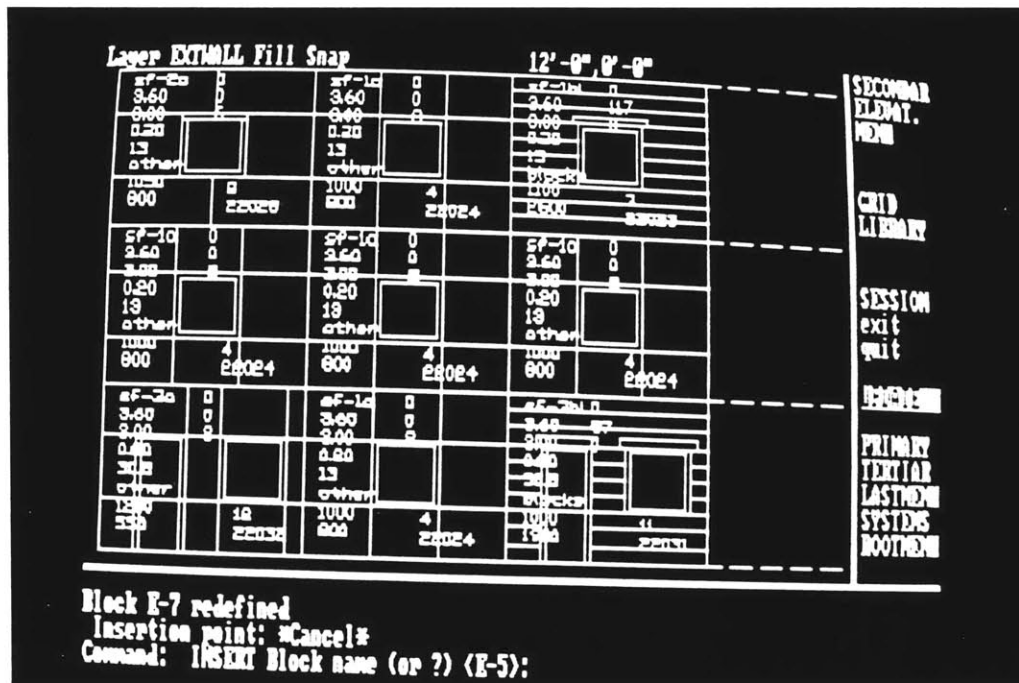


Figure 3-24: Screen display of the UPDATE command. Each panel is replaced by the final drawing of panels associated with attribute values.

### **Data Processing**

All the components the students have inserted in his drawings have some attributes related to :

CODE

LENGTH

HEIGHT

THICKNESS

MATERIAL

PERCENT OF OPENING RATE

NUMBER OF BRICKS / FACADE ELEMENT

NUMBER OF BLOCKS / FACADE ELEMENT

NUMBER OF PANELS / FACADE ELEMENT

COST

WEIGHT

TYPE

FRAME (Each element is associated with an image file, the FRAME

NUMBER refers to the FRAME ADDRESS of this file stored on videodisc).

Those attribute data are extracted from the AutoCad drawing and filed directly as a text file with an .TXT extension. Then, this data file, renamed as a .PRN file, can be sent to Lotus123 and processed with a subroutine, which will do the cost estimates or the bill of quantities. A video control subroutine, programmed with the macros in the spreadsheet, is also available to the user in order to view still images, pre-programmed animation sequences at the speed he wants. The video

control program is also menu driven. So far there are three menus available.

The first menu (cf. Fig.(3-30)) presents the general control display commands of the videodisc player. To get access to this menu, the user holds the {ALT} key and types N simultaneously. A 2-line text menu will pop out on the top part of the computer screen above the spreadsheet. It looks like:

STOP PLAY RESET STILL REVERSE INDEXON INDEXOFFF

Under each option, there is a one-line text explaining the option he chooses. For example , he would see for the STILL option:

STILL

Stop at image

The options are almost self explanatory.

In order to choose either of the options, the user places the highlit cursor on the option and hits carriage return twice. The required informations will then be displayed on the TV monitor screen, showing images from the videodisc.

The second menu (cf. Fig.(3-31)) allows the user to display a preprogrammed sequence of still images (slides) and also to search for any random image if he knows the frame address of the image he wants to look at. To get access to this menu, the user holds the {ALT} key and types M simultaneously.

The menu looks like:

SYSTEM ASSEMBLY INITIALIZATION SEARCH

SEARCH allows the user to look at a specific image. He has to type in the frame number which refers to the address of this image stored in the videodisc.

INITIALIZATION resets the program to the beginning of the sequence

SYSTEM ASSEMBLY will display a sequence of slides on the TV monitor.

Those slides or images are stored in different places in the videodisc where the frame addresses are not in sequence. (see Fig.(3-32)).

The third menu (cf. Fig.(3-33)) allows the user to display a preprogrammed sequence of animation, whereas the previous one displayed only still images. To access this menu, the user types Z while holding the {ALT} key. The menu looks like:

SEGMENT1      SEGMENT2

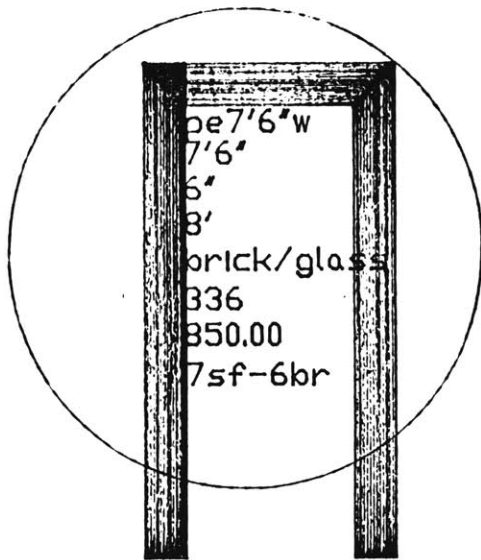
If the user chooses SEGMENT1, a new menu comes out:

PLAY   STILL   REVERSE   INDEXON   INDEXOFF   QUIT

He can then PLAY the animation sequence , stop at one image (STILL), play reverse (REVERSE), put the the frame address on (INDEXON) or off (INDEXOFF). After viewing the sequence, he chooses QUIT, which brings him back to the previous menu and he can then keep on viewing another sequence.

The use of a pre-programmed segment, accompanied with voice instructions, can be used as a tutorial by the student, explaining, for example, the principles of assembly of a structural system or the construction process, etc.

The figures in the following pages are samples of worksheets as displayed on the computer screen as well as the associated images displayed simultaneously on the videodisc TV monitor.



Each element is associated with attributes which can be extracted and read as a data file by a Data Base System for data processing. They are such as:

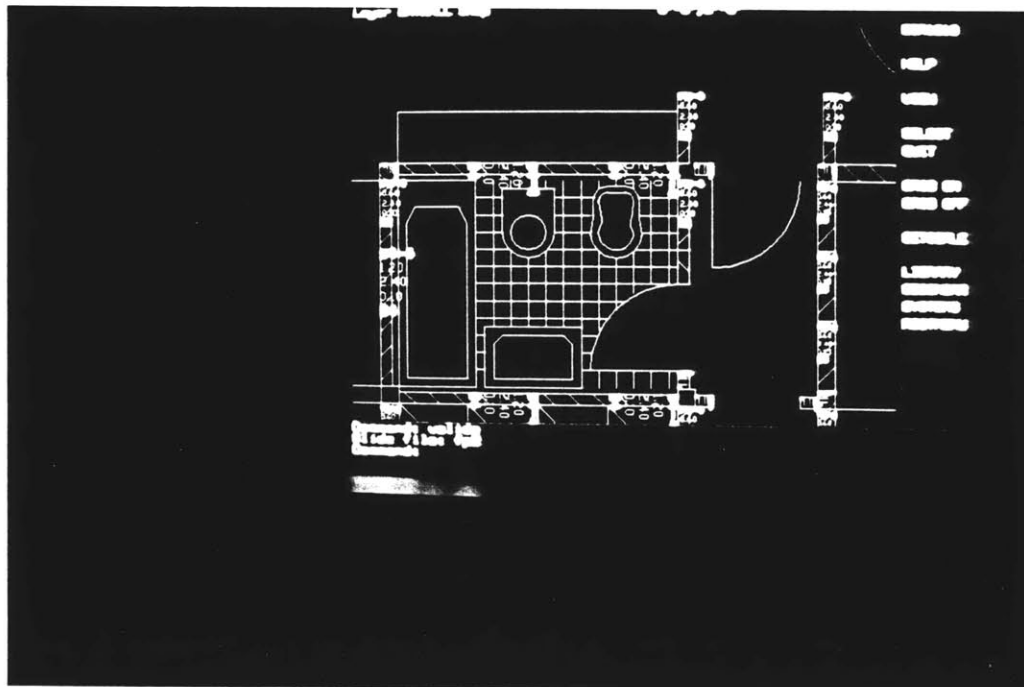
- Height
- Material
- # of bricks
- cost
- Elevation reference code

The user is asked to input their values. If he types a carriage return, the default values are input in the drawing.

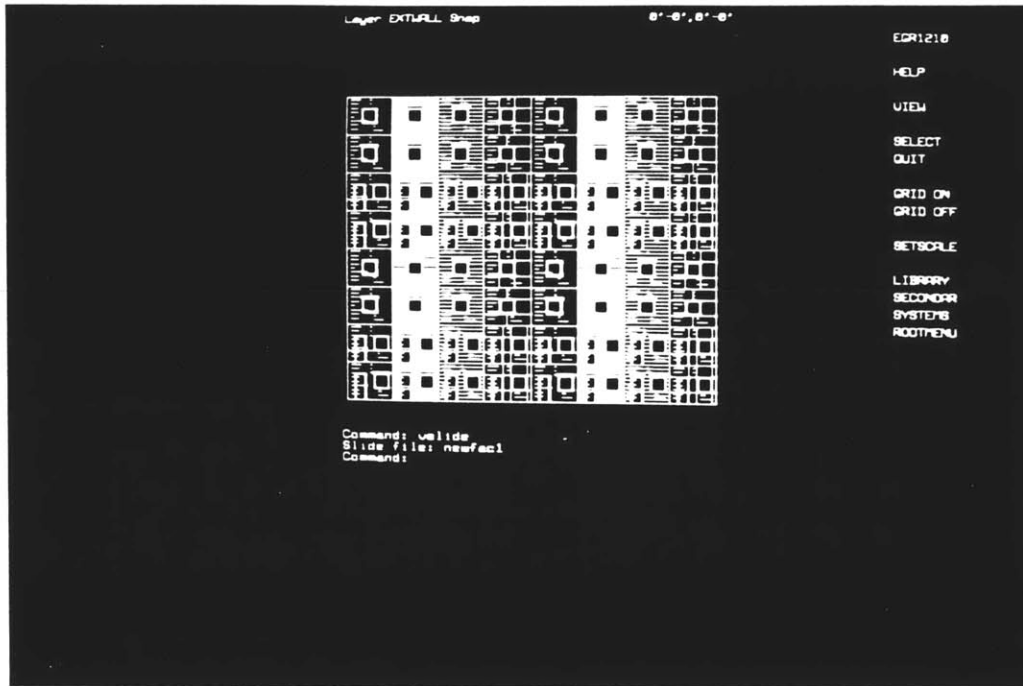
**Figure 3-25:** Sample of some attributes associated to floor plan partitions



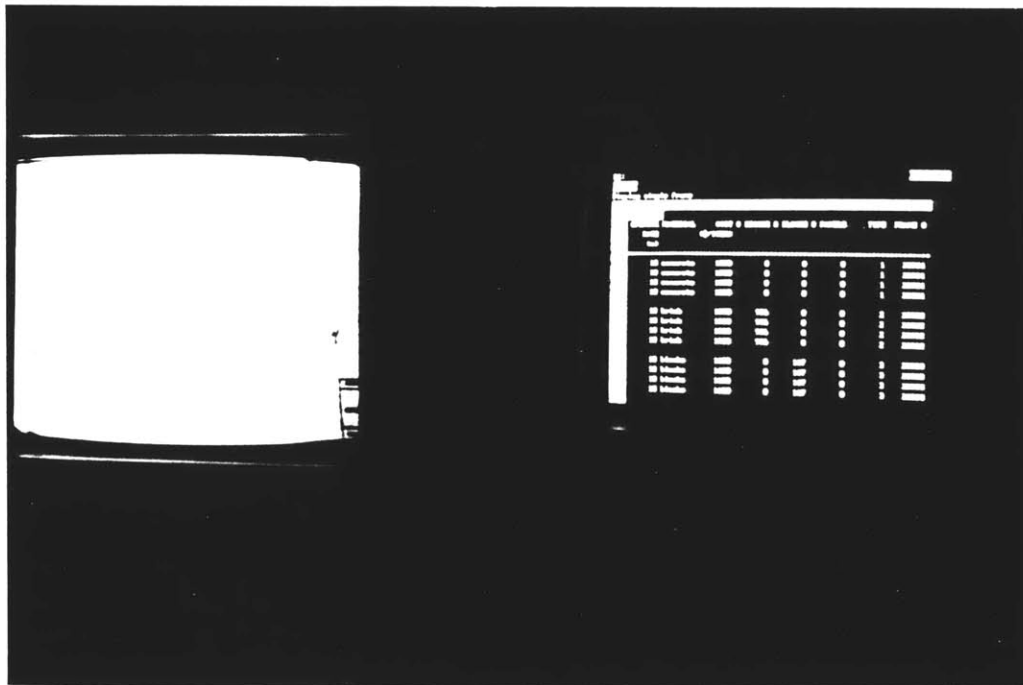
**Figure 3-26:** Sample of a floor plan with attribute definition



**Figure 3-27:** Detail of a bathroom unit with associated attribute values



**Figure 3-28:** Screen display of a facade generated with a combination of prefabricated panels



**Figure 3-29:** Screen display of the Lotus123 worksheet showing the alpha-numeric information extracted from the previous drawing of facade

BI: [ ]  
PLAY NEXT STILL HOME ENDL OFF  
Play Playng system

CODE	VALUE	LENGTH	INCREASE	QUANTITY	MATERIAL	COST	WEIGHT
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1b	3.6	3	0.2	12	brick	1200	900
1-1b	3.6	3	0.2	12	brick	1200	900
1-1b	3.6	3	0.2	12	brick	1200	900
1-1b	3.6	3	0.2	12	brick	1200	900
1-1d	3.6	3	0.2	12	blocks	1200	0
1-1d	3.6	3	0.2	12	blocks	1200	0
1-1d	3.6	3	0.2	12	blocks	1200	0
1-1d	3.6	3	0.2	12	blocks	1200	0

Figure 3-30: Screen display of the worksheet with attributes and MENU 1

BI: [ ]  
PLAY NEXT STILL HOME ENDL OFF  
Play Playng system

CODE	VALUE	LENGTH	INCREASE	QUANTITY	MATERIAL	COST	WEIGHT
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1a	3.6	3	0.25	12	concrete	3600	0
1-1b	3.6	3	0.2	12	brick	1200	900
1-1b	3.6	3	0.2	12	brick	1200	900
1-1b	3.6	3	0.2	12	brick	1200	900
1-1b	3.6	3	0.2	12	brick	1200	900
1-1d	3.6	3	0.2	12	blocks	1200	0
1-1d	3.6	3	0.2	12	blocks	1200	0
1-1d	3.6	3	0.2	12	blocks	1200	0
1-1d	3.6	3	0.2	12	blocks	1200	0

Figure 3-31: Screen display of the worksheet with MENU 2



Terminal window showing the output of the 'SYSTEMS ASSEMBLY' option. The title is 'Display expenses of the structural system assembly'. The table lists various components with their respective quantities, unit costs, and total costs.

LINE	QUAN	LENG	THICK	GRADE	REMARKS	UNIT PRICE	TOTAL
1-1a	3.6	3	0.15	13 concrete		2000	0
1-1b	3.6	3	0.15	13 concrete		2000	0
1-1c	3.6	3	0.15	13 concrete		2000	0
1-1d	3.6	3	0.15	13 concrete		2000	0
1-2a	3.6	3	0.2	13 brick		1200	288
1-2b	3.6	3	0.2	13 brick		1200	288
1-2c	3.6	3	0.2	13 brick		1200	288
1-2d	3.6	3	0.2	13 brick		1200	288
1-3a	3.6	3	0.2	13 blocks		1500	0
1-3b	3.6	3	0.2	13 blocks		1500	0
1-3c	3.6	3	0.2	13 blocks		1500	0
1-3d	3.6	3	0.2	13 blocks		1500	0

Figure 3-32: Screen display when selecting the SYSTEMS ASSEMBLY option

Terminal window showing a menu structure. The title is 'MENU 3'. The table lists various menu items with their respective quantities, unit costs, and total costs.

LINE	QUAN	LENG	THICK	GRADE	REMARKS	UNIT PRICE	TOTAL
1-1	3.6	3	0.15	13 concrete		2000	0
1-2	3.6	3	0.2	13 brick		1200	288
1-3	3.6	3	0.2	13 blocks		1500	0

Figure 3-33: Screen display when selecting MENU 3

### **3.2 Planning for Developing Countries**

This case study elaborates on two aspects of the integrated computer system described in Chapter 2.1

First, it demonstrates the capability of interfacing AutoCad with any sophisticated model built with the Lotus123.

Second, is discussed the usefulness of such a system in a context of large scale planning for development of Third World countries.

#### **3.2.1 Principles of the system**

This case is based on an affordability model developed for the World Bank by Alain Bertaud. More extensive literature and technical references are available at the World Bank (The "Bertaud Model" Urban Development Technical Paper #2. Prepared by PADCO Inc., in collaboration with World Bank staff. Dec. 1981). It is intended to address some specific issues of design and analytic criteria for low-income housing alternative in the developing world, such as affordability criteria involving:

- Calculation of space and infrastructure costs for different types of plot layouts;
- Differential land pricing;
- Graduated payment loans; and,
- Analysis of subsidies and financial flows.

Based on the integrated computer system described in Chapter 2.1, this case study will show how, and to what extent, the system can be used as a working tool for architects, planners, and policy makers who want to design a master plan at a large scale planning level and have continuous feedback from the drawing, both in

terms of design criteria to the alphanumeric data and in terms of data management, cost calculations or other calculations involved in the Bertaud Model.<sup>10</sup> The integrated computer system adds up a CAD/CAM capability that is useful in a context of site development for attaching design options (i.e. variation in location, plot size, plot shape, infrastructure, location of social facilities) to variations in cost (affordable cost constraints, variations in land pricing, etc.)

Drawings are generated in AutoCad. Each drawing is associated with attribute names such as length, width, point of circulation etc. When the plots are put together to create a block shape, those attributes will be entered, and their corresponding values, will be entered by the user. The numeric data associated with the block are then extracted from the AutoCad drawing and sent to the Lotus123 spreadsheet in the form of a .PRN file.

### **3.2.2 Limitations**

The principal functions of this system is to assist in analyzing options for the supply and pricing of shelter and to assist in identifying the financial consequences of alternative plot configurations for potential user groups and the government agencies involved.

Although this system can be of considerable help in facilitating and accelerating decision making during the design phase of project formulation and appraisal, it does not pretend to give an optimal and exclusive solution for shelter problems. When using the system, the designer should already have in mind the human standards and lifestyle of the target groups for whom the project is designed; for example, in some countries such as Bangkok, people would live happily in row

---

<sup>10</sup>"The Affordability Program Submodel of the Bertaud Model programmed on IBM/PC" User's Manual. Prepared by Marie Agnes Bertaud.

houses in urban areas, whereas in arabic countries the patio-type housing is preferred.

Another limitation is in the technical performance of the system itself. So far it is not possible to have a feedback from the Lotus 123 spreadsheet to the AutoCad drawing. As a result if numeric data were changed manually in the affordability program, the drawing--for example the site plan--would not be updated automatically with new plot configurations.

As explained in the "Bertaud Model" manual, the model has been designed as an aid in identifying affordable solutions for each type of household in a defined cultural context and country. The type of questions the model will help to answer relates to:

1. Affordability: How much can specific types of low-income households afford to pay for shelter, and how can such type of shelter be financed?
2. Financial terms: How can interest rates, recovery periods or down payments affect affordability.
3. Plot and housing design: What plot sizes are feasible within the expenditures the households can afford? What types and standards of infrastructure, community facilities (sizes) and housing (block configurations) are feasible?
4. Cost recovery and project design.
5. Site selection: This issue is very much related to question 3: what particular types of shelter solutions (plot sizes, building systems) can be considered, given the land prices and off-site infrastructure associated with a specific site.

As far as our system is concerned, the data transferred from the drawing should deal essentially with question 3:

According to those above cited issues, the Bertaud Model is made up of five submodels which:

1. analyze the relationships amount the base variables in settlement projects which have layout approximately a simple grid;
2. analyze the variables which affect circulation space and the cost of on-site infrastructure in more complex layouts;
3. analyze the consequences of differential land pricing;
4. help to analyze the impact of graduated monthly loan payments which reflect expected increases in household incomes; and,
5. make it possible to identifying the subsidies implied by alternative settlement options, together with their institutional cash flow implications.

Fig. (3-34) shows the structure of the program based upon the above mentioned considerations.

Fig. (3-35) is a sample printout of the Affordability Model.

Part I: Land and Development Costs contain data related to question 2. It is used to calculate space and the costs of on-site and off-site infrastructure for selected types of project layouts.

Part II: Land Use of Pricing and Non-residential Land, contain data related to 3. It is designed to examine the changes of differential land pricing of non-residential land on the household incomes.

Part III: Pricing and Affordability of Residential Plots contain data related to 4. It is designed to examine the changes in plot configurations as well as the consequences of graduated monthly loan payments by households with the payments increasing each year over a designated period.

LAND AND DEVELOPMENT COSTS		Unit
line number		
input	6- Land cost	\$/M2
input	7- Site preparation cost	\$/M2
input	8- On site infrastructure cost	\$/M2
input	9- Off site infrastructure cost	\$/M2
-----		
OUTPUT	11-+AVERAGE DEVELOPMENT COST PER GROSS SQUARE METER	
----- ---b--- ---c--- ---d--- ---e--- ---f--- ---g--- ---h--- ---i--- ---j--- ---		
	LAND USE	PRICING OF NON RESID.LAND
-----		
input	15- Total area of site	Ha
input	16- Percentage of circulation space	%
input	17- " of open space	%
input	18- Area occupied by schools	.....M2. Sale price of school
input	19- Commercial area	.....M2. Sale price of commerc.
OUTPUT	20-+Total residential area	M2 area
OUTPUT	21-+TOTAL NUMBER OF PLOTS	unit
OUTPUT	22-+Population density	people/ha
-----		
OUTPUT	24-+AVERAGE DEVELOPMENT COST PER NET SQUARE METER	\$/M2
----- ---b--- ---c--- ---d--- ---e--- ---f--- ---g--- ---h--- ---i--- ---j--- ---		
PRICING AND AFFORDABILITY OF RESIDENTIAL PLOTS		
-----		
input	28-Plot type	
input	29-Monthly income per household	\$
input	30-Percentage of plots in each type	\$
OUTPUT	31-+number of plots in each type	units
input	32-Plot size per type	M2
input	33-Sale price per plot type	\$/M2
-----		
OUTPUT	35-+TOTAL PRICE TO BE CHARGED PER HOUSEHOLD	\$
-----		
input	37-Percentage downpayment	%
input	38-Yearly interest rate	%
input	39-Recovery period	years
-----		
OUTPUT	41-+MONTHLY PAYMENT PER HOUSEHOLD	\$
OUTPUT	42-+PERCENTAGE OF MONTHLY INCOME	%
input	43-Monthly water charges	\$
input	44-Other maintenance charges	\$
OUTPUT	45-+TOTAL MONTHLY PAYMENT PER HOUSEHOLD	\$
OUTPUT	46-+PERCENTAGE OF MONTHLY INCOME	%
-----		
COST RECOVERY		
-----		
OUTPUT	50-+AVERAGE PRICE RECOVERED PER NET SQUARE METER	\$/M2
OUTPUT	51-+AVERAGE DEVELOPMENT COST PER NET SQUARE METER	\$/M2
OUTPUT	52-+SURPLUS OR DEFICIT AS A PERCENTAGE OF TOTAL PROJECT COST	%
-----		

Figure 3-34: Data required as input in the Affordability Model

2	B	C	D	E	(-79-)	G	H	I	J	
3	I - LAND AND DEVELOPMENT COSTS		Base cost	Percentages		Inter. Construct	*TO BE RECOVERED \$/M2			
4			/m2	Physic.al	Design					
5				Contengencie	Sup.Mgmt					
6	Land	cost/gross	m2	1.20	0.00	2.00	9.00	1.33		
7	Site preparat.	"	/m2	0.35	5.00	8.00	9.00	0.43		
8	On-site infrast.	"	/m2	3.50	10.00	12.00	9.00	4.70		
9	Off-site infrast.	"	/m2	0.50	10.00	12.00	9.00	0.81		
10	Other developmt	"	/m2	0.00	0.00	0.00	0.00	0.00		
11	CONSTRUCTION COST		Area m2							*FINAL COST/UNIT
12	Superst. Unit #1	0.00	5.00	10.00	12.00	0.00	#1	0.00		
13	" Unit #2	0.00	0.00	0.00	0.00	0.00	#2	0.00		
14	" Unit #3	0.00	0.00	0.00	0.00	0.00	#3	0.00		
15	" Unit #4	0.00	0.00	0.00	0.00	0.00	#4	0.00		
16	" Unit #5	0.00	0.00	0.00	0.00	0.00	#5	0.00		
17	" Unit #6	0.00	0.00	0.00	0.00	0.00	#6	0.00		
18	<hr/>									
19	*DEVELOPED LAND COST PER GROSS m2 TO BE RECOVERED :						7.27			
20	<hr/>									
21	II - LAND USE & PRICING OF NON-RESIDENTIAL LAND									
22				*PERCENT Non-Residential						
23	Total area in ha	4.86	100.00 %	Devel. land price						
24	Circulation %	25.83	25.83 %	per net m2						
25	Open spce+com.fac.%	3.53	3.53 %							
26	Primary schools m2	1729	2.39 %	0.00						
27	Second. schools m2	960	1.33 %	0.00						
28	Other facilities m2	0	0.00 %	0.00						
29	Commercial #1 m2	476	0.66 %	0.00						
30	Commercial #2 m2	0	0.00 %	0.00						
31	Commercial #3 m2	0	0.00 %	0.00						
32	Small industry m2	0	0.00 %	0.00						
33	*TOTAL MARKETABLE m2	34331	70.64 %							
34	*TOTAL RESID.AREA m2	31166	66.26 %							
35	*TOTAL NUMB.OF PLOTS	197	Hshd size :	5						
36	*POPULAT. DENSITY/ha	203								
37	<hr/>									
38	*DEVELOPED LAND COST TO RECOVER/NET m2 TO BREAK EVEN :						10.29			
39	B	C	D	E	F	G	H	I	J	
40	III - PRICING & AFFORDABILITY OF RESIDENTIAL PLOTS									
41	Resident.plot types	#1	#2	#3	#4	#5	#6	#7	#8	
42	Monthly income/hshd	50.00	55.00	65.00	100.00	0	0	0	0	
43	Plot size in m2	72.00	162.00	252.00	189.00	0.00	0.00	0.00	**	
44	Plot/type percent.	46.05	6.25	16.36	5.75	0.00	0.00	0.00	**	
45	*NUMB. OF PLOTS/TYPE	36	92	16	53	0	0	0	0	
46	Dev.landprice/netm2	6.00	6.00	8.00	8.00	0.00	0.00	0.00	**	
47	Superst. cost/plot	67.14	67.14	67.14	8.00	0.00	0.00	0.00	**	
48	Other cost per plot	12.00	12.00	12.00	12.00	0	0	0	0	
49	<hr/>									
50	*TOT.CAPITAL COST/HH	1251	2681	4635	3434	0	0	0	0	
51	<hr/>									
52	Down paymnt percent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
53	" " lump sum	0	0	0	0	0	0	0	0	
54	Interest rate/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
55	Loan term (years)	0	0	0	0	0	0	0	0	
56	<hr/>									
57	*MONTH.MORTGAGE PYMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
58	Water & elect.charg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
59	Other month.charges	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
60	*TOTAL MONTH.PAYMENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
61	* %OF MONTHLY INCOME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**	
62	<hr/>									
63	IV - COST RECOVERY									
64	*DEVELOPED LAND COST RECOVERABLE PER NET m2 :						15.51			
65	*DEVELOPED LAND COST TO RECOVER/NET m2 TO BREAK EVEN :						10.29			

Figure 3-35: Sample printout of the Affordability Model

Part IV: Cost Recovery is related to c and d. It shows whether the input data would induce any deficit or surplus and calculates the break even point.

Part V: Percentage of Circulation. It contains data related to b and calculates the percent of circulation space in a given block configurations.

Part VI: Community Facilities. It is designed to check if the area for schools and other facilities correspond to the urban norms imposed for this type of development.

Part VII: Alternatives to Break Even. It identifies the level of base costs for individual project components (land and on-site infrastructure) which would have to be achieved to make the project affordable for the target groups and at the same time to break even. To break even one may choose to:

- change the cost of on-site infrastructure;
- change the land base cost; or,
- change the land sale price.

### **3.2.3 Description of the Case Study**

This case is an illustrative example of the capability of the integrated computer system to perform simultaneous updates of different configurations of site plans, with cost analysis related to affordability issues. The computer system model allows the planner, while designing a site layout, to calculate the associated space and infrastructure costs, differential land pricing and to analyze subsidies and financial flows using the "Bertaud" model. The graphic representation of the different plots is generated with AutoCad. A library of different types of plots is available for the user. The Affordability Model allows iterations of different types of plots up to 10. But this case will only present 4 types of plots, namely Plot1, Plot2, Plot3 and Plot4. See Fig.(3-36).



Each plot in the CAD system is associated with 9 attributes which can either be constant or variable according to the user's needs (see Fig.(3-37)):

- CODE
- TYPE
- WIDTH
- LENGTH
- MONTHLY INCOME/HOUSEHOLD
- PCT OF PLOT TYPE
- DEVELOPED LAND PRICE/NET SQUARE METER
- SUPERSTRUCTURE COST/PLOT
- OTHER COST/PLOT

The first 4 attribute values (CODE, TYPE, WIDTH, LENGTH) are made constant for reasons of consistency with the graphic representation. But the others are made variable and subject to the user's input. The user can therefore build up his site plan by inserting these 4 types of plots in any desired configuration: While inserting these plots, the user will be asked to input the desired value for attributes 5, 6, 7, 8 and 9. For example, the system will prompt on the command line:

"What is the monthly income/household associated with Plot1?"

The user then types in the desired value. Once a typical configuration arranged with a combination of the desired plots is drawn, the user can multiply the block with the command ARRAY (explained later in the section).

### **Graphic Representation**

The physical setting of the workstation is very much similar to the one described in Section 3.1. The user types DESIGN which calls up on the computer screen the right program he needs in order to start working on the site plan he

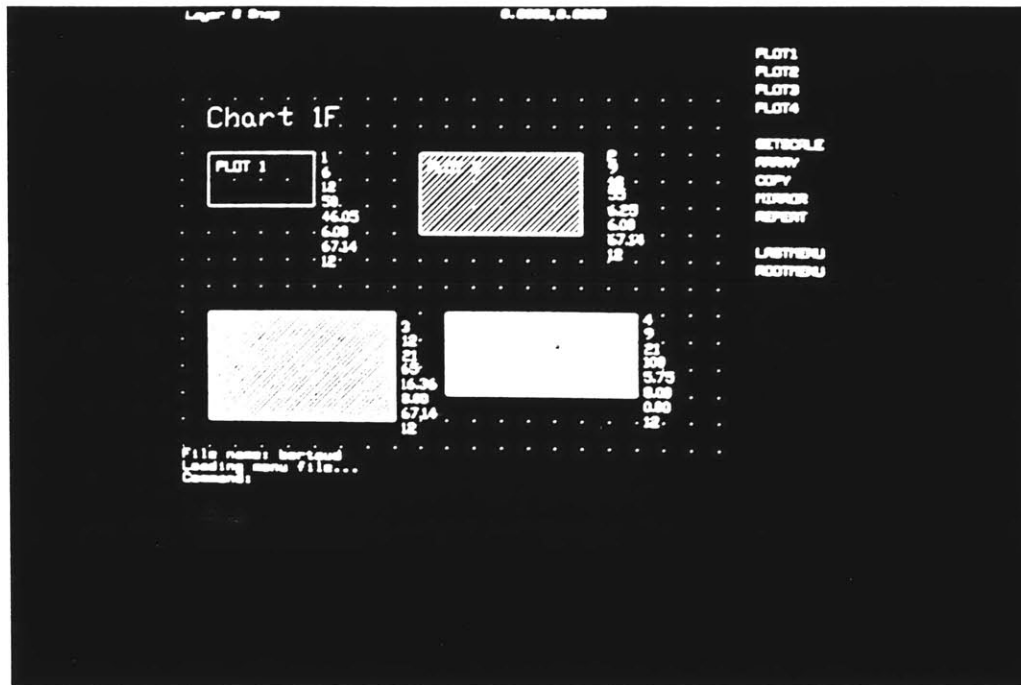


Figure 3-36: Screen display of the library of plots

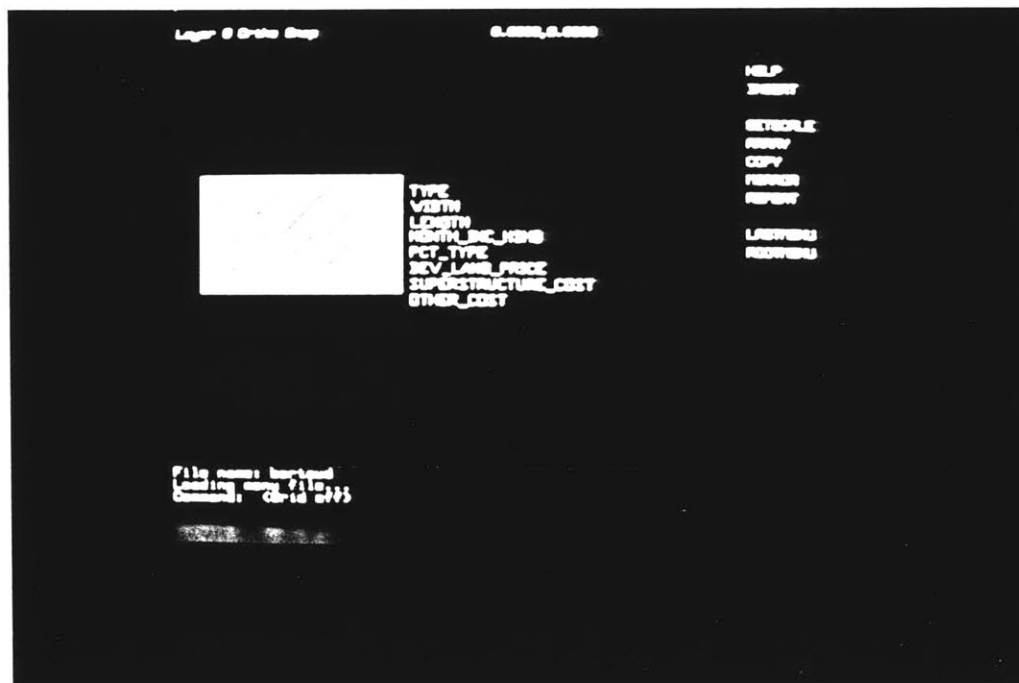


Figure 3-37: Screen display of the attributes associated with each plot

wants to create. The program loads the menu called DESIGN on the AutoCad drawing editor (described in Section 2.2). The screen menu looks like:

DESIGN

MENU

Plot Options

PLOT1

PLOT2

PLOT3

PLOT4

SETSCALE

ARRAY

COPY

MIRROR

LASTMENU

ROOTMENU

This menu presents the different types of plots available in the library. (Plot1, Plot2, Plot3, Plot4). The commands such as ARRAY, COPY and MIRROR are part of the AutoCad built-in drawing functions which facilitate duplication of blocks created within the drawing. They are very useful commands for generating geometrically regular pattern of plots.

The ARRAY command allows the user to make multiple copies of selected objects in a rectangular or circular pattern. Each resulting object can then be manipulated independently.

The COPY command is less powerful than the previous one. It lets the user to copy selected objects, one at a time.

The MIRROR command allows the user to make mirror images of existing objects, either by deleting the original objects or retaining them.

Choosing either of the above commands brings to a submenu which specifies the format of each command. The LASTMENU and ROOTMENU command are used to navigate between the menu branches. LASTMENU brings back the menu previously selected. ROOTMENU brings to the general AutoCad drawing menu.

Selecting either type of the plot options brings up a submenu which looks like:

PLOT 1

HELP

INSERT

SETSCALE

ARRAY

COPY

MIRROR

LASTMENU

ROOTMENU

The HELP command, when selected, displays informations about the size of the Plot and instructions of how to insert it as an object in the drawing.

The INSERT command allows also the user to input the desired values for the attributes described earlier in this section.

### Data Processing

After the user has finished designing the site plan, the computer stores the graphic representation in two files: the drawing file and the data file. The drawing file stores the drawing data base which describes the geometric relationships between drawing entities. The data file stores the user's alpha-numeric data as a text file, in the format .TXT. After renaming this text file into a .PRN file, it can be read by Lotus123. 123 will then store this alpha-numeric data in its worksheet. A macro which is described below will input these data in the Affordability Model. When the Affordability Model is loaded on the computer, the user types M while holding the {Alt} key, one will see on the screen a new menu which looks like:

MENU1   MENU2   MENU3   MENU4   MENU5   MENU6   LOTUS

To choose either one of the menu options, the user places the highlight cursor on it and hits the carriage return. One line of text explains the function of each menu.

MENU1

Reset values for income/household

MENU2

Reset values for Plot/Type pct

MENU3

Reset values for developed land

MENU4

Reset values for superstructure cost

MENU5

Reset values for other cost

MENU6

Recalculation

## LOTUS

### Return to Lotus operations

The above different options will input the new data file in the corresponding section of the Affordability Model. (Part III:Pricing & Affordability of Residential Plots). The user then can do sensitivity analysis and iterations to break even developed land cost according to given assumptions, with the various built-in functions of the Affordability Model.

This case shows basically one of the numerous potential applications of how to take advantages of a CAD system drawing capabilities for doing data processing.

The following figures are samples of the screen display showing the various menus described with the Affordability Model spreadsheet.

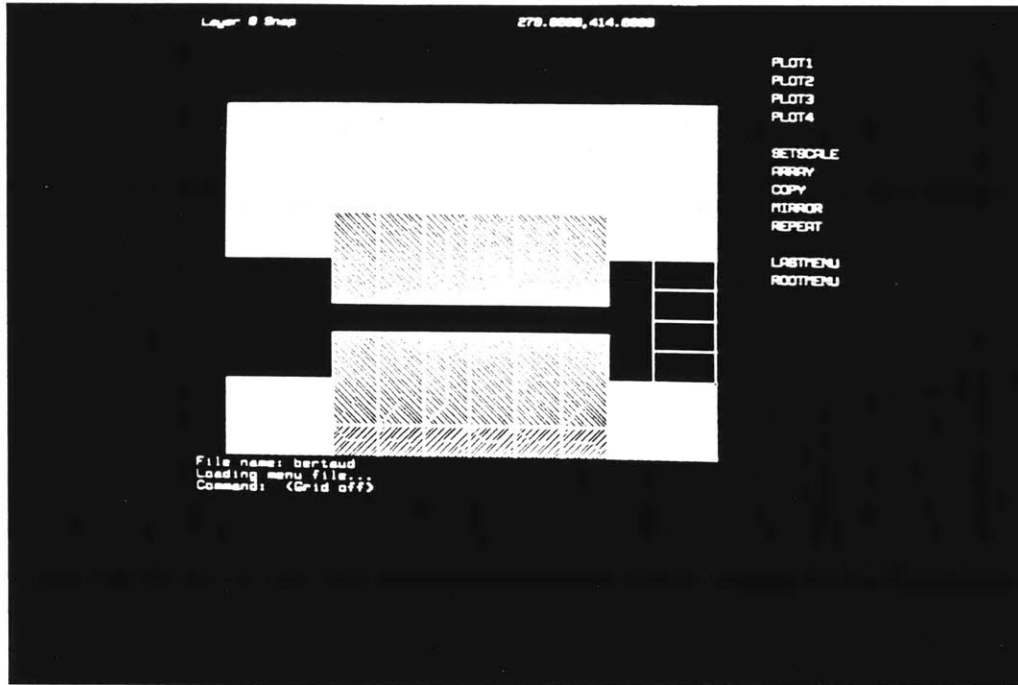


Figure 3-38: Screen display of a typical block configuration

AREA:

CODE	TYPE	WIDTH	LENGTH	MINIMUM INCHES/MSD	FLAG/TYPE	PCT
				( $\phi$ )	( $\phi$ )	(%)
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	
PLOT 1	1	6.00	12.00	50.00	45.00	

Figure 3-39: Screen display of the attribute values from a site plan

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MENU 2 MENU 3 MENU 4 MENU 5 MENU 6 LOGOFF

KEY IN VALUES FOR INCOME /HOUSEHOLD

III - PRICING & AFFORDABILITY OF RESIDENTIAL PLOTS

	01	02	03	04
41 Resident plot types				
42 Monthly income/habd	50.00	55.00	65.00	100.00
43 Plot size in a2	72.00	162.00	252.00	300.00
44 Plot/type percent.	45.85	6.25	16.25	5.75
45 -NO. OF PLOTS/TYP	26	32	16	53
46 Res. land price/haud	6.00	6.00	6.00	6.00
47 Superet. cost/plot	67.14	67.14	67.14	6.00
48 Other cost per plot	12.00	12.00	12.00	12.00
49				
50 -TOT. COST/RES	1201	2601	4635	3434
51				
52 Down payment percent	0.00	0.00	0.00	0.00
53 " " " " " " " "	0	0	0	0
54 Interest rate/year	0.00	0.00	0.00	0.00
55 Loan term (years)	0	0	0	0
56				
57 -MONTH. MORTGAGE PAY	0.00	0.00	0.00	0.00
58 Water & elect. chary	0.00	0.00	0.00	0.00
59 Other month. charges	0.00	0.00	0.00	0.00

Figure 3-40: Screen display of Menu 1

041: (00) 1-0-00 PAGE 1

MENU 1 MENU 2 MENU 3 MENU 4 MENU 5 MENU 6 LOGOFF

KEY IN VALUES FOR PLOT/TYPE PCT

III - PRICING & AFFORDABILITY OF RESIDENTIAL PLOTS

	01	02	03	04
41 Resident plot types				
42 Monthly income/habd	50.00	55.00	65.00	100.00
43 Plot size in a2	72.00	162.00	252.00	300.00
44 Plot/type percent.	45.85	6.25	16.25	5.75
45 -NO. OF PLOTS/TYP	26	32	16	53
46 Res. land price/haud	6.00	6.00	6.00	6.00
47 Superet. cost/plot	67.14	67.14	67.14	6.00
48 Other cost per plot	12.00	12.00	12.00	12.00
49				
50 -TOT. COST/RES	1201	2601	4635	3434
51				
52 Down payment percent	0.00	0.00	0.00	0.00
53 " " " " " " " "	0	0	0	0
54 Interest rate/year	0.00	0.00	0.00	0.00
55 Loan term (years)	0	0	0	0
56				
57 -MONTH. MORTGAGE PAY	0.00	0.00	0.00	0.00
58 Water & elect. chary	0.00	0.00	0.00	0.00
59 Other month. charges	0.00	0.00	0.00	0.00

Figure 3-41: Screen display of Menu 2



A41: (00) 1-0-00  
MENU 1 MENU 2 **MENU 3** MENU 4 MENU 5 MENU 6 LOGS  
RESET VALUES FOR DEV. LAND PRICE

**III - PRICING & AFFORDABILITY OF RESIDENTIAL PLOTS**

41 Resident plot types	01	02	03	04
42 Monthly income/habit	50.00	55.00	65.00	100.00
43 Plot size in a2	72.00	162.00	252.00	180.00
44 Plot/type percent.	45.85	6.25	16.25	0.00
45 <b>NO. OF PLOTS/TYP</b>	26	32	16	53
46 Dev. land price/ha2	6.00	6.00	0.00	0.00
47 Superst. cost/plot	67.14	67.14	67.14	0.00
48 Other cost per plot	12.00	12.00	12.00	12.00
49				
50 <b>TOT. CAPITAL COST/NO</b>	1251	2001	4625	2424
51				
52 Down payment percent	0.00	0.00	0.00	0.00
53 " " " " " " " "	0	0	0	0
54 Interest rate/year	0.00	0.00	0.00	0.00
55 Loan term (years)	0	0	0	0
56				
57 <b>MONTH. SERVICE FEE</b>	0.00	0.00	0.00	0.00
58 Water & elect. charge	0.00	0.00	0.00	0.00
59 Other month. charges	0.00	0.00	0.00	0.00

Figure 3-42: Screen display of menu 3

A41: (00) 1-0-00  
MENU 1 MENU 2 MENU 3 **MENU 4** MENU 5 MENU 6 LOGS  
RESET VALUES SUPERSTRUCTURE COST

**III - PRICING & AFFORDABILITY OF RESIDENTIAL PLOTS**

41 Resident plot types	01	02	03	04
42 Monthly income/habit	50.00	55.00	65.00	100.00
43 Plot size in a2	72.00	162.00	252.00	180.00
44 Plot/type percent.	45.85	6.25	16.25	0.00
45 <b>NO. OF PLOTS/TYP</b>	26	32	16	53
46 Dev. land price/ha2	6.00	6.00	0.00	0.00
47 Superst. cost/plot	67.14	67.14	67.14	0.00
48 Other cost per plot	12.00	12.00	12.00	12.00
49				
50 <b>TOT. CAPITAL COST/NO</b>	1251	2001	4625	2424
51				
52 Down payment percent	0.00	0.00	0.00	0.00
53 " " " " " " " "	0	0	0	0
54 Interest rate/year	0.00	0.00	0.00	0.00
55 Loan term (years)	0	0	0	0
56				
57 <b>MONTH. SERVICE FEE</b>	0.00	0.00	0.00	0.00
58 Water & elect. charge	0.00	0.00	0.00	0.00
59 Other month. charges	0.00	0.00	0.00	0.00

Figure 3-43: Screen display of menu 4

## Chapter 4

### POTENTIAL OF THE SYSTEM: FUTURE DEVELOPMENTS

A few lessons have been learned from developing this integrated computer system. It was especially helpful to define more precisely a certain number of criteria for choosing any CAD system as well as a Data Processing system to be best suitable for integration.

#### For the CAD system

It should have :

- A rather powerful layering capability which is used to group associated components of a drawing. Such a feature gives the flexibility of independence in terms of assigning specific colour, linetypes or modes of display. For example in the case study 1<sup>11</sup>, in a floor plan, the columns, beams, floor slabs, exterior partitions, interior partitions are respectively in five different layers assigned to meaningful names, e.g. Column, Beam, Flslab, Extwall, Intwall.
- A "Snap" capability which is useful to draw with very accurate dimensions. The "Snap" resolution, in fact, defines the spacing of a given grid and all the screen crosshairs as well as input coordinates are locked to the nearest point on the grid.
- An attribute definition and extraction capability which allows to input alpha-numeric information at the same time as the drawing generation.

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<sup>11</sup>cf Section 3.1.2

- A drawing interchange file capability in order to use the AutoCad drawings in other CAD system.
- A programming language capability. The latest version of AutoCad 3.0 with the 3-D capabilities include an efficient programming language whose structure is close to the programming language LISP. It allows the definition of variables, string functions and conditional expressions which are very useful when research is oriented to "Expert Systems".

### **Data Base System**

It should have:

- A data structure capability which can read a data file already created in any other computer system.
- A wide range of arithmetic functions and a built-in programming language.

Obviously "more" and "better" can always apply to any portion of the system, but there are essentially three points which need further development:

1. Digital data decoding
2. Multi-tasking capability
3. User's input interaction

- Further development on such an integrated computer system should be oriented towards the capability of the Visual-Information System for storing digital data. The potential capability for decoding digital data will enable the system to store vector drawing files which can be downloaded to the local computer system and be manipulated within AutoCad. Linking the videodisc with the microcomputer already gives a new and valuable architectural design tool, for the practitioner. Additional use of the digital decoder will enable the system to process

the images stored in videodisc. In that case, for example, the user will be able to build up his own floor plan using standard parts of any construction manufacturer, stored as vector drawings in the videodisc.

- Another area which should also be explored is related to moving from the AutoCad environment to the Lotus environment. A multi-tasking program could be used in this case. It would allow the user to run the video control programs through Lotus123 (for example, the program would display a sequence on structural assembly accompanied with instructions) while working simultaneously on a construction detail.
- Integrating three stand-alone programs faces the problem of discomfort from the user. Improving the user's interaction should be a major concern. The use of an "*intelligent*" digitizer (PENCEPT) which has the ability for pattern recognition is an option which should be explored along the line of this research project.

The data processing aspect within the Lotus123 environment, besides the video control subroutines, is useful for developing a structural analysis subroutine which could use as input data file, the attribute values entered at the same time as the graphic generation in the computer. Those data will be extracted directly from the AutoCad environment, as explained in the earlier sections.

The integrated computer system presented in this thesis is not yet a complete architectural design tool. Although it is a promising aid for the architect, more research still has to be undertaken in order to have it actually help the designer in making decisions about details of the ways things are put together; for example, the exact nature of a connection between two spaces, or the exact nature of a structural connection. It is hopeful that the programming language provided with AutoCad 2.1 can be used in order to make the computer know that the geometric figures

drawn on the screen are meant to be living environment.

It is also predictable that one component of the integrated system, the Visual Information System, associated with the capability of digital data decoding, holds tremendous potential in changing the traditional way of storage media of a given data base. Nevertheless this technology is still not popularized enough to be adopted by most industrial or construction firms domestically or internationally. The main reason for it is the hardware cost and its disponibility (cost of a videodisc player is approximately US \$ 15,000 and cost of a videodisc production can vary from US \$ 300 to US \$ 5,000). But more than any economic reason, suspicion arises deeper from human behaviour because the videodisc technology involves a drastic change in the way people perceive visual information. To some extreme limits, it is similar to telling people to trade paper books with electronic books; in other words, it would be like asking people to give up the act of flipping pages of a book, feeling the texture of the paper for interacting with a screen through a computer keyboard or any pointing device. Any kind of computerized simulation can be very fascinating and convenient but still can be to some extent very dangerous, because it has the potential to reduce greatly, human physical sensitivity. For example, a pilot who exercises in an enclosed room through a computer simulation of aircraft landing or bombing would not have much sense about physical harm and the impact of bombing. Everything would look like so simple: destroying a city and human lifes would just mean pressing a button. Similar examples could be applied in architecture. Visualizing an architectural space through three dimensional simulation on a computer screen is far removed from actually feeling the ambiance of it. Although one can argue that in the traditional way of designing and drawing it is even more difficult to perceive a space until it is built. Some buildings could be wonderful on paper but once constructed total failure and quite unliveable.

The future of architecture in this computer age is not grim. More and more research is oriented towards this area. But one should keep in mind it is one of the most difficult task to try to replace the designer with the computer. Most likely and hopefully the computer should remain a human slave and not the opposite.

## Appendix A

### USER'S DOCUMENTATION

This section serves as an User's guide for using the system described in case study 1.<sup>12</sup>

#### **1. Necessary hardware connections**

1. Connect the videodisc player to the COM2 of the computer with an RS-232C cable.
2. Connect the TV monitor to the videodisc player.
3. Connect the digitizer to COM1 of the computer with an RS-232C cable.
4. Connect the video display and the keyboard to the computer system unit.
5. Make sure to turn on the power for each of the system components (videodisc player, TV monitor, computer) and to put the videodisc in the videodisc player.

Fig.(A-1) describes the front panel of the videodisc player<sup>13</sup>.

Fig.(A-2) describes the rear panel of the SONY LDP- 1000A.

Fig.(A-3) describes the different locations of cable connections to the TV monitor and the computer system unit.

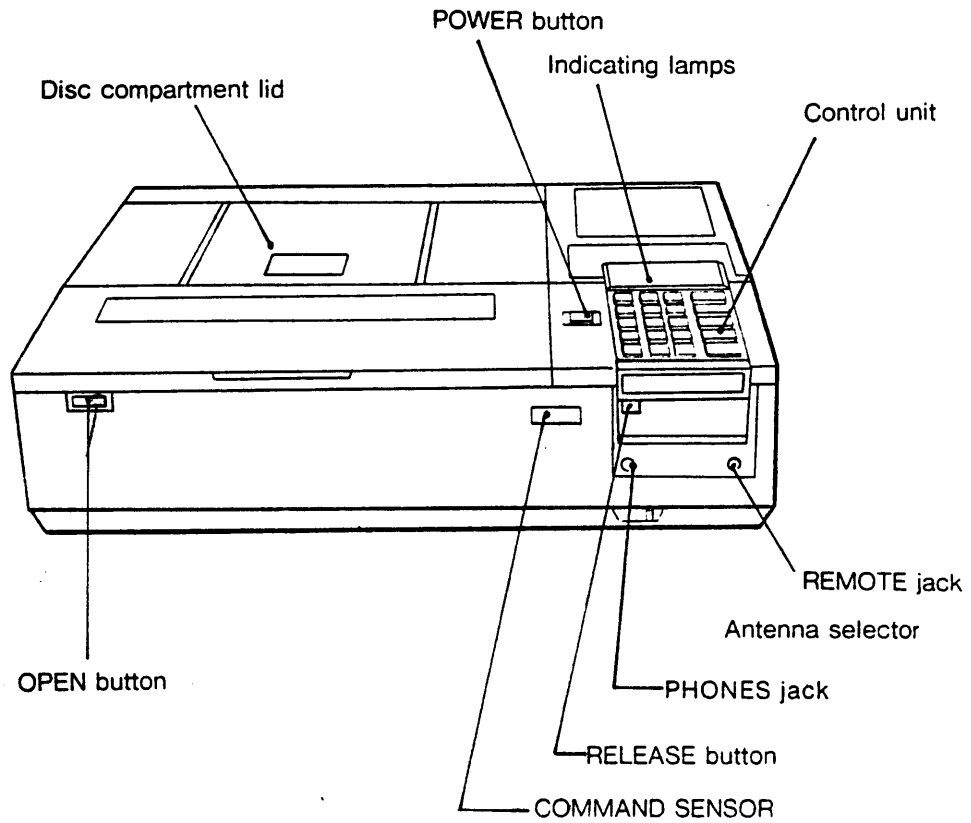
#### **2. Loading the program**

It is assumed that the AutoCad and Lotus are already installed in their proper

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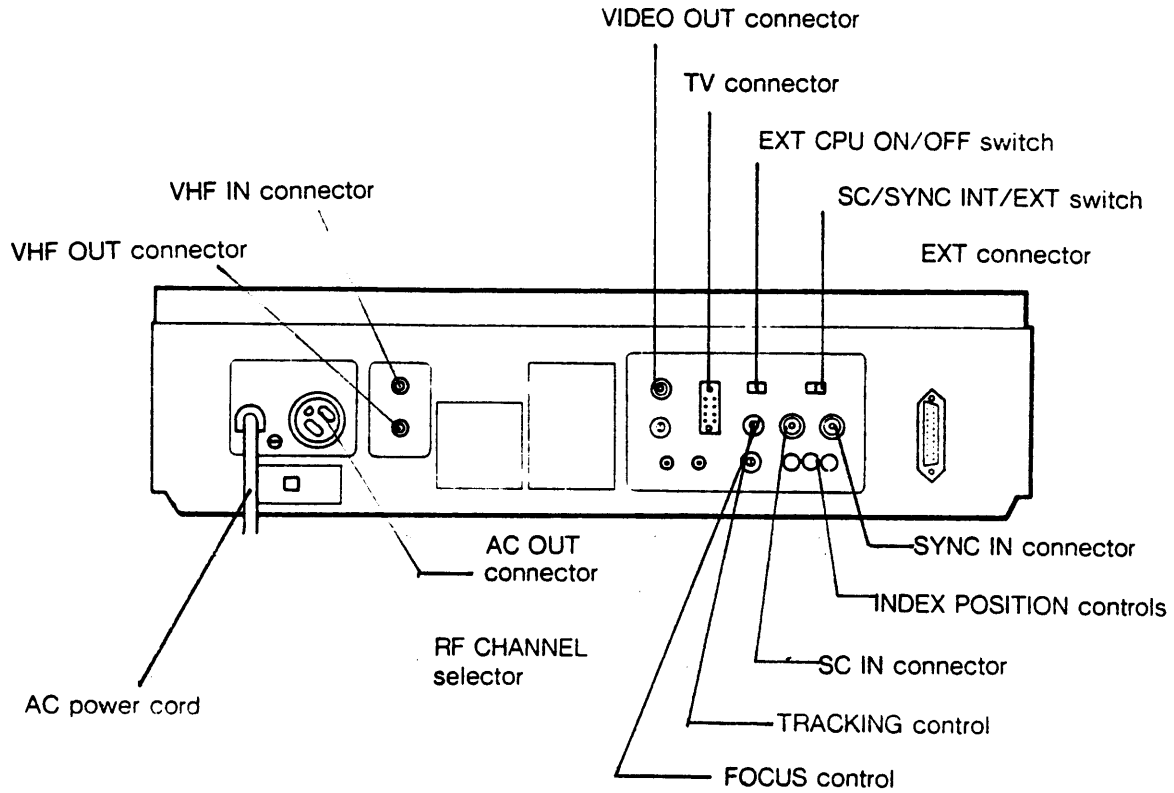
<sup>12</sup>cf Section 3.1

<sup>13</sup>cf Operating Instructions of the Videodisc player SONY LDP-1000A, published by Sony Corp. 1983

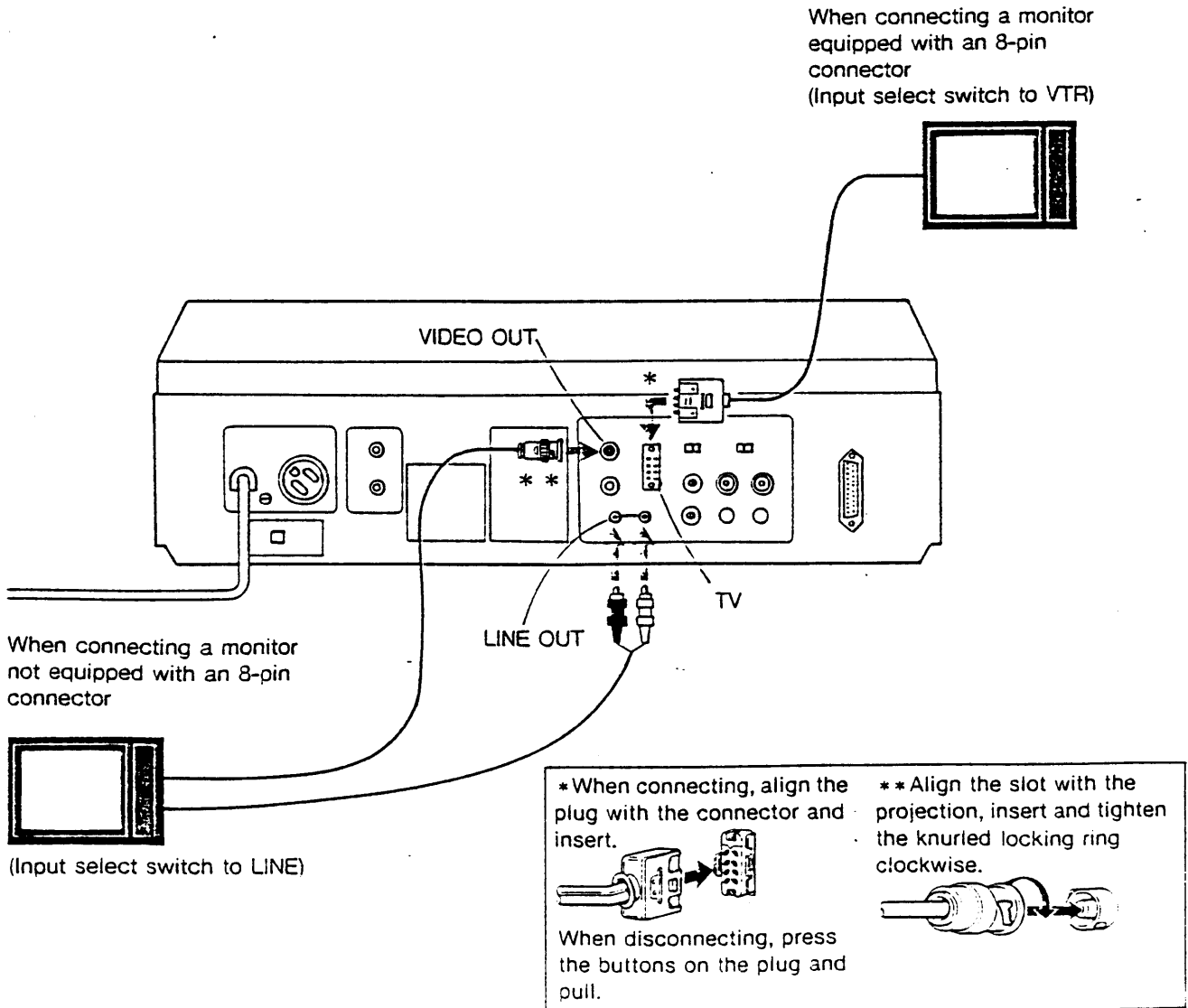


**Figure A-1:** Description of the front panel of the SONY LDP-1000A





**Figure A-2:** Description of the rear panel of the SONY LDP-1000A



**Figure A-3:** Description of the cable connections of the videodisc player

directories in the hard disk of the IBM PC-AT being used. When the user sees the Dos 3.0 prompt C>, he types "A:" and hits carriage return then he types "SYSTEMS" and hits carriage return. SYSTEMS is the name of the batch file which loads the necessary files stored in the high-density floppy diskette in drive A into the appropriate directories of the drive C in order to run the program. There are five different types of files which are necessary for the AutoCad software:

1. Drawing files (their format is "filename.DWG").
2. Script files (their format is "filename.SCR").
3. Slide files (their format is "filename.SLD").
4. Text files (their format is "filename.TXT").
5. Menu files (their format is "filename.MNU").

There are two different types of files which are necessary for the Lotus software:

1. Print files (their format is "filename.PRN").
2. Worksheet files (their format is "filename.WKS").

The batch file will also directly put the user in the AutoCad drawing editor with the appropriate menu loaded. The name of the latest is SYSTEMS. The user will then proceed as explained in Section 3.1.2.

## References

- [Autocad 85] *Autocad User Reference Version 2.1*  
Autodesk, Inc., 1985.
- [Bailey 80] H. Whitney Bailey.  
The Computer Interactive Videodisc.  
*Filmmakers Monthly* :11-29, November, 1980.
- [Bertaud 79] Marie-Agnes Bertaud.  
*The Affordability Program: submodel of the Bertaud Model  
programmed on the IBM/PC.*  
Technical Report, World Bank, 1979.
- [Brockenbrough 81]  
S. Allen Brockenbrough.  
The video-computer nexus: toward an Agenda for Instructional  
Development.  
*Journal of Educational Technology Systems* 10(2):81-97, 1981.
- [Cairo 79] Joint Research Team on the Housing and Construction Industry  
Industry Cairo University/Massachusetts Institute of Technology.  
*The Housing and Construction Industry in Egypt: Interim  
Report Working Papers 1978.*  
Technical Report, Joint Research Team on the Housing and  
Construction Industry Cairo University/Massachusetts Institute  
of Technology, sponsored by United States Agency for  
International Development, 1979.
- [Clemens 82] John K. Clemens.  
Videodisks: Three Choices.  
*IEEE Spectrum* :38-42, March, 1982.
- [Drew 80] Lisa W. Drew.  
In the Video Vanguard.  
*The Boston Phoenix* , November, 1980.
- [Eastwood 79] Lester F. Eastwood, Jr.  
Motivations and Deterrents to Educational Use of Intelligent  
Videodisc Systems.  
*Educational Technology Systems* 7(4):303-333, 1979.

- [Glenn 81] Allen D. Glenn.  
The Intelligent Videodisc: An Instructional Tool for the Classroom.  
*Educational Technology* :60-63, October, 1981.
- [Habraken 78] Nicholas J. Habraken.  
*A Position Coordination System for Building Elements.*  
Technical Report, Department of Architecture and Related  
Methods, Graduate Program (MIT), sponsored by The National  
Bureau of Standards, May, 1978.
- [Hawkes 75] Models and Systems in Architecture and Buildings.  
In Dean Hawkes (editor), *Land use and Built For in Studies  
Conference No 2.* 1975.
- [Hirschbuhl 80] John J. Hirschbuhl.  
Hardware considerations for computer based education in the  
1980's.  
*Journal of Research and Development in Education* 14(1):41-55,  
1980.
- [Hooper 80] Kristina Hooper.  
*Experimental Mapping: The Perceptual Representation of  
Environments.*  
Technical Report, University of California, November, 1980.
- (ICCA 72) *International Conference on Computers in Architecture, 1972.*
- (ICCA 79) ON LINE.  
*International Conference on Computers in Architecture, 1979.*
- (ICCA 83) ON LINE.  
*International Conference on Computers in Architecture, 1983.*
- [Kehrberg 80] Kent T. Kehrberg.  
An Interactive Economics Course.  
*Creative Computing* :98-102, October, 1980.
- [Lansdown 82] J. Lansdown.  
Expert Systems: their Impact on the Construction Industry.  
*R.I.B.A. Conference Fund* , 1982.
- [Lewis 80] Elizabeth M. Lewis.  
Video Scan Picture Searching.  
*Visual Resources* 1(1):40-51, 1980.

- [Lippman 80] Andrew Lippman.  
*An Application of the Optical Videodisk to Computer Graphics.*  
Technical Report, Architecture Machine Group, MIT, 1980.  
unpublished.
- [Lippman 81] Andrew Lippman.  
*The Computational Videodisk.*  
Technical Report, Architecture Machine Group, MIT, 1981.
- [Little 82] Little S.E.  
  
In *Architectural Design Process in the 1980's: Transition and  
Need for Re-appraisal.* London, 1982.
- [Lotus 84] *123, Spreadsheet, Graphics, Information Management Plus*  
Lotus Development, Inc., 1984.
- [McClain 83] Larry Mc Clain.  
A Friendly Introduction to Videodiscs.  
*Popular Computing* :79-87, April, 1983.
- [Miller 78] David C. Miller.  
Interactive Instruction with the Videodisc (TV).  
In *Frontiers in Education Conference Proceedings.* 1978.
- [Mohl 80] Robert Mohl.  
  
In *The Interactive Movie Map: Surrogate Travel with the Aid of  
Dynamic Aerial Overviews.* Dallas Convention Center,  
November, 1980.
- [Mueller 82] Rober Mueller.  
Videodisc Technology Provides Greater Interactive Capability.  
*Videotext/Videotex* 2(3):178-180, 1982.
- [Negroponte 68] N. Negroponte and L. Groisser.  
*Urban 5: An on-line Urban Design.*  
Technical Report IBM 320-2012, IBM, 1968.
- [Padco 81] Alain Bertaud.  
  
Technical Report, International Bank for Reconstruction and  
Development/ The World Bank, 1981.
- [Purcell 72] Patrick Purcell.  
The Computer as an Aid for the Architect.  
In *The Symposium of Interactive Graphics.* Delft, 1972.

- [Purcell 80] Patrick Purcell.  
Computer Education in Architecture.  
*C.A.D.* 12(5):239-251, 1980.
- [Sony 83] *Sony LDP-1000A Operating Instructions*  
Sony Corporation, 1983.
- [Webster 83] Webster R.  
Expert Systems.  
*Personal Computer World* 6(1):118-119, 1983.