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REPORT DOCUMENTATION PAGE

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8. ABSTRACT (Continue on reverse if necessary and identify by block number)

The equipment purchased under this grant is now being used in the following research projects:

- 1) Visual pattern detection and recognition research focusing on intensity requirements,
- 2) Hearing and speech research concerning intelligibility of Chinese Mandarin phonemes and connectionist models for hearing,
- 3) Cognitive processing research in which neural components of attention switching behavior and pupillary responses are being analyzed in studies of memory,
- 4) Language processing research focusing on the problem of the serial order of behavior in language perception and speech production,
- 5) Memory and learning strategies research concerning techniques for enhancing memory and the problem of information overload,
- 6) Intelligent instructional systems research focusing on the interaction of humans with large databases and the development of an intelligent query system.

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| 1. DISTRIBUTION / AVAILABILITY OF ABSTRACT<br><input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS |  | 21. ABSTRACT SECURITY CLASSIFICATION               |                          |
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All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

#19 continued

The DoD award provided the impetus for several important campus developments relating to Human Information Processing. These developments have greatly amplified the impact of the award.

- 1) An undergraduate Cognitive Science Program has been developed. Students are receiving training in state-of-the-art systems. The program is a useful model for other institutions, and national scientific manpower resources in this important new area are being enhanced.
- 2) The hiring of two additional faculty in Human Information Processing has been completed. The excellent laboratory facilities funded by the DoD award and the additional university contributions have made UCLA a very attractive place for faculty and graduate students in this area.
- 3) The university is funding the development of a campus-wide interdisciplinary program in Cognitive Science. This program will soon be receiving a sizeable award of a network of advanced workstations from a major computer company. The initial contact with this company regarding the award was in connection with purchase of workstations for the DoD grant.

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University of California, Los Angeles

September 1, 1986  
(Amended March 25, 1987)

Final Report

AFOSR-TN- 87-0431

HUMAN INFORMATION PROCESSING

US Air Force, Office of Scientific Research  
AFOSR 84-0299

Morton P. Friedman, Professor of Psychology  
Principal Investigator

Attached is a listing of the budgeted and actual costs for the items specified in the award. Considering that a very large number of items were purchased for several separate laboratories, the deviations from the budgeted costs were not significant.

The equipment is now being used in a number of research projects. These will be briefly outlined. However, of equal or greater significance are the "spinoffs" from the award that will multiply the impact of the award.

1. Research projects.

a. Visual Pattern Detection and Recognition (J. Thomas). This research concerns visual detection and recognition focusing on intensity requirements. A template model for describing contrast effects is being developed and tested.

b. Hearing and Speech (E. Carterette). Research is underway concerning intelligibility of Chinese Mandarin phonemes. Another project is beginning to look in detail a connectionist models for hearing.

c. Cognitive Processing (E. Bjork and D. Kaye). Two areas of research interest are cognitive processing limitations and ability assessment. The neural components of attention switching behavior and pupillary responses are being analyzed in studies of memory.

d. Language Processing (D. MacKay). This research focuses on the problem of the serial order of behavior, particularly in language perception and speech production. One research project is concerned with attention and performance in situations involving conflicting information. A second project deals with the mechanisms underlying mental and physical practice effects.

e. Memory and Learning Strategies (R. Bjork). This research concerns techniques for enhancing memory and the problem of information overload. One particular lines of research concerns the study of failures in the memory updating task.

f. Intelligent Instructional Systems (M. Friedman). A research project is underway that focuses on the interaction of humans with large databases, and the development of an intelligent query system.

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## 2. "Spinoffs" from the award.

The DoD award provided the impetus for several important campus developments relating to Human Information Processing. These developments have greatly amplified the impact of the DoD award.

a. An Undergraduate Cognitive Science Program. Along with the DoD proposal, the Cognitive Psychology faculty proposed an undergraduate Cognitive Science curriculum. (We define Cognitive Science as the study of intelligence - biological and artificial.)

Based on the outcome of the DoD award, the university funded the development of this new curriculum with an award of \$140,000 in equipment costs for a new laboratory in Human Information Processing, \$90,000 in development funds, a permanent personnel increment of two graduate teaching assistants, considerable additional space, and facilities renovation. The new Cognitive Science major is turning out to be popular, and students are receiving training in state-of-the-art systems. The program is a useful model for other institutions, and national scientific manpower resources in this important new area are being enhanced.

b. The DoD award also led to the hiring of two additional faculty in Human Information Processing. The award led the university to see some strength in this area and decided to add to that strength. A senior "star" level person (Keith Holyoke), and an junior person (Patricia Cheng) have joined our faculty. Both are resarcher in the new Cognitive Science tradition. It also should be noted also that we are in the process of recruiting another very high-level researcher in Cognitive Psychology. The excellent laboratory facilities funded by the DoD award and the additional univeristy contributions have made UCLA a very attractive place for faculty and graduate students in this area.

c. A Campus-wide Cognitive Science Program. Partly due to impetus provided by the DoD award, the university is funding the development of a campus-wide interdisciplinary program in Cognitive Science. The faculty group include, in addition to Cognitive Psychology faculty, researchers from Linguistics, Neuroscience, Computer Science, Library Science, Anthropology, and Philosophy.

The Cognitive Science program will soon be receiving a sizeable award of a network of advanced workstations from a major computer company. The initial contact with this company regarding the award was in connection with purchase of workstations for the DoD grant. Through this, the company learned of UCLA's competence and commitment in this area.

It is our view that, in addition to providing important research instrumentation, the DoD award seeded additional local campus developments that will be very beneficial to the national scientific effort.

APOSR 84-0299  
EQUIPMENT REPORT

A. VISUAL PATTERN RECOGNITION AND DETECTION

| ITEM   | MANUFACTURER                                       | BUDGETED COST | ACTUAL COST                             |
|--|--|---------------|---|
| COLOR VIDEO GRAPHIC SYSTEM   |  |               |   |
| CAT 1600 COLOR VIDEO GRAPHIC SYSTEM MODEL 31                       | DIGITAL GRAPHIC SYSTEMS, INC.<br>MOUNTAIN VIEW, CA | 914,246       | 918,800.00                              |
| WITH   | " "  |               |   |
| OPTION 81 (VIDEO FLASH DIGITIZER)                                  | " "  |               | 92,060.00                               |
|  |  |               | 917,860.00<br>(92,679.00)               |
|  |  |               | DISCOUNT                                |
|  |  |               | FREIGHT                                 |
|  |  |               | 919,181.00<br>866.18                    |
|  |  |               | 918,246.18                              |
|  |  |               | APPLIED TO<br>MATCHING FUNDS<br>BY DEAN |
|  |  |               | 912,181.00                              |
|  |  |               | FINAL COST                              |
|  |  |               | 93,068.18                               |
| COLOR MONITOR  |  |               |   |
| BARCO 5137 LP RGB MONITOR  | BARCO  | 99,200        | 94,098.00<br>802.50                     |
|  |  |               | 94,177.90                               |
| MONOCHROME MONITOR   |  |               |   |
| TEKTRONICS 60B MONOCHROME MONITOR WITH P-31 PHOSPHOR. NO GRATICULE | TEKTRONICS<br>WOODLAND HILLS, CA                   | 92,815        | 92,494.75                               |
| WITH   | " "  |               |   |
| OPTION 21 - DIFFERENTIAL INPUTS                                    | " "  |               |   |
| AND  | " "  |               |   |
| OPTION 25 - TTL BLANKING   | " "  |               | 961.00                                  |
|  |  |               | 963.75<br>912.73                        |
|  |  |               | 92,622.23                               |

A. VISUAL PATTERN RECOGNITION AND DETECTION (CONT.)

| HOST MICROPROCESSOR SYSTEM  | ITEM | MANUFACTURER | BUDGETED COST | ACTUAL COST |
|---|------|--------------|---------------|-------------|
| CROMENCO MICROPROCESSOR SYSTEM II   |      | CROMENCO     | \$12,786      | \$10,998.00 |
| CONSISTING OF   |      |              |               |             |
| 1 - CROMENCO CS-2HD98 (INCLUDING DPU, MCU, 512MSU, MDI, 16FDC)              |      |              |               | \$2,495.00  |
| 1 - CROMENCO 512MSU (TO BRING TOTAL RAM TO 1024K)                           |      |              |               | \$396.00    |
| 1 - CROMENCO IRT TWIN UART DIGITAL INTERFACE                                |      |              |               | \$495.00    |
| 1 - CROMENCO DAC-12 12 BIT D/A CONVERTER                                    |      |              |               | \$395.00    |
| 1 - CROMENCO 4P10 ELECTRICALLY ISOLATED 4 PORT PARALLELED I/O INTERFACE     |      |              |               | \$1,788.00  |
| 1 - CROMENCO C-10SP SUPER PAK WITH C-10, DISK DRIVE, KEYBOARD, AND SOFTWARE |      |              |               | \$700.00    |
| 1 - VISUAL 80 TERMINAL  |      |              |               | \$1,700.00  |
| 1 - NEC 35 CHARACTER/SECOND SERIAL PRINTER 30CPL                            |      | NEC          |               | \$18,960.00 |
|   |      |              | DISCOUNT      | (89,610.00) |
|   |      |              | FINAL COST    | \$15,350.00 |

B. HEARING AND SPEECH RESEARCH

TIME-VARYING SIGNALS, ANALYSIS, MEASUREMENT & CALIBRATION

| ITEM  | MANUFACTURER                          | BUDGETED COST | ACTUAL COST |
|---|---------------------------------------|---------------|-------------|
| PRECISION INTEGRATING SOUND LEVEL METER, MODEL 2230 | BRUEL & KJAER INSTRUMENTS ANAHEIM, CA |               | \$2,975.00  |
| PORTABLE ACOUSTIC CALIBRATOR MODEL 4230             | " "                                   |               | \$306.00    |
| CARRYING CASE, MODEL KE0226                         | " "                                   |               | \$241.00    |
| TRIPOD, MODEL UA0801                                | " "                                   |               | \$147.00    |
| 3 METER MICROPHONE CABLE MODEL A00027               | " "                                   |               | \$279.00    |
| MICROPHONE HOLDER, MODEL UA0688                     | " "                                   |               | \$34.00     |
| BNC TO MINIPHONE CABLE, MODEL A00173                | " "                                   |               | \$36.00     |
|   |                                       | FREIGHT       | \$12.14     |
|   |                                       |               | -----       |
|   |                                       |               | \$4,029.14  |
|   |                                       |               | \$2,066.00  |
|   |                                       | FREIGHT       | \$2.99      |
|   |                                       |               | -----       |
|   |                                       |               | \$2,068.99  |
|   |                                       | TOTAL COST    | \$6,088.13  |
|   |                                       |               | -----       |
|   |                                       | \$7,207       |             |
|   |                                       | \$10,790      |             |
|   | HEWLETT-PACKARD                       |               | \$10,867.50 |

ACTIVE FILTER SET  
MODEL 1625

DYNAMIC SIGNAL ANALYZER, DC-100 KHZ  
W/OPTION 001 BUBBLE MEMORY

B. HEARING AND SPEECH RESEARCH (CONT.)

COMPUTATION AND CONTROL OF TIME VARYING SIGNALS SUCH AS SPEECH

| ITEM   | MANUFACTURER    | BUDGETED COST     | ACTUAL COST       |
|--|-----------------|-------------------|-------------------|
| <b>COMPUTER SYSTEM</b>                         |                 |                   |                   |
| A800 BOX COMPUTER WITH 768K BYTES              | HEWLETT-PACKARD | 933,400           |                   |
| 1.5M BYTE MEMORY PACKAGE                       |                 |                   |                   |
| 3 SOCKET MEMORY CONNECTOR                      |                 |                   |                   |
| 25KHZ SINE WAVE CARD                           |                 |                   |                   |
| ASYNCHRONOUS INTERFACE SUPPORTS RS232C.        |                 |                   |                   |
| RS423 & HEWLETT PACKARD FIBEROPTIC LINK        |                 |                   |                   |
| 8 OR 16 BIT PARALLEL DUPLEX REGISTER INTERFACE |                 |                   |                   |
| RP-18 INTERFACE                                |                 |                   |                   |
| 4 METER CABLE                                  |                 |                   |                   |
| A-SERIES ANALOG INPUT CARD                     |                 |                   |                   |
| EDGE CONNECTOR KIT                             |                 |                   |                   |
| CALIBRATION SOFTWARE                           |                 |                   |                   |
| 8-CHANNEL INPUT CABLE                          |                 |                   |                   |
| 4 CHANNEL INPUT CABLE                          |                 |                   |                   |
| EDGE CONNECTOR KIT FOR 4-CHANNEL               |                 |                   |                   |
| DIGITAL TO ANALOG CONVERTER                    |                 |                   |                   |
| 32-CHANNEL DIGITAL CABLE                       |                 |                   |                   |
| 8-PEM GRAPHICS PLOTTER WITH BUILT-IN           |                 |                   |                   |
| AUTOSHEET FEED                                 |                 |                   |                   |
| 2 METER CABLE SHIELDED                         |                 |                   |                   |
| 88-DISK DRIVE, MODEL 7945A                     |                 |                   |                   |
| 2 EACH CABLE ASSEMBLY, 12008-6008              |                 |                   |                   |
| HAYES 1200 EXTERNAL MODEM                      | HAYES           |                   | 939,273.44        |
|  |                 | <b>TOTAL COST</b> | <b>939,273.44</b> |
| LAZERJET PRINTER                               | HEWLETT-PACKARD | 92,500            |                   |
| 4-CHANNEL DIGITAL TO ANALOG CONVERTER CARD     | " "             | 91,820            | 994.20            |
| 8-CHANNEL ASYNCHRONOUS MULTIPLEXER WITH        | " "             | 91,870            | 91,618.80         |
| CONNECTOR PANEL                                |                 |                   |                   |
| 32-CHANNEL DIGITAL I/O CARD                    | " "             | 91,820            | 91,250.00         |



| C. COGNITIVE PROCESSING | ITEM   | MANUFACTURER   | BUDGETED COST | ACTUAL COST |
|-------------------------|--|--|---------------|-------------|
|                         | BASIC COLOR GRAPHICS SYSTEM, PS330 INCLUDING | EVANS & SUTHERLAND<br>LOS ANGELES, CA                | \$60,000      |             |
|                         | RS 232C INTERFACE                            |  |               |             |
|                         | GRAPHICS CONTROL PROCESSOR                   |  |               |             |
|                         | 1 MBYTE MEMORY                               |  |               |             |
|                         | DISPLAY PROCESSOR                            |  |               |             |
|                         | 19" (48 CM) CALLIGRAPHIC                     |  |               |             |
|                         | COLOR SHADOW MASK (CSM) DISPLAY              |  |               |             |
|                         | ALPHA NUMERIC KEYBOARD W/12 FUNCTION KEYS    |  |               |             |
|                         | DATA TABLET                                  |  |               |             |
|                         | SOFTWARE & LICENSE INCLUDING                 |  |               |             |
|                         | 1. HOST INTERFACE SOFTWARE                   |  |               |             |
|                         | 2. HARDWARE DIAGNOSTICS                      |  |               |             |
|                         | USJR AND OPERATOR DOCUMENTATION              |  |               |             |
|                         | OPTIONAL LED DISPLAYS FOR KEYBOARD           |  |               |             |
|                         | 6 CONTROL DIALS WITH OPTIONAL LED DISPLAYS   |  |               |             |
|                         |  |  |               | \$53,000.00 |
|                         |  |  |               | \$94.34     |
|                         |  |  |               | \$53,994.34 |
|                         |  |  |               | \$18,000.00 |
|                         | INTERFACE & TIMING CONTROLLER, PS300         | TERABIT COMPUTER ENGINEERING<br>SALT LAKE CITY, UTAH |               |             |
|                         |  |  |               | \$68,994.34 |
|                         |  |  |               | \$5,397.45  |
|                         |  |  |               | \$16,316.45 |
|                         | NEURODATA ACQUISITION SYSTEM                 | GRASS INSTRUMENTS<br>QUINCY, MA                      | \$8,223       |             |
|                         | 16-CHANNEL, MODEL 12                         |  |               |             |
|                         | PUPIL/HEAD TRACKING SYSTEM, MODEL RK-417     | RCA  | \$16,600      |             |
|                         | LOW LIGHT BLACK & WHITE CAMERA               | "  |               |             |
|                         | RCA TC1008 U01                               | "  |               |             |
|                         | LOW LIGHT BLACK & WHITE CAMERA               | "  |               |             |
|                         | RCA TC2011U                                  | "  |               |             |
|                         | 2 EACH 9" BLACK & WHITE MONITORS, RCA TC     | "  |               |             |
|                         | RACK MOUNT KIT, RCS TC1910MK                 | "  |               |             |
|                         | OPTICS PACKAGE                               | "  |               |             |
|                         | CAMERA MOUNT                                 | KALT   |               |             |
|                         | LENS   | TOKINA   |               | 931.90      |
|                         | CLAMP  | BOGAM  |               | 810.22      |
|                         | MASK   | BOGAM  |               | 939.83      |
|                         |  |  |               | 891.12      |
|                         |  |  |               | \$16,316.45 |
|                         |  |  |               | \$4,995.00  |
|                         |  |  |               | \$16,899.52 |
|                         | NORTSTAR HORIZON 30 MB MICROCOMPUTER         | NORTSTAR COMPUTERS                                   | \$10,800      |             |

2. LANGUAGE PROCESSING

| BASE SYSTEM   | MANUFACTURER            | BUDGETED COST | ACTUAL COST |
|---|-------------------------|---------------|-------------|
| ITEM  |                         |               |             |
| NORTESTAR HORIZON 30 MEGABYTE, 2 USER TURBODOS SYSTEM WITH DUAL PROCESSOR (8 BIT) | NORTESTAR COMPUTERS     | 98,995        | \$8,882.08  |
| MICROWARE 87 CHIP FASTPAK FLOATING POINT ARITHMETIC CHIP AND SUPPORTING SOFTWARE  | MICROWARE               | 8495          | \$150.00    |
| LABORATORY MICROSYSTEM PC/FORTH WITH 8087 SUPPORT                                 | LABORATORY MICROSYSTEMS |               | \$200.00    |
| DESK PRO COMPAQ WITH 640 RAM, 20MB HARD DISK & FLOPPY DISK DRIVE                  | COMPAQ                  | 8650          | \$350.00    |
| IBM PC/XT WITH ONE DISKETTE DRIVE   | IBM                     | 83,480        | \$2,950.00  |
| DISCITRON 20MG HARD DISK  | DISCITRON               |               |             |
| AST 6 PACK WITH TIMER   | AST                     |               |             |
| SONY KV 1311 VIDEO MONITOR  | SONY                    |               |             |
| CABLE FOR MONITOR   | SONY                    |               |             |
| MERCULES COLOR CARD   | MERCULES                |               |             |
| ASYNC CLOCK CARD  | AST                     |               |             |
| OKIDATA 193 PRINTER   | OKIDATA                 |               |             |
| PARALLEL PRINTER CABLE  | OKIDATA                 |               |             |
| PERIPHERALS   |                         |               |             |
| OKIDATA, 93 DOT MATRIX PRINTER  | OKIDATA                 | \$1,199       | \$518.00    |
| NEC 8610 LETTER QUALITY PRINTER W/BIDIRECTIONAL TRACTOR FEED & SERIAL CABLE       | NEC                     | \$3,055       | \$1,985.96  |
| VISUAL GRAPHICS TERMINAL MODEL 241 & CABLE  | VISUAL TECHNOLOGIES     | \$2,695       | \$1,655.00  |
| TELEVIDEO 960 TERMINAL  | TELEVIDEO               | \$1,195       | \$998.00    |
| HAYES 1200 SMARTMODEM   | HAYES                   | \$495         | \$389.00    |
| TOTAL COST  |                         |               |             |

D. LANGUAGE PROCESSING (CONT.)

VIDEO COLOR GRAPHICS SUBSYSTEM

| ITEM  | MANUFACTURER   | BUDGETED COST     | ACTUAL COST       |
|---|--|-------------------|-------------------|
| TAXAN 440 COLOR MONITOR WITH COLOR CARD   | TAXAN  | \$2,995           | \$1,000.00        |
| GRAPHICS LAB SYSTEM<br>COMPAQ PORTABLE COMPUTER 128K<br>2 FLOPPY DISC DRIVES<br>CENTRONIC-TYPE CABLE  | COMPAQ   | \$3,700           | \$1,913.94        |
| TECHMAR LAB TENDER<br>OKIDATA/93 DOT MATRIX PRINTER<br>AST MEGAPLUS II 64K MULTIFUNCTION CARD<br>QUBIE 384K COMMUNICATIONS CARD<br>CABLE<br>7 BOXES POLOROID DOUBLE SIDED<br>DOUBLE DENSITY DISKETTES | TECHMAR<br>OKIDATA<br>AST<br>QUBIE<br>COMPAQ<br>POLOROID |                   | \$1,696.00        |
| FISHER MODEL 840 VIDEO RECORDER   | FISHER   | \$700             | \$699.00          |
|   |  | <b>TOTAL COST</b> | <b>\$3,608.94</b> |

F. MEMORY

PROJECTION SYSTEM

| ITEM   | MANUFACTURER | BUDGETED COST | ACTUAL COST |
|--|--------------|---------------|-------------|
| 3 EACH SONY MONITORS, PVN 1271Q  | SONY         | \$6,880       | \$1,976.40  |
| 1 SONY VIDEOTAPE CAMERA PLUS<br>VIDEOTAPE PLAYER/RECORDER<br>PXC-1620K/SLO-340 PACKAGE | "            |               | \$3,178.20  |
| SONY MONITOR, PVN-1910   | "            |               | \$644.40    |
|  |              | TOTAL COST    | \$5,796.00  |
| COMPUTER SYSTEM  |              |               |             |
| IBM PC/AT, 512K, 20 MB HARD DISK   | IBM          | \$12,830      |             |
| IBM PROPRINTER   | "            |               |             |
| 5K PRINT BUFFER 4000   | "            |               |             |
| SERIAL/PARALLEL ADAPTER (NS 232)   | "            |               |             |
| PRINTER CABLE  | "            |               |             |
| MONOCHROME DISPLAY   | "            |               |             |
| 3 EACH COLOR GRAPHIC ADAPTERS  | "            |               | \$6,660.76  |
| 3 EACH LEADING EDGE PC<br>MODEL M, SINGLE DISK, 256K                                   | LEADING EDGE |               | \$3,000.00  |
| MOBILE MICROMASTER 48"   | IMMAC        |               | \$349.58    |
| 3 EACH OAK COMPUTER TABLES   | O'SULLIVAN   |               | \$537.00    |
|  |              | TOTAL COST    | \$9,867.34  |

G. INTELLIGENT INSTRUCTIONAL SYSTEMS  
 INFORMATION PROCESSOR.

| ITEM   | MANUFACTURER             | BUDGETED COST | ACTUAL COST |
|--|--------------------------|---------------|-------------|
| APPLE MACINTOSH COMPUTER 512K<br>W/MACWRITE/MACPRINT SOFTWARE 3M2612             | APPLE                    | 934.160       |             |
| 2 EACH MACINTOSH EXTERNAL DISK DRIVE   | "                        |               | 92,800.00   |
| APPLETALK CABLE KIT  | "                        |               | 91,199.16   |
| 2 EACH APPLETALK CONNECTOR KIT   | "                        |               | 8900.00     |
| MACINTOSH HARD DISK  | "                        |               |             |
| BRIGHAM YOUNG UNIVERSITY<br>MOVIE GRAPHICS LICENSE AND TAPE<br>1600 DPI, 9 TRACK | BRIGHAM YOUNG UNIVERSITY |               |             |
| INTERFACE FOR APOLLO 560 COMPUTER  | NATIONAL COMPUTER'S      |               | 82,830.09   |
| CIPHER STREAMING TABLE DRIVE 3P880   | CIPHER                   |               |             |
| CIPRICO MODEL TMA02 CONTROLLER<br>CABLES & ENCLOSURE                             | CIPRICO                  |               | 96,161.98   |
| 3 EACH INTELLIMODEN EXT-300/1200<br>FOR APOLLO & IBM PC/AT SYSTEMS               | INTELLIMODEN             |               | 9760.00     |
| APOLLO MODEL DM550-3MB PROCESSOR   | APOLLO COMPUTERS         |               |             |
| APOLLO MODEL UPQ DM560-3MB UPGRADE   | "                        |               |             |
| APOLLO MODEL MDS 867-86M DUAL DISKS  | "                        |               |             |
| APOLLO MODEL K3D-MSE KEYBOARD  | "                        |               |             |
| APOLLO MODEL MBUS MULTIBUS   | "                        |               |             |
| APOLLO MODEL DOMAIN OPERATING SYSTEM & COMPILER                                  | "                        |               |             |
| APOLLO SPN-PC1 PC INTERFACE  | "                        |               |             |
| APOLLO DM3000-M2 MONOCHROME WORKSTATION<br>WITH 2M MEMORY AND 86 MB DISK         | "                        |               | 948,916.29  |
|  |                          |               | 969,161.52  |
|  |                          |               |             |
|  |                          |               | (81,612.93) |
|  |                          |               | (9496.49)   |
|  |                          |               | 961,042.14  |

MATCHING FUNDS  
 MINIGRANT  
 DEPARTMENT

TOTAL COST

G. INTELLIGENT INSTRUCTIONAL SYSTEMS  
(CONT.)

| SYSTEM PRINTER<br>ITEM   | MANUFACTURER | BUDGETED<br>COST  | ACTUAL<br>COST |
|--|--------------|-------------------|----------------|
| APPLE LASERWRITER PRINTER M460   | APPLE        | \$5,200           | \$4,592.00     |
| COMPUTER CONTROLLED<br>VIDEODISK & GRAPHICS SYSTEM                         |              |                   |                |
| 3 EACH SONY VIDEODISK PLAYERS  | SONY         | \$9,480           | \$4,434.00     |
| SUNMA SKETCH PAD FOR IBM-PC<br>INCLUDING STYLUS, PAD, CABLE 7 POWER SUPPLY | SUNMA        |                   | \$420.83       |
| IBM PC/AT WITH 612K AND 30 MB DRIVE  | IBM          |                   |                |
| IBM MONO DISPLAY/PRINTER ADAPTER<br>MONO ADAPTER BOARD                     | "            |                   |                |
| MATH CO-PROCESSOR  | "            |                   |                |
| MONOCHROME DISPLAY   | "            |                   |                |
|  |              | TOTAL COST        | \$4,783.00     |
|  |              | TOTAL ALLOCATION  | \$9,607.83     |
|  |              | TOTAL EXPENDITURE | \$298,672.00   |