Computers in Ethnological Studies : As a Tool and an Object

Computers in Ethnological Studies: As a Tool and an Object

SHIGEHARU SUGITA
National Museum of Ethnology

The National Museum of Ethnology is a research center as well as a computerized information center for ethnology or cultural anthropology. Its unique research division, *Computer Ethnology*, performs several functions; computerized database, information processing, modeling and simulation, and comparative study of a social scientific approach to computer use. Each of these can be considered from the ethnological viewpoint.
Several computer application problems, which will give new direction to research in human sciences, are currently under study at the National Museum of Ethnology. They are technological, economic, and social; together, they illuminate the usefulness and even necessity of computers in this research domain.
On the technological side there are several reasons why researchers in human sciences have not used computers widely. The responsibility lies largely on the technology side. Several specifications, desired by the real end users, might increase the use and usefulness of computers among this group.
Computers are usually thought of as a tool for calculation, control, data storage, retrieval, or information processing. From the ethnological viewpoint, however, computer development in society may itself be studied, particularly the rate of its acceptance according to differences in culture or their stage of development.

INTRODUCTION

The National Museum of Ethnology, the first Japanese museum in ethnology or cultural anthropology, was established in 1974, in EXPO'70 Memorial Park, Senri, Osaka, and opened to the public in November, 1977. The museum provides up-to-date information, based on ethnological field research into the world's cultures. Its goal is to provide a deeper knowledge and understanding of mankind. To help the research this museum introduces several computer systems and special input/output devices for database, image processing, or sound processing, etc.

The museum constitutes an integral part of the national university system of Japan, under the jurisdiction of the Ministry of Education, Science and Culture (Monbusho). As an interuniversity research institute, it makes its facilities available to university faculty who engages in ethnological studies. Combining the operations of research, materials collection, and public exhibition and education, it aims to reach every part of the globe and to investigate all peoples. Its collection comprises not only such primary artifacts of daily life as clothing and utensils, but also secondary materials, such as written documents, photographs, films, records and tapes. In short, the museum is striving to assemble and to make available a comprehensive collection of ethnological materials dealing with all areas.

The museum is composed of an exhibition section, an administration department, an information and documentation center, and five research departments. In the exhibition section, there is an unique system VIDEOTHEQUE, an automatic audio-visual program transmission device, which was originally developed by our museum. This system can afford about 750 TV programs of world people's life styles according to the request from 40 booths or terminals.

The information center stores all information which this museum collects and manages the library, artifacts collection, studio, computers, and auditorium. From its planning stage, the museum was designed to be a computerized information center with powerful computer systems. It now has more than one million items, including books, periodicals, and video tapes. The database for these materials is now implemented on the IBM STAIRS system, which manages storage and retrieval of bibliographic data for each item.

The research departments have responsibilities as follows: East, North and Central Asia; Southeast, South, and West Asia; Europe and Africa; the Americas and Oceania; and cross-cultural problems, such as ethnic arts, technology, oral culture, music, and *computer ethnology*. Covering these fields are 21 research divisions and 62 researchers, now.

Its unique research division, *computer ethnology*, was initially considered synonymous with computer applications to ethnological studies, such as computerized database, information processing of text, image, or sound, etc.

The concept of computer ethnology has gradually changed somewhat parallel with the development of data processing systems. Its main aim is the analysis of culture and the comparison of civilizations by the technique of modeling and simulation, using the computer as a tool to amplify the human ability to process data.

Further, from a quite different angle, *computer ethnology* is defined as a research field which treats comparative study of a social scientific approach to computer use. The interesting point of this study is to find why and how the computer systems develop in different cultures or civilizations. In this sense, *computer* is used as an object in material culture.

Here the word *computer* is used symbolically to express three meanings: (1) a tool to activate a researcher's information processing ability; (2) the method of making a model and applying simulation using rigid algorithm; and (3) an object whose development is affected by culture and which has very important relationships with many systems in civilization. Each of these can be considered from the ethnological viewpoint.

In this paper several problems concerning the computer in human sciences are described.

DESIRED SPECIFICATIONS FOR COMPUTERS IN HUMAN SCIENCES

On the technological side, there are several reasons why researchers in human sciences have not used computers widely. The responsibility lies largely on the technology side. Several specifications, desired by the real end users, might increase the use and usefulness of computers among this group. In technological terms computers can continue their rapid evolution, but their development must be considered carefully from the perspective of the human sciences. Several specifications can make computers more suitable for such researchers.

Non-Programming Computer

As explained below, the concept of programming language is very difficult for the end user to understand, especially the researcher in the human sciences. Extra time is needed to study a programming language, and even when a language is mastered, the human scientist often finds that using a new machine requires learning a new language. An obviously useful tool will be a computer that needs no programming. Prototypes for such a machine are the dedicated word-processors, or the microcomputers that can be used as such with appropriate software. As part of the current drive to integrate artificial intelligence concepts into both machines and programs, the reduction and final elimination of programming by users should increase not only the quantity but also the quality of computer applications in cultural fields.

The most important concept here is man-machine interface, which accepts much higher command languages than so-called high level languages such as Fortran, Cobol, Basic, Lisp, Prolog, etc. This system, with menu guided system, will make it easy for end users to use computer systems. The large thesaurus system is greatly needed to manage natural language flexibly.

Multi-Window and Multi-Display

The major difference between using computers and manual operations is that the range of information in view is very limited in computer displays. The human eye can take in more than 180 degrees, but the usual computer display is at largest 26 inches in diagonal. The multi-window system, developed recently, is an improvement over other displays, because one screen shows several different files, but its defect is the smallness of each window. To solve this problem, I propose a multi-display system with each display working as if it were a window in multi-window system.

Natural Input System

From the beginning of computer use, almost the only input device has been the typewriter keyboard. For some tasks, however, it is convenient to use a tablet or touch-panel for input. Of course, speech input is easier than a keyboard, and the optical character reader is almost ideal for written text. But they are still under development and will need several years to become of practical use. For the present, therefore, users concerned with a wide variety of input forms, *e.g.*, written words, spoken words, music, two- and three-dimensional artifacts, must be provided with a full range of input devices to match their changing needs.

Intelligence Amplifier

Most computer use aims to decrease the need for human power, and generally requires high cost/performance, as the machines are taught to work in place of human beings. But in intellectual activity we must change the machine's way of thinking. The main role of a computer system is not to reduce our labor, both physical and intellectual, but to amplify our abilities.

From this viewpoint the design of a computer system becomes different from that of other systems in industry or commerce. For the human sciences a system must include human beings as the main element. The special relationship between humans and machines must take into consideration that human beings are non-linear. The main goal is a flexible system environment where the human user can behave as if doing without machines but with greatly enhanced ability.

High-Speed Processing

A thought occurs in the brain at a tremendously high speed, if we think of the information retrieval and information association process. Although computers can perform numeric calculations very quickly (for example, up to about 800 million operations per second), for information retrieval or other processing, such as pattern recognition, their speed is much slower than a human's. Even in a simple operation, such as information browsing (for example, a card search), if the items exceed one million the speed of display is slower than human manual operation.

While, therefore, the human sciences may be thought not to need fast processing because manual operations take longer, intelligent tasks still require very quick response to match the speed of thinking.

Manual Free

The instruction manuals for users of computer systems are usually not helpful for beginners, because they are not understandable by people without experience on a particular machine. Generally, they serve only as references in case of errors in operation or changes in command names. Without good manuals the computer cannot be utilized to its full capability. They must be written for the user by the user.

The ideal computer system, however, is that any instructions which user wants to do are guided by the computer with help function or menu list. It means that user does not need to consult manuals. This may be possible by giving many default knowledges to the computer. The research of Artificial Intelligence must make more effort to clear human brain behavior as well as to develop expert systems which reduce human activity in intelligent problems.

PROBLEMS OF COMPUTER USE IN HUMAN SCIENCES

Although digital computers have been available for a generation, there are still not many applications in human sciences in which they are the main facilities. In the several problems for which computers were used their chief role has been data processing. For example, there are KWIC (Key Word In Context) indexes or concordances of literature or ethnographic text, mechanical translation, automatic abstracting, or statistical analysis of questionnaire data. Most of these problems are based on research in the fields of information science or engineering, where the goal was to design an intelligent machine or artificial brain. The other applications were a by-product.

Among the several reasons why computer use in human sciences is not active nor progressive must be listed technological problems (hardware, software, manuals); research problems (creative activity, non-routine work, data input); economic problems; and social problems.

Hardware

The rapid advance of computer technology over the brief forty years since its invention implies even greater changes in the immediate future. Following vacuum tubes, transistors, integrated circuits and very large scale integrated circuits, the next generation will be based on a functional or biological device of micro size and very high speed. In Japan, Europe and the United States, non von Neumann machines are expected to achieve parallel operation, pattern recognition, natural language understanding, association function, inference function, and many other capabilities beyond those currently developed.

These extensions may bring the human sciences (in the broadest sense of the term) up to the same level of use that characterizes almost all other modern activities: commerce, industry, communications, science, and social research. Until it reaches higher levels of sophistication, the computer will not advance from the realm of the technologists who develop it into that of users who presently refuse to master either the development of information processing for all the types of material that human scientists concern themselves with: text, image, or sound. Hardware for this application is only now being developed.

Software

For non-technical researchers, the major obstacle to using computers is programming. Although all programming languages use English words, their meanings are not always those of natural language, and the machine requires absolute accuracy in spelling. A single missing or incorrect character can prevent a whole program from running. Furthermore, most programs were written for imaginary users, rather than being created to meet the real needs of the real users.

Among major improvements in software for human science and social science applications is a greater responsiveness to the behavior patterns of such users.

Sophisticated programs should operate either by simple commands or by combining several current programs into one well-organized system. Because the relatively small number of users require a large diversity of application programs, achieving such a system may be difficult. Perhaps the best interim solution is some compromise, like the ability to change parameter settings, which will allow current programs, and future ones, to be modified for individual users.

Research Problems

In the human sciences, problems do not seem to lend themselves to effective computer use. The obvious merits of computer use are the ability to store large quantities of data and to retrieve them quickly, and to apply repeatedly the same kind of processing.

But in the human sciences, we need much more intelligent work than simple information storage and retrieval. The important problems are to create and to distinguish many existing data. We humans do not know how that intelligent process goes on inside our brains. We must know the algorithm of that process before we can make programs and computers do the same.

The main issue is that there is no common program which is useful for many researchers to carry out such intelligent tasks. The main cause of this defect may be that the essential problems of this field cannot be solved by the computer, and only the human brain can do very high quality work. Many individuals believe that computers cannot help their activities in the human sciences. A typical problem for human scientists is to read many bibliographies of work done previously, so that they can add their own knowledge to their discipline. For this kind of problem, the computer is not useful. Though it is possible to input bibliographies into a computer and retrieve a necessary part of them very quickly, a human brain is needed to extract new information from them.

Most engineering works in information processing aim to realize full automatic computer systems which omit human participation. Most research problems in human sciences, however, is rather complicated than they are reduced to a simple packaged software. We need the really friendly tools by which we can take out hypothesis or proposition from vague idea.

Economic Problem

Until recently computers, even small ones, were so expensive that it was impossible to buy them for personal use. When computers are introduced they require higher cost/performance than human beings. If there is any possibility of idle time, when the computer is not in use, its introduction is refused by the manager or government. Even sharing one system among many human scientists is very difficult, since the frequency of their use is generally too low.

Development of integrated circuits has now reduced the expense of computers so that even children can now buy those that ten years ago cost a thousand times their current price. Although there are, of course, substantial differences between large systems and personal computers in the ability to treat large quantities of data, we generally do not need to share large computers because we can buy our own personal computers with almost the same capability as the large ones of the past.

Social Problem

Some governments prohibit the free flow of information, even limiting the use of copy machines. People who cannot use computers freely find their desire to do so reduced. Furthermore, underdeveloped countries which cannot produce their own computers must import them. Unless international relations are good, it is often impossible to acquire data processing equipment. Researchers then cannot use computers, though they know good application problems.

COMPUTER ETHNOLOGY

Many of these objectives already guide the research activities at the National Museum of Ethnology, which is probably the first in the world to use the term *computer ethnology* for a research division. Because it is not an information center but a research facility, its role is not limited to constructing and maintaining databases. Several computer application problems, which will give new direction to research in the human sciences, are currently under study at this museum. They are technological, economic, and social; together, they illuminate the usefulness and even necessity of computers in this research domain.

But defining its character is very difficult at this moment, even though twelve years have passed since this division was established, and seven years since the computer systems began to be installed.

The vague image of *computer ethnology* derived from twelve years' experience in the National Museum of Ethnology must include at least the following research concepts:

(a) Data management systems by computers for ethnological studies;
 a. Database construction
 b. Information processing

(b) Development of new ethnological study using computers;
 a. Model making
 b. Simulation

(c) Comparative study of the computer itself as a cultural artifact.
 a. Computer development
 b. Computer impact on society

Information Processing

These problems of data management are not so different from information processing carried out in other fields. The only difference from the research of computer science departments is that while they test the possibility of computer algorithms, they do not require large systems for practical use. The theoretical aspect and practical one are sometimes different. To the end user a computer system seems like a tool for data processing whereas to a computer scientist the system itself is the object to be developed.

Modeling and Simulation

The second problem may include proper subjects for ethnological study. A new approach to ethnological studies may be developed from the computer's capabilities. In short, these are: storage capacity for large quantities of data in one place, high-speed retrieval, and routine repetition of processing operations.

Using these features we can solve problems which could not otherwise even be attempted by human researchers. For example, to display information from several different sources on the same map is quite simple as a principle, but to draw such a map and to transfer information from all the sources require a tremendously long time. This problem is solved very easily, however, with a graphic display and database prepared for many purposes. Speed of response is very important in such a problem, because we can test, immediately and interactively, much more hypotheses than would be possible if a hand-drawn map had to be prepared for each one.

This technique, which may be not called simulation in the usual senses, presents a new problem in the field of ethnological studies. We are at present short of interesting challenges suitable for modeling and simulation; the only ones available are very primitive. We hope to get some suggestions about this from reserchers in other fields, such as the human sciences.

This can be regarded as theoretical ethnology. But it cannot be done only by computer; there must be cooperation between the ethnologist and the information scientist. Especially important is model-making, for after the model is established, simulation is easy with the computer.

In this field, the computer scientist plays the role of *human interface* between the computer and the ethnologist. Generally speaking, when computer itself is not a main object but only a tool, there must be a human interface who stands on the user side. He must have both the knowledge of computer technology and the ability to understand the special field with which he works as interface.

Computer as an Object

The third problem is quite different from the other two. Usually, computers are regarded as a tool for calculation, control, data storage, retrieval, or information processing. Here the computer is regarded not as a tool for information processing, but as an object for ethnological study, like housing, food, clothing, or customs.

From the ethnological viewpoint, computer development in society may itself be studied, particularly the rate of its acceptance according to the differences in culture or their stage of development.

Very interesting from the viewpoint of the relationship between culture and civilization is the question of the computer's impact on culture. Until recently ethnology mainly concentrated its study on the small society. Although the social development of larger urban societies does not necessarily follow the same patterns as these smaller, rural ones, it obviously will be profitable to extend ethnological methods to the comparative study of both types.

The computer now provides a suitable reference point for measuring differences in various societies. Whether computer systems or applications are accepted without resistance depends on social structure or culture. A society must be matured enough to accept computers when introducing them in it. The installation of robots in a factory, for example, relates directly to the labor union system.

Still to be established are one or more clearly defined area of research and the appropriate methodology. Here technology pushes us to (and perhaps over) the limits of a discipline which has only just begun to operate within its *traditional* boundaries.

Though this problem seems to be very specific, it is of major importance because unlike other machines or tools, the computer has a very large impact on society. It has the power to change human life. If the main focus of ethnology is the study of human beings, it must include the study of the computer. In every country, there is an apparently different history of computer development, perhaps because the materials in any society are organized into one system, whose elements affect each other in a network. New material entered into the existing system must disturb it. Different from other materials, and working as if they were artificial brains, computers must exercise a very powerful effect on human life. While this area of study may be regarded as a subcategory of material culture study, still, the vigor and range of the computer's impact on society is so strong and wide that it should be recognized as a new division in the field of ethnology.

INFORMATION SYSTEMS AT THE NATIONAL MUSEUM OF ETHNOLOGY

Systems

The fundamental principle of our information processing is to manage all information which the museum possesses. Also, we intend to treat every kind of information medium, for example, characters, numerals, photographs, music, or speech sounds. For this purpose we have introduced several computer systems which can properly manipulate many kinds of information. And also these systems are connected by way of network system using optical fiber and token ring. We are going to introduce new multimedia work-stations into this network, so that any related information can be retrieved and displayed at the same time in their own form.

Main System

The main system is a dual system of IBM 4341's with 16 megabytes and 8 megabytes, and is used for the database and control of the subsystems. It has about 30 gigabytes disk memory, 5 magnetic drives, and about 80 terminals distributed throughout the museum.

IMAGE PROCESSING SYSTEM

The other is the image processing system, which includes many special input/output devices for pictures and artifacts. These include a drum scanner, motion film analyzer, Landsat film analyzer, color plotter, TV camera, and film printer. And also we have several kinds of graphic display systems, such as three-dimensional display of Evans & Sutherland, Ramtek, Tektronix, etc.

Our Image Input and Automatic Measuring System for Artifacts uses three CCD cameras to digitize their images on a turntable, measures the maximum size from three views, plus a bird's-eye view, and prints out an information sheet using a laser beam printer.

This system generates 7 megabytes data for each artifact. These huge data are stored on optical disks controllable by usual computer, and displayed on the high-resolution image display by the on-line retrieval system linked to the database in the main system.

SOUND WAVE PROCESSING SYSTEM

For sound wave processing, we use VAX 11 and PDP 11 systems with AD/DA devices, array processor, melograph and graphic display.

Multimedia Database

BIBLIOGRAPHIC DATABASE

The philosophy for computerization of this museum is to make the computer an amplifier of human ability, not to replace human activity by machines. When the first five-year plan began, in 1978, its main purpose was to develop a database which would contain all available information about research materials owned by the museum: books, records, tapes, artifacts, etc. Now more than a million items are stored in the database and are retrieved by an on-line system. But they are limited only to records describing the material.

IMAGE DATABASE

The second seven-year project, begun in 1984, aims to construct an image database. This system will make it possible to retrieve images or photographs of artifacts, slides, pages of text, etc. These are stored, not in written form, but as images. When in digital form, the system will need more than a thousand gigabytes. We are now using optical digital disks, which can contain as many as 3 gigabytes on a single disk.

By connecting these two systems, we can realize a total information system from which we can get both descriptions and images of materials.

SOUND DATABASE

Also we plan to make an audio database, in which music or speech can be stored in the computer and retrieved as sound.

Application Softwares

Using the three systems and several intelligent terminals connected to them, we are trying to develop several pieces of application softwares for ethnological studies. Some of them are as follows.

CHARACTER AND TEXT PROCESSING

It is very useful if a whole texts are inputted into computer and any part of a text is retrieved by natural language commands. The problem is how to input a large volume of texts, since the optical character reader is not yet practically available for many different fonts, especially Japanese characters such as *kanji*.

It is very important to develop a multilingual word-processor. Already there are dedicated word-processing devices for European languages and the Japanese language. We can treat even *kanji* characters very easily. For Asian and African languages, however, the several prototype word-processors now appearing are limited to a single language each. Since research covers the whole world, many languages must be handled at the same time. For printing many writing systems such as *kanji*, even if there are ten thousand characters, there is no problem if a laser beam printer is provided with dot patterns. It is the inputting and editing which is not easy. So far, we have developed a word-processing terminal for Thai and Korean, with which we have made a KWIC index of the *Three Seals Law* (about 350,000 lines).

IMAGE PROCESSING

1) Motion Analysis

The computer analysis of human motion of gesture, a very attractive theme for ethnological studies, makes possible quantitative comparison between walking styles or manners of greeting, for example, of different ethnic groups. Also possible are records of dancing motion from which we can extract patterns of dances and other kinetic information.

2) Pattern Analysis

The analysis or classification of patterns on artifacts, or shapes of such artifacts as masks, baskets, ceramics, or clothes, are requested by researchers into material culture. It is necessary to retrieve and compare pictures or photographs from the very large number which have similar patterns or shapes.

3) Remotely Sensed Image Processing

The pictures taken by Landsat are very useful to investigate land use or vegetation of areas where researchers cannot enter because of distance or danger. They can also keep track of seasonal movements of cultivation sites.

4) Map Handling

Fieldworkers, especially in underdeveloped areas, greatly need several kinds of maps. Often they need to consolidate several maps of different scales into one. Also they need to overlay several maps which bear different kinds of information.

5) Distribution Maps

It is very powerful and useful for the ethnological researchers to display distribution of cultural elements on the area maps. It is not so difficult problem to realize this by computer. First we must make a matrix of the fundamental data taken out from many ethnographies which describes whether a certain tribe possesses or not specified cultural materials. On the other hand, map data, such as contour line and position data of tribes, are inputted into computer. Combining this matrix and map data, the distribution of cultural elements can be shown very quickly on color graphic display in on-line mode.

SOUND WAVE PROCESSING

1) Speech Processing

Linguistics plays a very important role in ethnological studies. The collection and analysis of spoken language is especially necessary to identify or to derive the distinctive phonemic features of small ethnic groups. This process is different from artificial intelligence, in which we want a computer to recognize human speech. Though machine translation or speech recognition is very challenging problem for the computer field, its performance level is still too low to be useful to ethnologists.

2) Music Analysis

In ethnological studies, music collection and analysis hold an important position in connection with rituals. It is not enough to transform recorded sound to music notation with the western-style five-line score; we also need a computer software system which can manipulate waves in many ways using digital filtering, Fast Fourier Transform, or pitch analysis, formant analysis, etc. The visualized characteristics of a sound wave can be powerful tool for researchers.

3) Sensing Wave Analysis

A new ethnological study can apply information processing techniques to the investigation of human physiological response, such as to movie projections of behavior which is not familiar to the informants. In such case, several sense data, such as brain wave, cardiac wave, pulsation, sweating, etc., are recorded on the multi-channel data recorder. Then they are digitized and analyzed by computer so that we can know cognitive response of people in different culture.

APPENDIX

In the following pages are shown several photographs and diagrams which will help to understand the explanation of this paper. They are configuration diagram of our computer systems, photographs of computer hardwares, and several output examples of information processing.

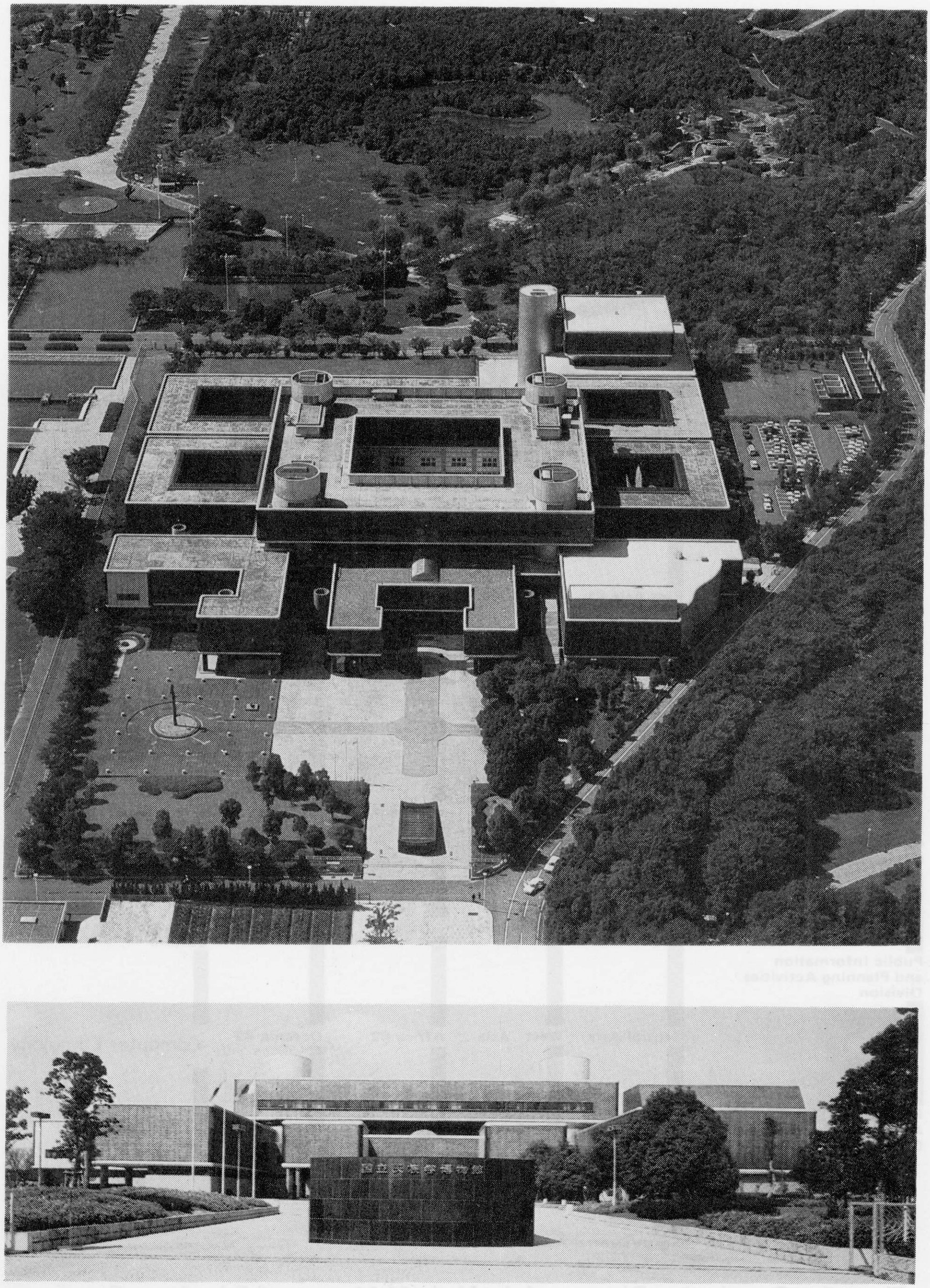


Photo 1. Bird's-Eye View (upper) and Front View (lower) of the National Museum of Ethnology; Located in the EXPO Park, Senri, Osaka, Japan)

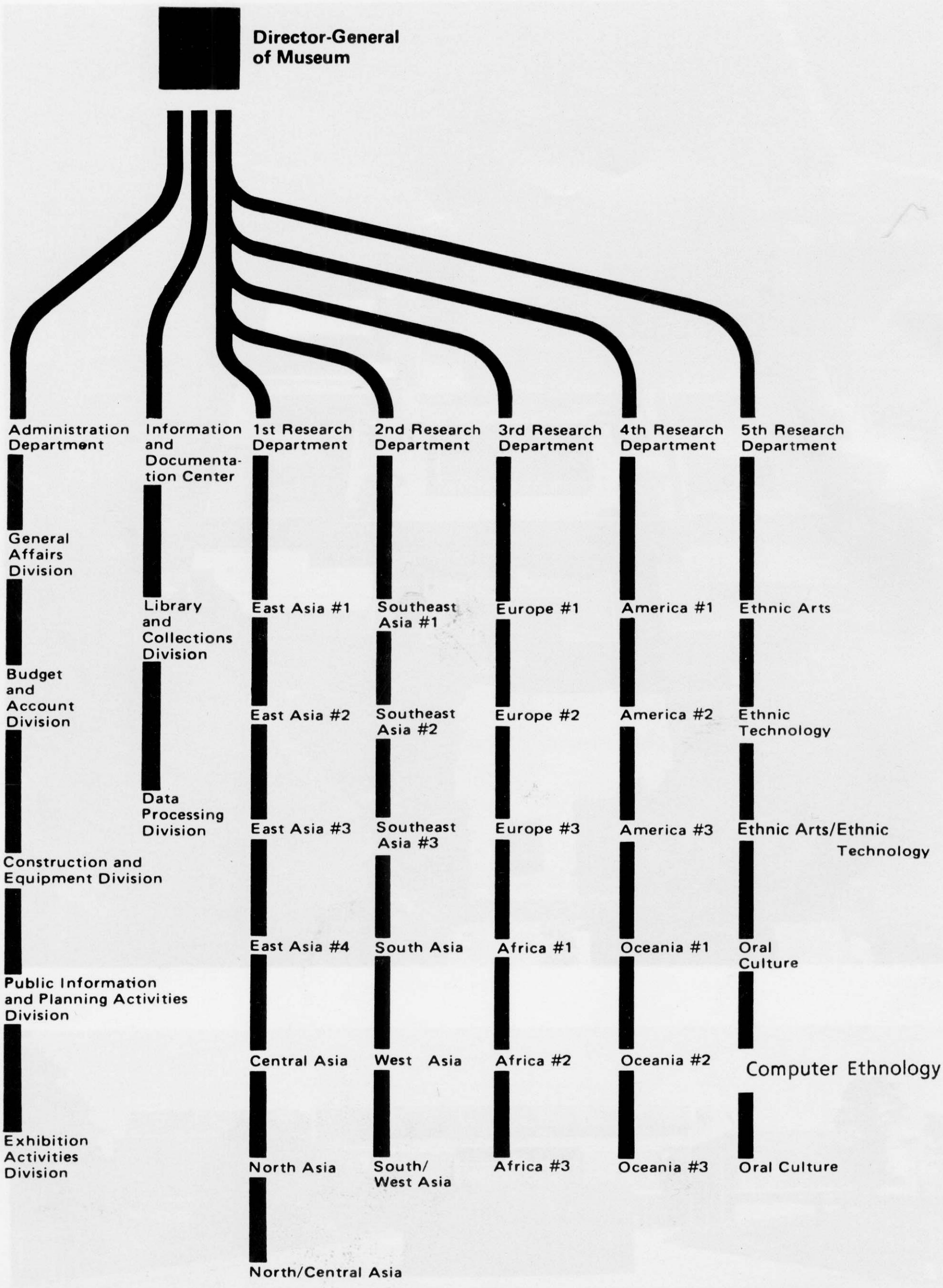


Figure 1. Organization Diagram of the National Museum of Ethnology; Computer Ethnology in the Fifth Research Department

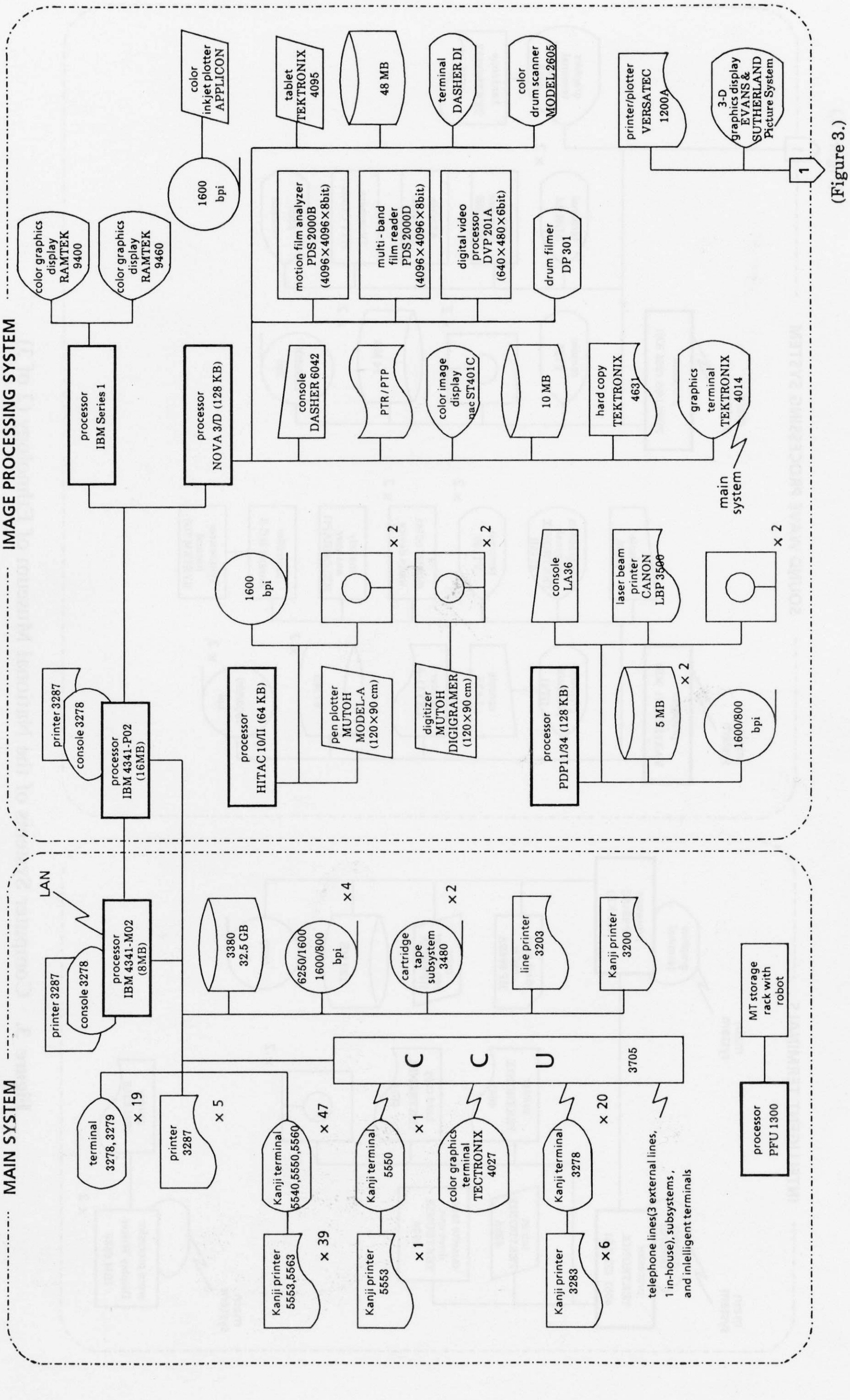


Figure 2. Computer Systems of the National Museum of Ethnology (1 of 3)

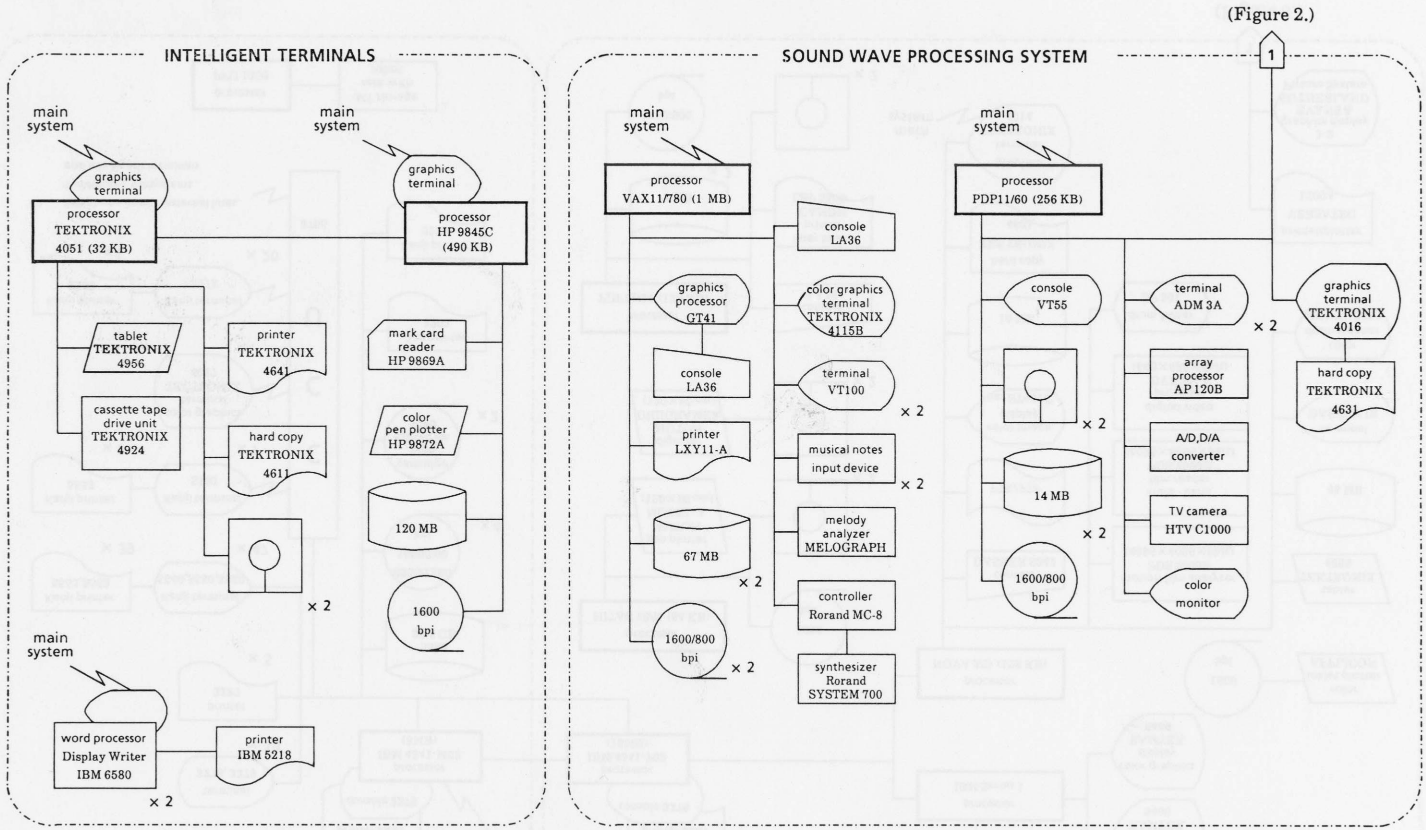


Figure 3. Computer Systems of the National Museum of Ethnology (2 of 3)

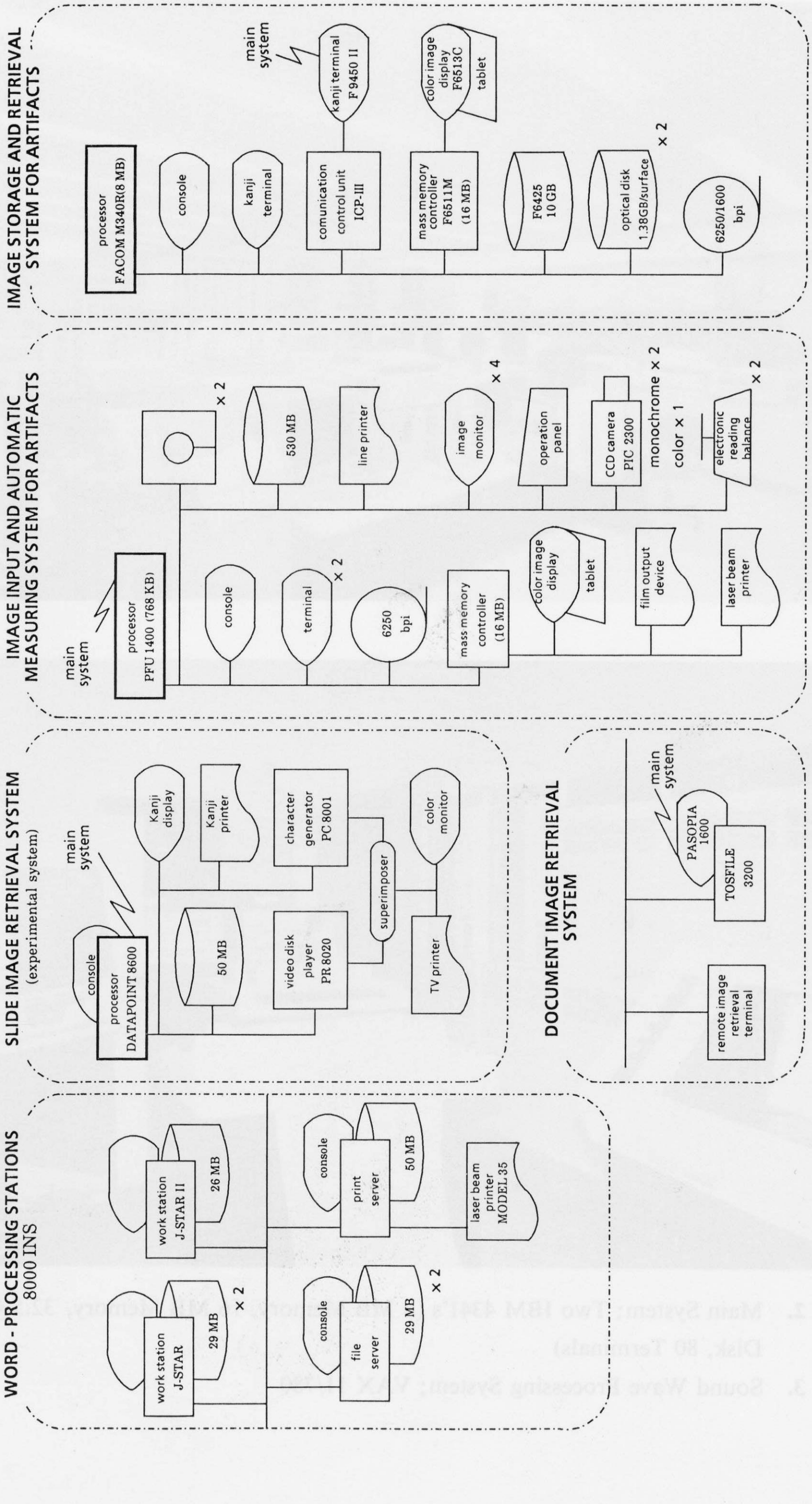


Figure 4. Computer Systems of the National Museum of Ethnology (3 of 3)

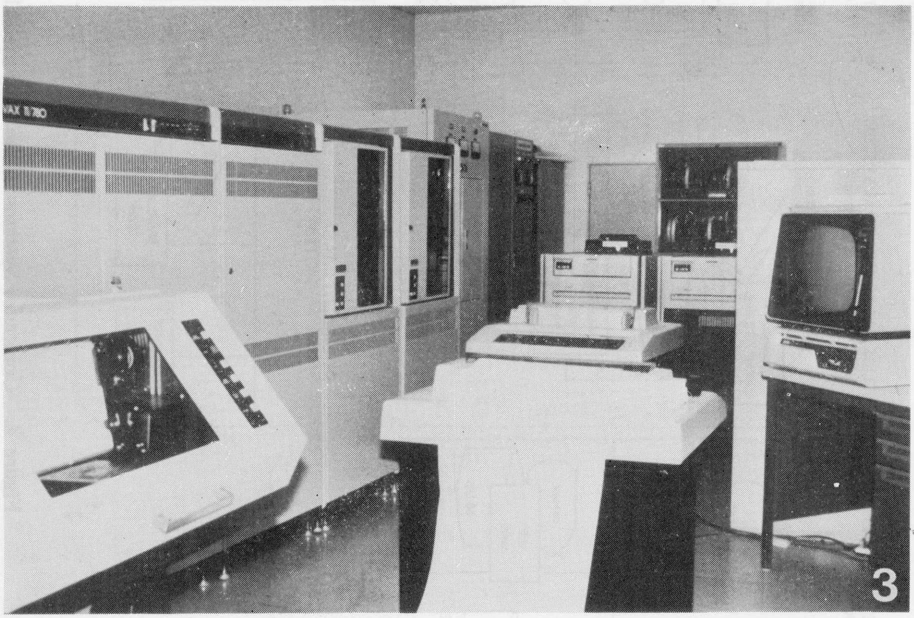
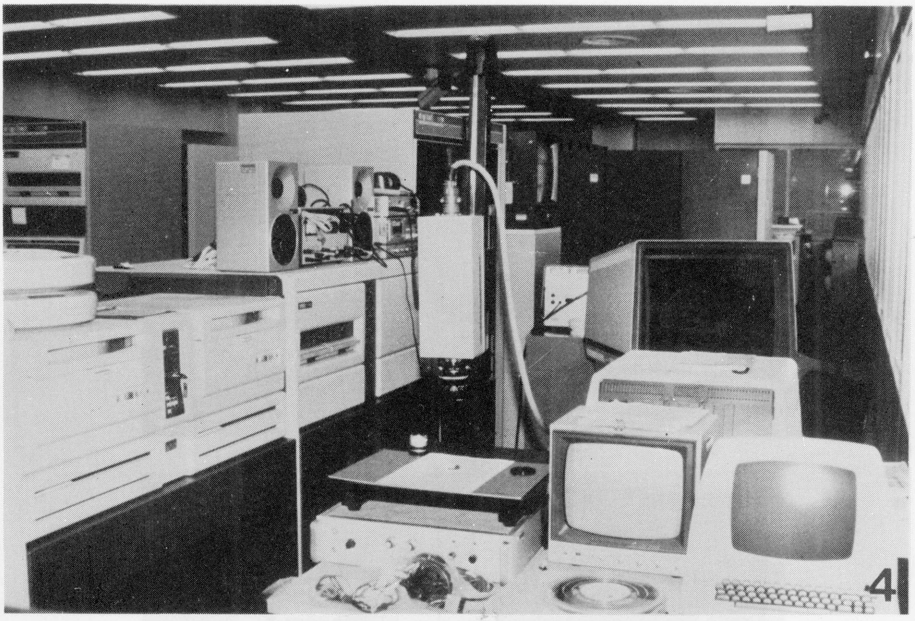


Photo 2. Main System; Two IBM 4341's (8 MB Memory, 16 MB Memory, 32.5 GB Disk, 80 Terminals)

Photo 3. Sound Wave Processing System; VAX 11/780



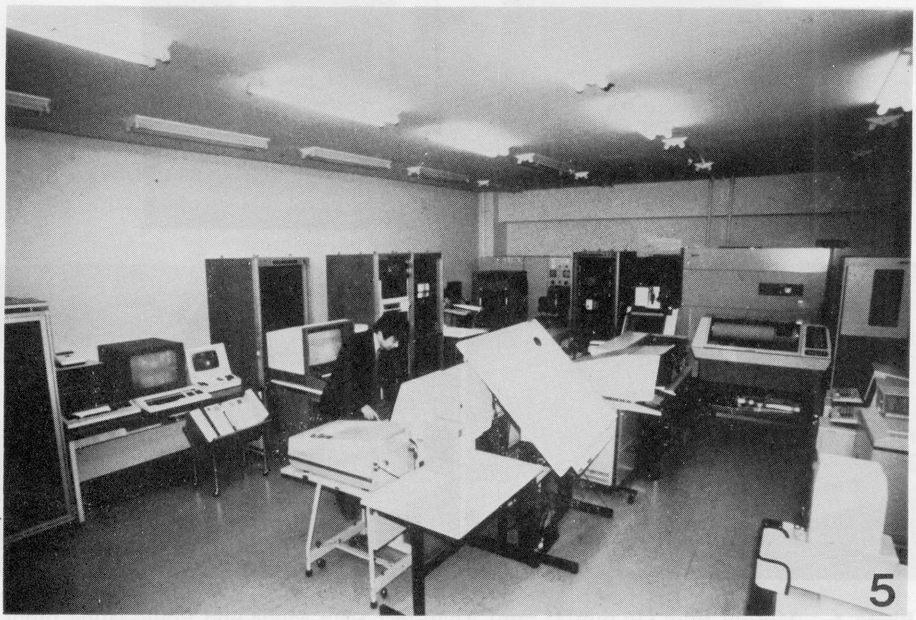
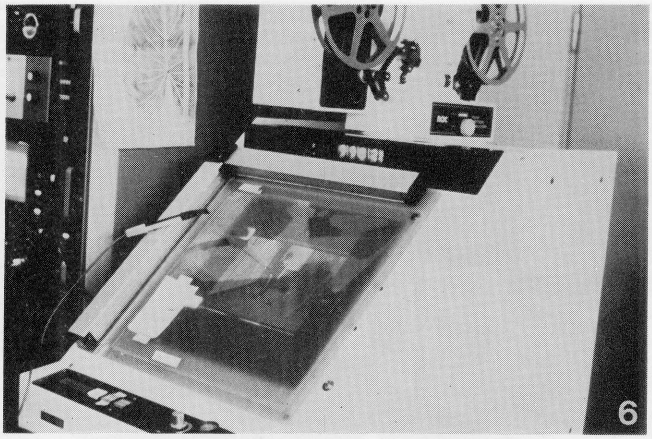
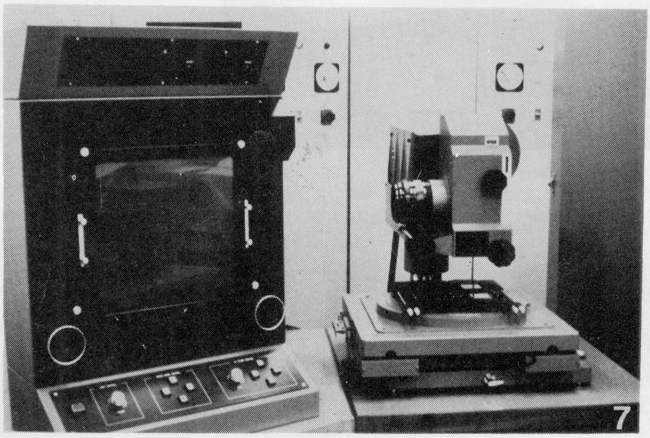


Photo 4. Sound Wave Processing System; PDP 11/60 with Array Processor

Photo 5. Image Processing System; Controller NOVA 3/D Connected to Channel of Main System





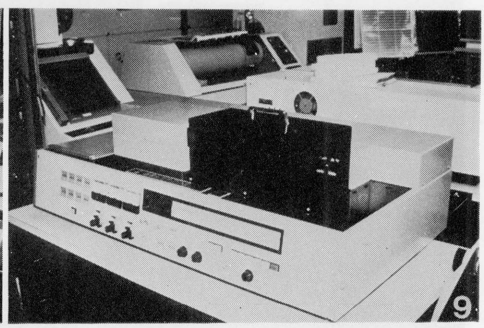
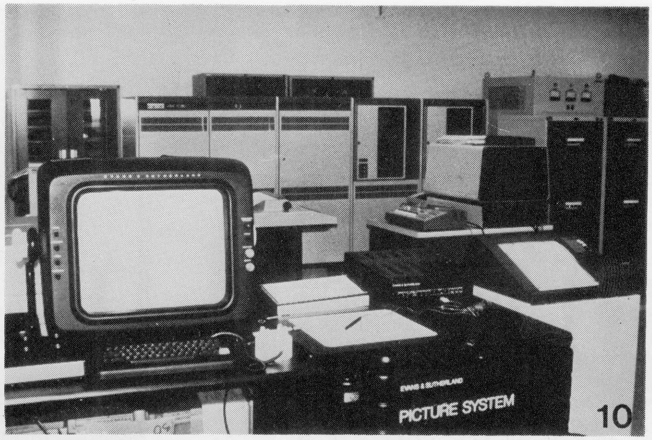


Photo 6. Motion Film (16 mm/35 mm) Analyzer; Scan-Mode and Point-Mode Input by Sonic Tablet

Photo 7. Landsat Multi-Band Film Reader

Photo 8. Drum Scanner

Photo 9. Drum Filmer



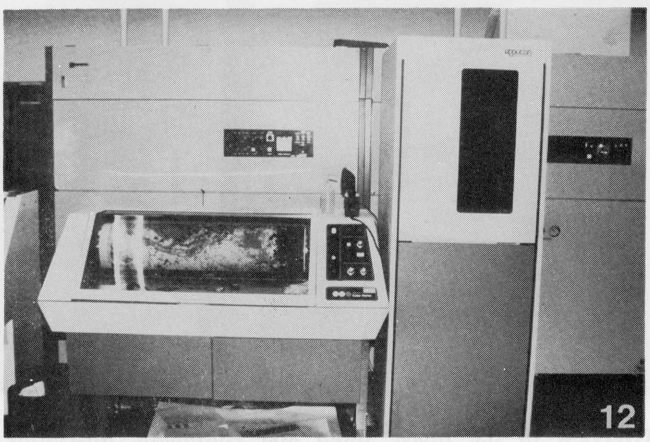


Photo 10. Three-Dimensional Display System; EVANS & SUTHERLAND Picture System

Photo 11. Graphic Display Systems; RAMTEK 9400 and 9460 (Connected to Main System by way of Optical Cable through IBM Series-1)

Photo 12. Color Inkjet Plotter; APPLICON

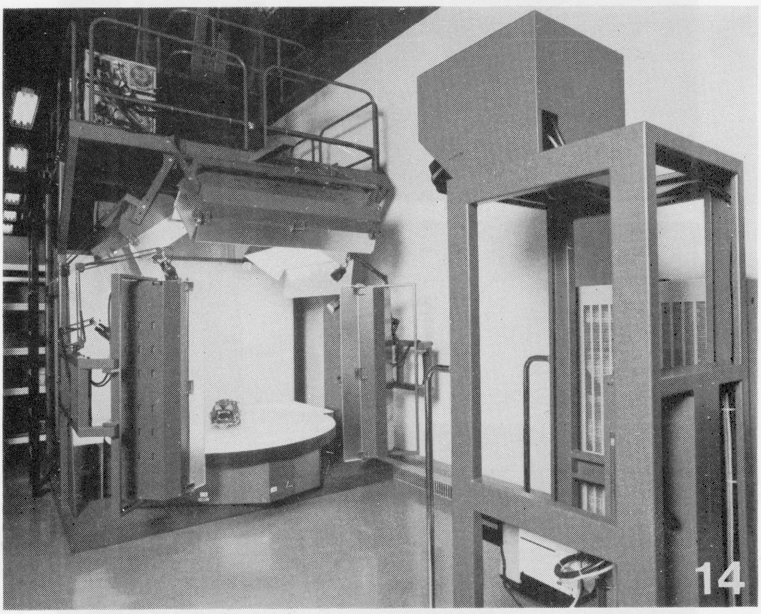
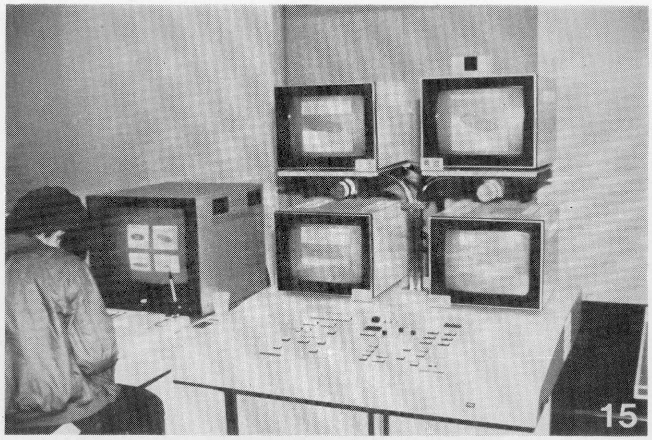
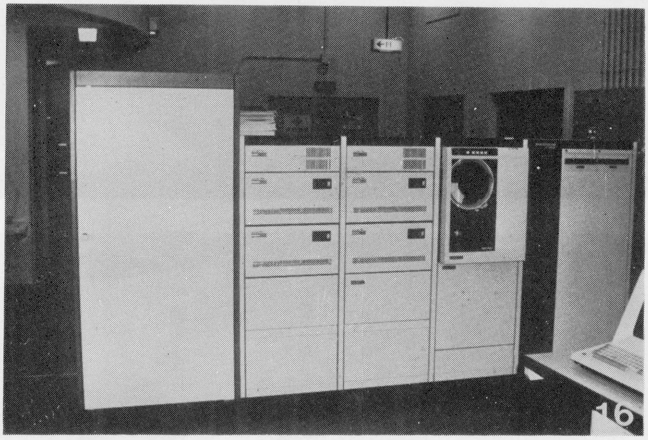


Photo 13. Overview of the Image Input and Automatic Measuring System for Artifacts

Photo 14. Input Stage; Three CCD Cameras and Turntable of Diameter 2 m





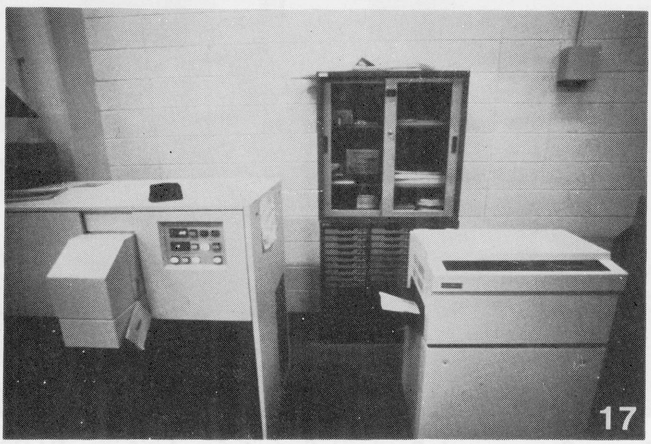


Photo 15. Monitor Part of the Image Input and Automatic Measuring System for Artifacts; Operating Console, Image Monitors and Color Image Display

Photo 16. Processing Part; Minicomputer PFU 1400, Image Processor with 16 MB Image Memory

Photo 17. Output Part; Laser Beam Printer (right side) and Film Output Device (left side)

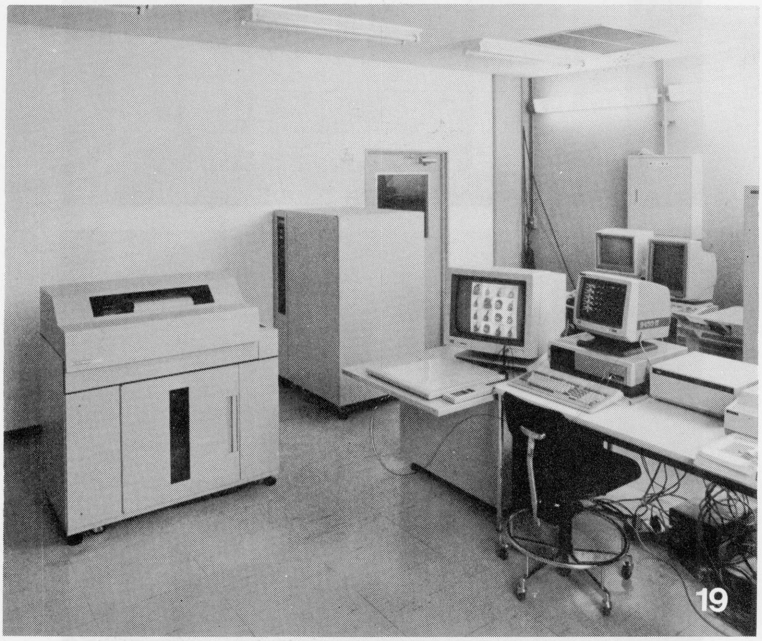
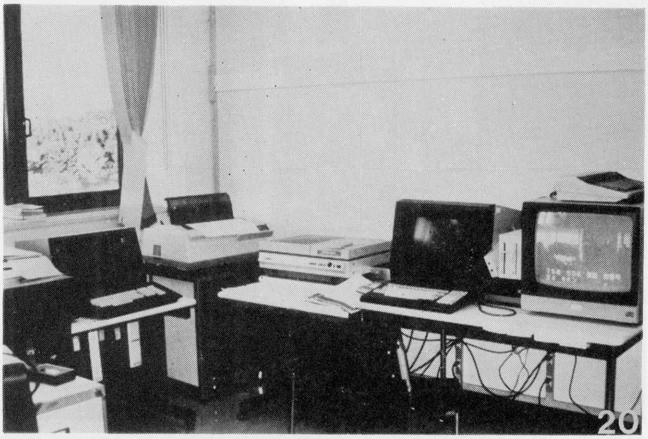


Photo 18. Image Storage and Retrieval System for Artifacts; FACOM M340R, 10 GB Disk, 2 Optical Disk Drives

Photo 19. Retrieval Station; Color Image Display and Terminal Connected to Main Database



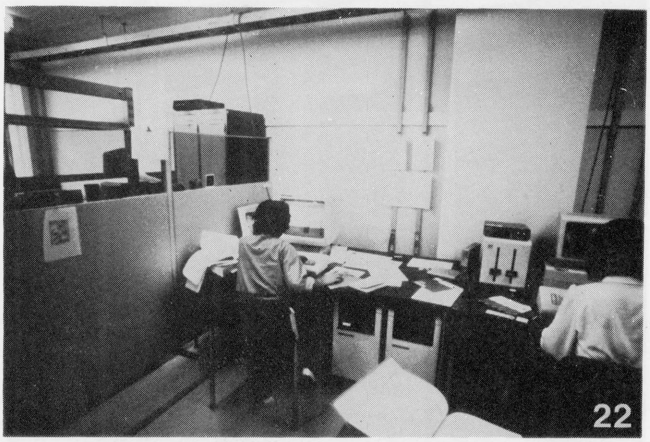
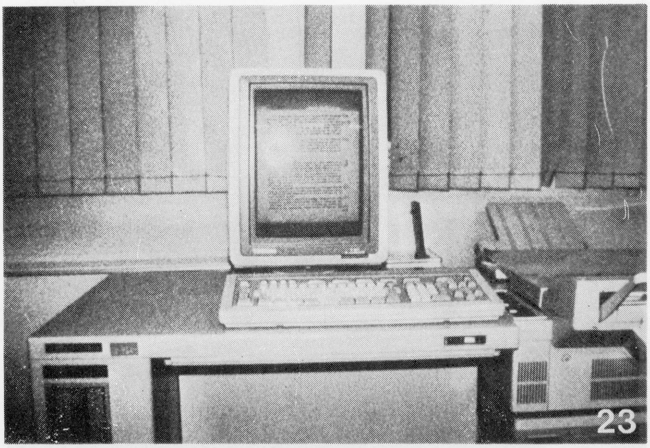
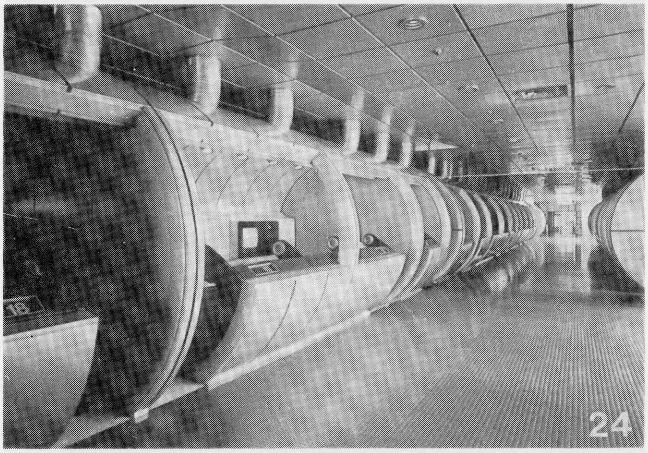


Photo 20. Slide Image Retrieval System; DATAPOINT Microcomputer and PIONEER NTSC-Type Video Disk Player (capacity of about 40,000 slides)
Photo 21. Intelligent Terminals; HP 9845C, TEKTRONIX 4051, 4115B
Photo 22. Word Processors; Fuji-Xerox J-STAR, IBM Display Writer





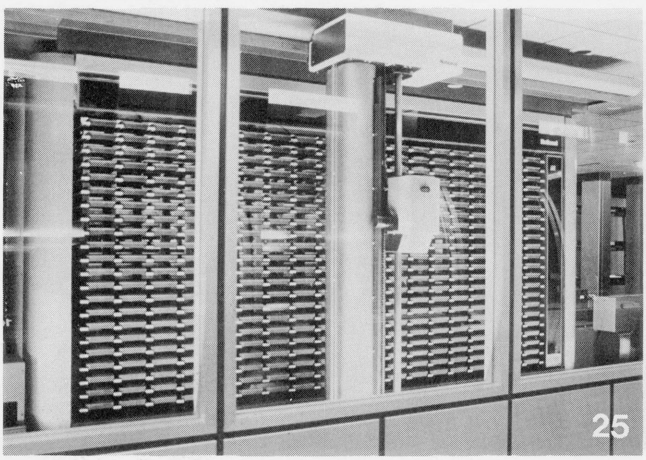
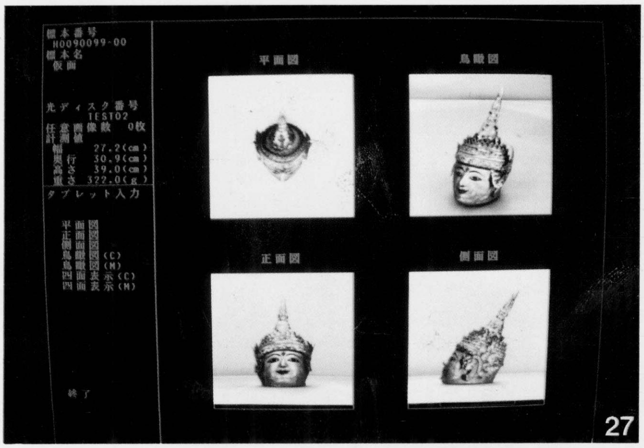


Photo 23. Document Image Retrieval System; TOSFILE 3200 (about 60,000 pages per one optical disk)

Photo 24. Booths of VIDEOTHEQUE (An Automatic Audiovisual Program Transmission Device)

Photo 25. Storage Part of VIDEOTHEQUE; 3/4 Inch Video Tape Storage and Robot Arm



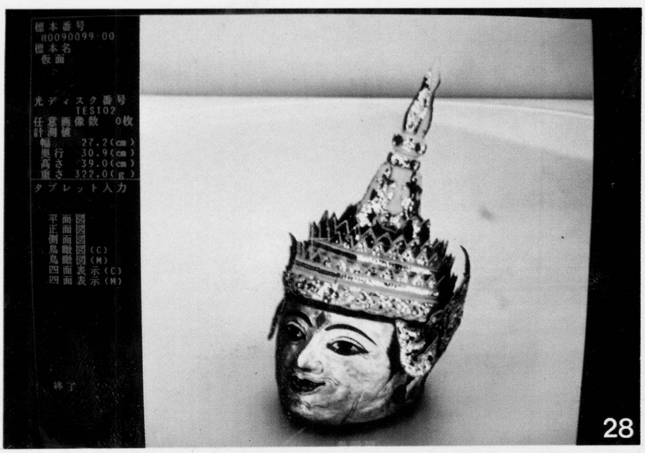
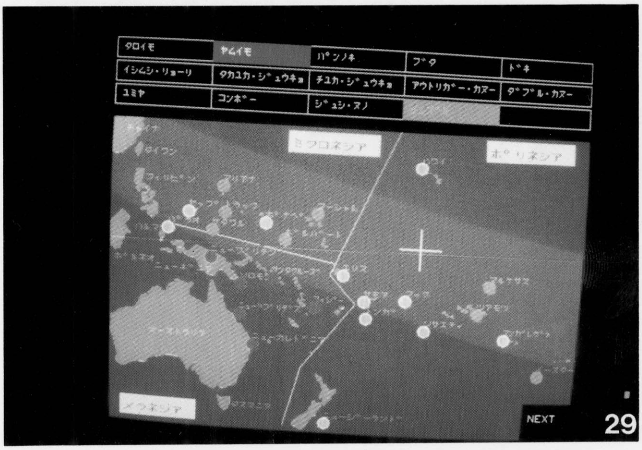


Photo 26. Multiple Display of Artifact Image Retrieval
Photo 27. Four-View Display of Artifact Image; Plane, Front, Side and Bird's-Eye
Photo 28. Full-Resolution Display of Artifact Image



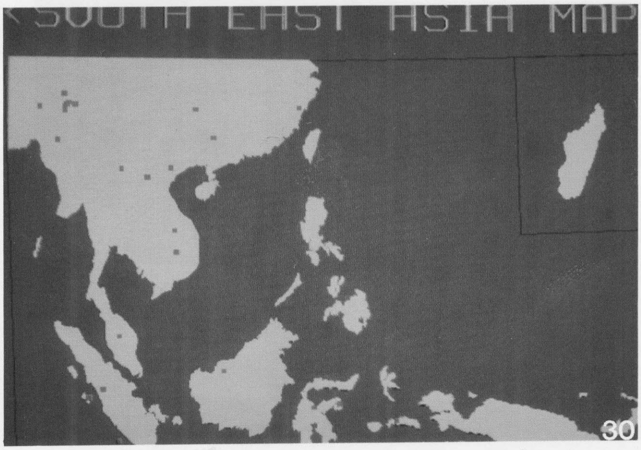
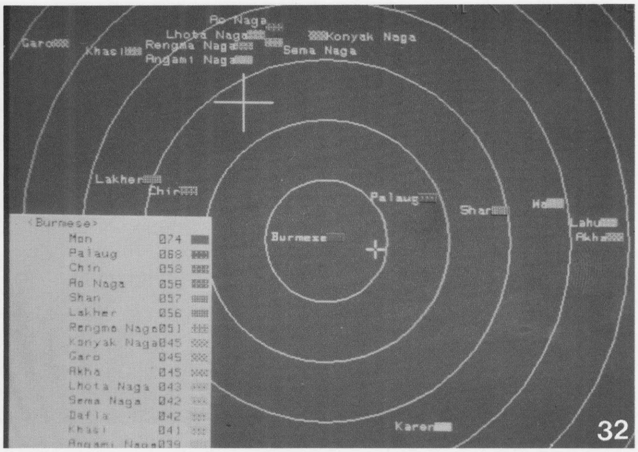
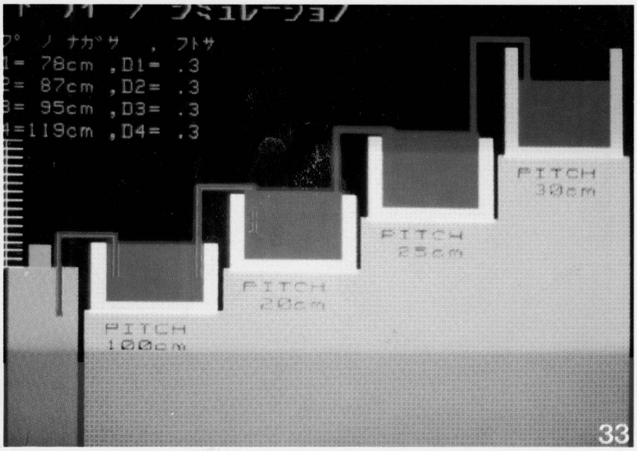
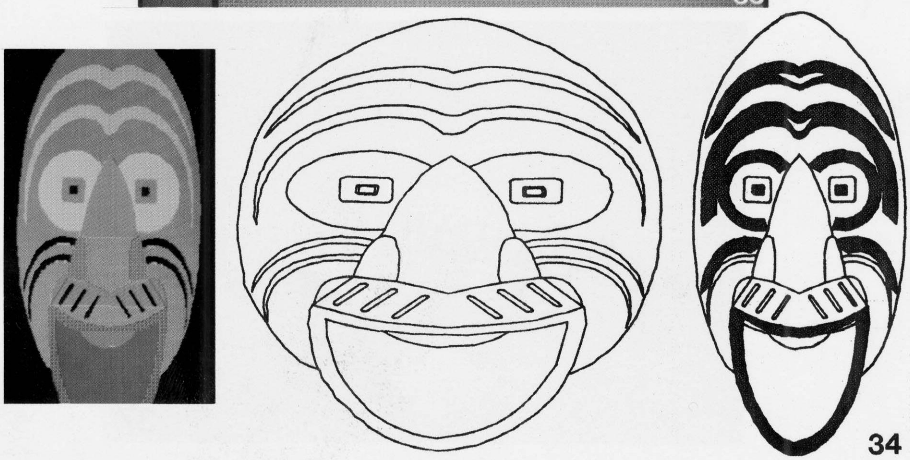


Photo 29. Cultural Elements Distribution Map; Oceania
Photo 30. Cultural Elements Distribution Map; Southeast Asia
Photo 31. Cultural Elements Distribution Map; Korea





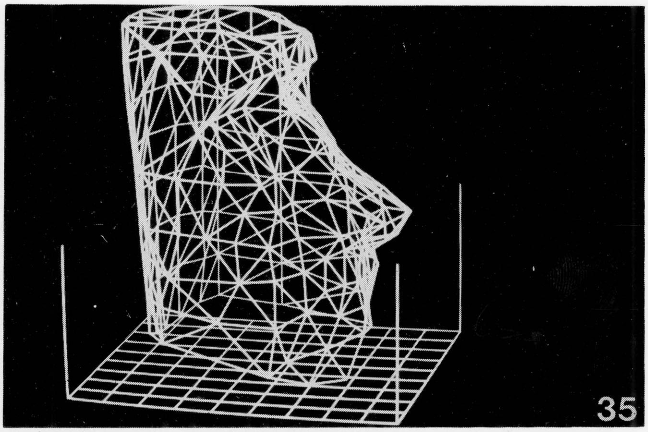


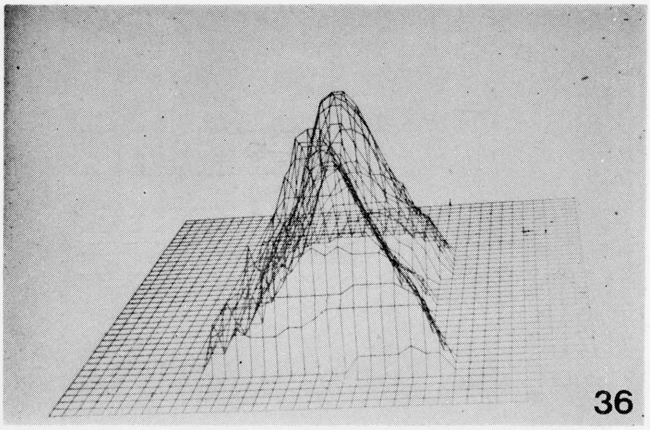
34

Photo 32. Graphic Display of Physical and Cultural Distance among Tribes; Burma and Assam Area

Photo 33. Simulation of Ancient Water Clock

Photo 34. Example of Mask Deformation





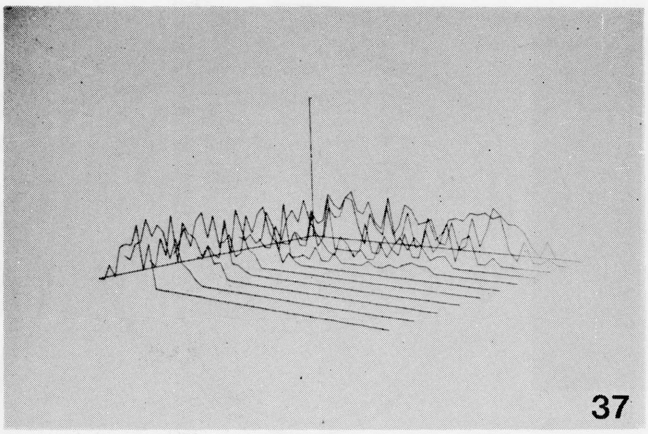
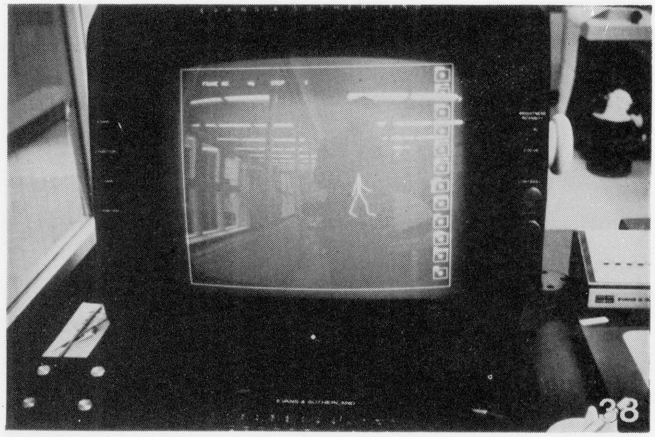
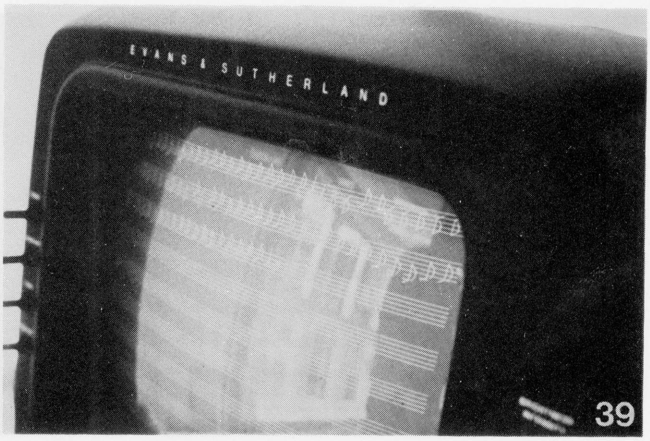


Photo 35. Three-Dimensional Dynamic Display of Moai Figure
Photo 36. Three-Dimensional Display of Old Tomb
Photo 37. Three-Dimensional Display of Speech Sound Wave





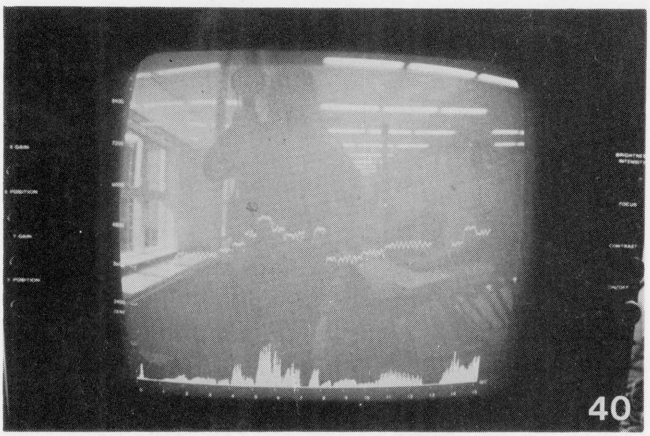
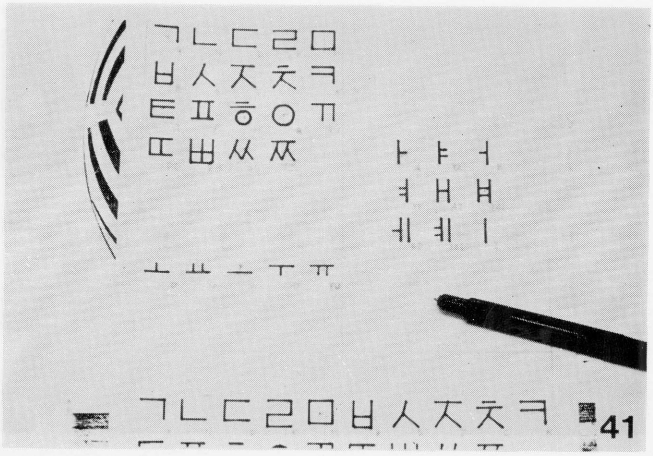
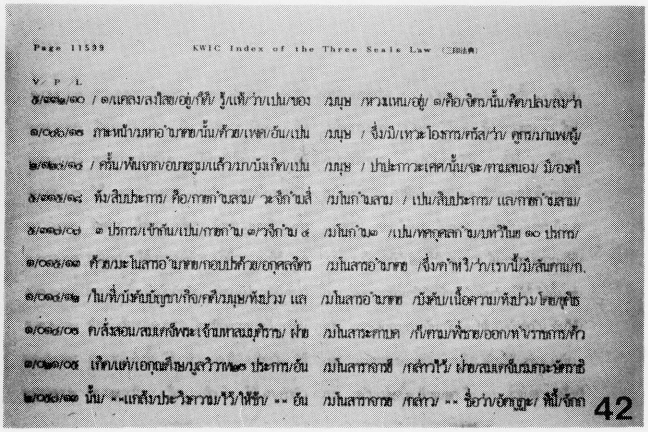


Photo 38. Dynamic Display for Human Motion Analysis
Photo 39. Transformation from Recorded Music Tape to Staff Notation
Photo 40. Visualization of Characteristic Features of Speech Wave





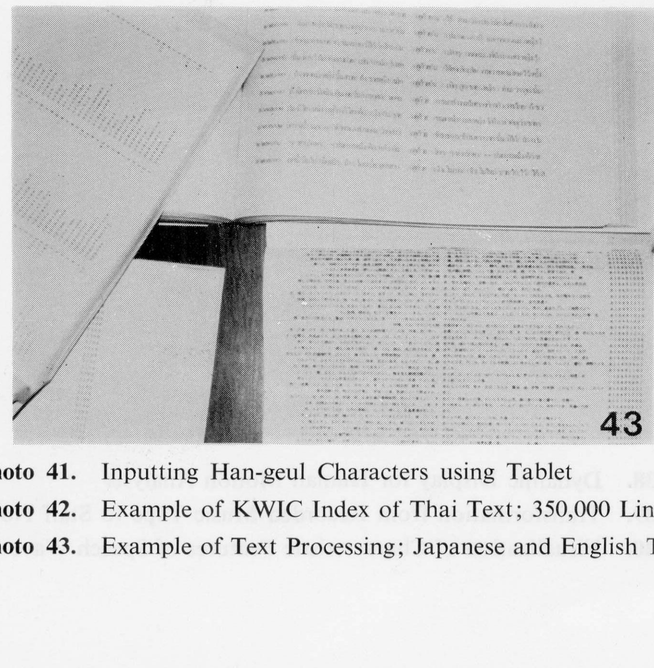


Photo 41. Inputting Han-geul Characters using Tablet
Photo 42. Example of KWIC Index of Thai Text; 350,000 Lines
Photo 43. Example of Text Processing; Japanese and English Text