COMPUTER LABORATORY

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*D*uring the past dozen years the Oriental Institute has been undergoing a transformation. Quietly and without much fanfare, a slow but steady stream of computer systems by this or that manufacturer have crept into the building. At the same time a wide variety of uses for these computers have been developed. Today, there are few individuals or projects in the Institute that have not, to use computerese, "retired" their typewriters in favor of a word processor.

A milestone in this continuing process was reached in July of 1990. The Oriental Institute established a Computer Laboratory to focus these efforts and to facilitate the application of computer technology by the faculty and staff in their analyses of the ancient Near East. After eighteen year as the Architect and Surveyor for the Nippur Expedition, the past nine of which were spent developing computer applications, I was asked to put on a new hat as the head of the Laboratory.

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During its first year of operation several different types of services were provided by the Computer Laboratory, ranging from basic training and familiarization with computer concepts and practices to the development of a three-dimension computer model of an entire archaeological site. These two extremes highlight the dual nature of the Laboratory's operation:

1. To provide expertise and advice concerning computer technology and its application for such uses as word processing, database management, and statistical analyses.
2. To undertake the development of computer databases for specific Institute projects.

The first of these two services is self-explanatory and does not need much elaboration. As head of the Computer Laboratory, I am available to suggest computer applications, equipment, and programs that will best suit the needs of Institute personnel, to solve problems associated with the use of computers, and to act as a resource concerning developments and trends in the computer industry.

THE ORIENTAL INSTITUTE COMPUTER NETWORK

The most important development of this type was the installation of a computer network connection in every Institute faculty and staff office, and the providing of a computer system for all Institute personnel who had not yet made the switch from manual office procedures. This single enhancement to the use of computer technology in the Institute has already had a profound impact on the faculty and staff's ability to conduct research, communicate within the building and with scholars from other universities, and access previously unobtainable resources by computer.

The computer network provides a means for all Institute personnel to communicate via Electronic Mail, or to send messages to colleagues in other institutions also connected to the world-wide computer network. This same process allows computer files or documents to be transferred between individuals over the network, a definite improvement in speed and ease of communication among scholars. The network also provides access from their desktop computer to the University of Chicago On-Line Library Catalogue, as well as more than 300 other library catalogs around the world. Access to a laser printer by all faculty and staff members is also available over the network, which improves the quality of computer documents that must be printed.

COMPUTER DATABASES

The second service of the Laboratory is more focused, and needs to be explained in more detail. Several Institute projects, the Demotic Dictionary, Materials for the Sumerian Lexicon, and the Hittite Dictionary, have developed large computer databases of textual material during the past few years. During this same period registrar Ray Tindel has been building a computer database for the Oriental Institute Museum collection. All of these efforts predate the establishment of the Computer Laboratory and were designed and are supervised by their respective project directors. The role of the Laboratory in their continuing development is similar to point one above, to offer advice and expertise when requested.

The various archaeological projects in the Institute, however, present the Laboratory with a different set of requirements and opportunities for collaboration in developing and maintaining computer databases of excavation and survey material. The common thread and underlying distinction of these archaeological projects is their use of computer graphics as the primary building block of their databases.

Computer graphics systems are widely used for all types of graphics work, where time savings, precision, and uniformity are needed in the production of graphic displays of information. *Interactive* computer graphics is a relatively new technology that gives the user the ability to create a drawing of some object on a computer screen. During its operation the user interacts with the computer graphics program and is continually updated with information concerning each operation's progress. Turn-around time is quick, approaching instantaneous.

An important concept to understand is that the computer does not store a picture of the drawing. What is created by the computer system is a data file containing a brief description of each of the graphic components that make up the drawing. Such a graphics database can be used as a general source of information for other database operations such as report generation or statistical analyses.

When computer-aided drafting techniques were developed they naturally replicated traditional drafting practices. Solid objects were *represented* on the computer screen through means of "orthographic projection," so the practice of two-dimensional, or 2D, representation was carried over from manual drafting. As more sophisticated equipment and programs emerged, along with more accomplished users, the idea of depicting solid objects as three-dimensional drawings was developed. This new representation is called "modeling."

Two-dimensional drawing is performed on a planar surface with an X and Y axis perpendicular to each other. Three-dimensional modeling introduces a Z axis perpendicular to the X,Y plane. Models may exist in this 3D environment in three basic forms:
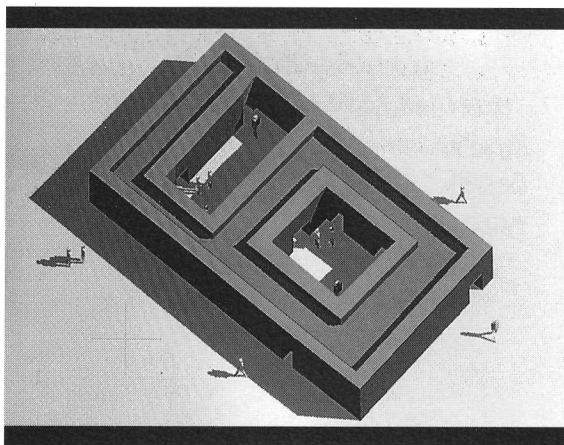

A **wireframe model** is constructed of lines, arcs, and circles. Picture a pyramid in wireframe 3D: it would have four lines forming the base and four lines connecting each of the intersections forming the base. These upper lines
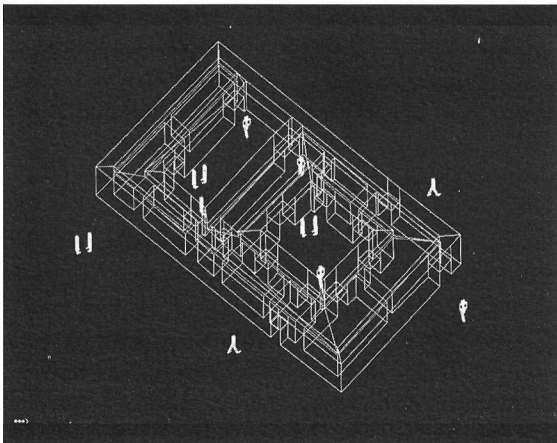
Computer generated three-dimensional wire frame geometry used to create the surface model of the old Babylonian Bakers' House from Nippur.

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intersect at a single point above the base. Five surfaces can be *imagined* when viewing this model (four side surfaces and the base). But in the computer graphics database the only identifiable points are those that exist where the lines intersect. Wireframe graphics operations are easy to perform and are not data-intensive, and it is a common microcomputer form of 3D computer-aided drafting.

A **surface model** results when you construct the surface planes formed by the edges of the pyramid in the previous example. Although simple enough to describe, constructing a surface model is complex. The resultant image, however, is a much higher quality representation of the object being drawn. For example, because points are identifiable on any surface, if two objects intersect, the points along the line of surface intersection can be identified. Surface modeling is much more data-intensive and is available for

Computer generated three-dimensional surface model reconstruction of an old Babylonian Bakers' House excavated at Nippur from 1972-1975.

powerful microcomputers, mini, and mainframe computers.

Solid modeling is the ultimate in 3D surface modeling, as well as the most data-intensive and most difficult format in which to draw. Not only does it allow for the determination of points on an object's surface, but it can also determine points above or below the surface (inside or outside the object). This form of 3D computer graphics permits the cutting of sections through an object to show structure and shape anywhere within the object.

LABORATORY PROJECTS

During this past year several Institute archaeological projects have asked the Laboratory to use these computer graphic techniques to construct databases that will serve both analytical and presentation purposes. Toward this end, the Institute has turned to Peggy Sanders, an independent contractor with Archaeological Graphic Services. For fourteen years the artist and assistant cartographer for the Nippur Expedition, she is now employed by various Institute projects to produce computer graphics and publication drawings.

The Nippur Expedition

The final changes to the plans and sections that will illustrate the publication for the thirteenth and fourteenth seasons' excavations in Area WC-1 were completed in June. Production of publication drawings for Area WF from the eighteenth

and nineteenth seasons at Nippur was an on-going project in the Laboratory throughout the year. We also started work on the publication drawings for the eighteenth season excavations in Area WG.

The contour map of the site of Nippur, which was originally surveyed in 1965-66 by Jim Knudstad, and which I have updated over the years as the work at Nippur continued, was given a whole new look after several weeks of work this past spring. With the help of a new computer graphics system obtained in
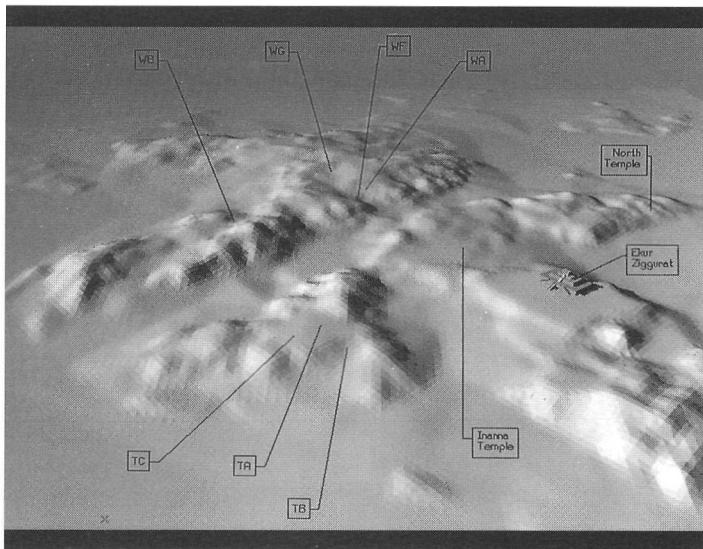
Computer generated three-dimensional surface terrain model of the site of Nippur, Iraq, as seen from the east.

the fall of 1990 the original two-dimensional contour plan was transformed into a three-dimensional surface terrain model of the site of Nippur. With this computer model it is possible to "fly around" as if in a helicopter, and view the site in three-dimensions from any angle or height you choose. Examples of several such images will become part of the Interactive Computer Display in the Oriental Institute Museum's Centennial Exhibit, *Sifting the Sands of Time.*

Aqaba

The Laboratory produced a three-dimensional computer surface model of the Visitor Orientation Center being constructed on the site of Aqaba. Jim Richerson, a former Institute preparator and a design consultant for the Orientation Center, provided the architectural plans and sections drawn by a Jordanian architect, and these were used to construct the computer model of the building. Color slides of several computer images showing different perspective views of the computer model were made, to be used in discussions with Jordanian officials as illustrations of what the building will look like when construction is completed.

Tell Yaqush

Doug Esse was introduced to computer graphics this past year when he was instructed how to use a sensitized board called a graphics tablet or "digitizer" to copy an existing paper drawing into a computer graphics database. He had several published plans from Megiddo that needed to be combined and updated for publication.

Giza Plateau Mapping Project

In May of 1991 Mark Lehner supplied the Laboratory with a one-meter contour map showing the topography and monuments of the Giza Plateau. In a process similar to that used with the Nippur contour map, the original Giza map was broken down into twenty-five 500 x 500 meter squares. The contour lines in each square were then "digitized" into the computer. Once all twenty-five squares are stored in the computer's memory, we will reconstruct them into one three-dimensional surface terrain model of the Giza Plateau. From this basic 3D surface we will be able to produce four separate computer models of the Giza Plateau in accordance with Mark Lehner's reconstructions of the different stages of its development: before any construction was undertaken, and after each of the Pyramids of Khufu, Khafre, and Menkaure were built.

An immediate use of these computer models will extend far beyond Mark Lehner's current studies of the Giza Plateau, its origins and its history. Public Television station WGBH in Boston contacted Lehner earlier this year concerning an upcoming production of their Nova series devoted to the building of the Pyramids. After discussions, it was decided that the Institute would supply Nova with a three-dimensional surface model of the Giza Plateau, complete with pyramids and associated architecture, that would be incorporated into an animated sequence for the production.

LABORATORY EQUIPMENT AND RESOURCES

When the Computer Laboratory opened its doors in July of 1990 several pieces of computer equipment that had been purchased previously by the Institute found a permanent home and became the cornerstone of the Laboratory's computer facilities:

1. GRID Model 1530 Computer: a high-performance laptop computer.
2. Hewlett Packard 71B Computer: a small, hand-held computer.
3. Houston Instruments DMP-52 Plotter.
4. Kurta IS/3 Digitizing Tablet.
4. Leitz-Sokkisha SET 3 Laser Theodolite.

The two computers have been used for several seasons in Iraq to collect, store, and analyze the material excavated by the Nippur Expedition. The digitizing tablet is used to trace an existing paper drawing into the computer, and the plotter is used to produce a drawing on paper or mylar once it is in the computer. The laser theodolite is used for mapping and surveying archaeological sites and has been used at Nippur during the past two seasons, yielding tremendous time savings and improved accuracy in field recording.

During the past year we have expanded the Laboratory's capabilities with the purchase of two very technologically advanced computer graphics systems:

1. Sun SPARCstation 1+: a multi-user, color graphics computer.
2. Macintosh IIfx: a high-performance color graphics computer.

The Laboratory also maintains the new Macintosh IIcx computer that serves as the operating center for the Institute's Electronic Mail system.

FUTURE DIRECTIONS

The expansion of computing facilities available to the Institute's faculty, staff, and students was made a priority this past year, and many improvements that will have a lasting effect on the quality of research at the Institute were implemented. Not every computer-related topic discussed during this first year was completed, however, and the field of computer technology is always expanding. As a result, several projects are currently being planned that will further expand the use and range of computer technology in the Institute.

Discussions are underway concerning the development of a single, integrated computer database that would link the various Institute collections: Research Archives, Photo Archives, Museum Registration, and Museum Conservation. This integrated database would incorporate not only textual information from each collection, but also video images of artifacts and photographs where appropriate. The integration of these related collections would greatly enhance their analytic potential for faculty and staff, as well as scholars outside the Institute, and provide for very efficient management of these collections. This undertaking will take several years to complete, but the initial planning stages are already underway.

Several of the Institute's archaeologists—McGuire Gibson, Douglas Esse, and William Sumner, in particular—have expressed an interest in the use of satellite photography for their respective projects, and of developing a capability within the Institute to process and analyze satellite image data obtained from government and private sources. Toward this end, the Laboratory has established a working relationship with Dr. Raymond Pierrehumbert, Director of the Computer Laboratory in the Geophysical Science Department, and Dr. Robert Beck, Director of the Center for Imaging Science, both of the University of Chicago. These facilities have extensive experience in image processing and satellite data analysis, and they have been very helpful in explaining how to use this new tool for archaeological research. They will continue to be valuable partners as the Institute "enters the space age" during the coming year.

Another technology that the Laboratory is investigating for use in the Institute involves the "scanning" of textual documents into computer-readable files. This process, known as Optical Character Recognition, or OCR, would dramatically reduce the time spent typing existing research materials and might even reduce the amount of photocopying required by the faculty and staff. The ability to have books, articles, and papers stored as computer files would allow scholars to search for particular words or phrases, create indexes and concordances, and to accomplish these tasks in less time and with greater accuracy than with similar manual procedures.

With the current and future expansion of advanced computer technology made available to faculty, staff, students, and researchers, the Oriental Institute will continue its role as a leader in the pursuit of knowledge of the ancient Near East.

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