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UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1992

HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP) REPORTS

VOLUME 14

ROME LABORATORY

RESEARCH & DEVELOPMENT LABORATORIES
5800 Uplander Way
Culver City, CA 90230-6608

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Bolling Air Force Base
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December 1992

94 4 21 086

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(Attn: Pat Mauby)

SUBJECT: Distribution of USAF (AFOSR Summer Research Program (Air Force Laboratories) and Universal Energy Systems, Inc., and the Research Initiation Program

FROM: AFOSR/XPT
Joan M. Boggs
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Bolling AFB DC 20332-0001

1. All of the books forwarded to DTIC on the subjects above should be considered Approved for Public Release, distribution is unlimited (Distribution Statement A).

2. Thank you for processing the attached information.

Joan M. Boggs
JOAN M. BOGGS
Chief, Technical Information Division

HSAP + SFRP Reports
(1992 Vol 13, 14, 16) (Vol 1, 2, 3, 4) - 1991

GSRP (Vol 10 + 11) - 1993
SRP

HSAP (Vol 12 - 16 - 1993)

14 Books

PREFACE

This volume is part of a 16-volume set that summarizes the research accomplishments of faculty, graduate student, and high school participants in the 1992 Air Force Office of Scientific Research (AFOSR) Summer Research Program. The current volume, Volume 14 of 16, presents the final research reports of high school (HSAP) participants at Rome Laboratory.

Reports presented herein are arranged alphabetically by author and are numbered consecutively -- e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

Research reports in the 16-volume set are organized as follows:

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A-1

VOLUME	TITLE
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2	Summer Faculty Research Program Reports: Armstrong Laboratory
3	Summer Faculty Research Program Reports: Phillips Laboratory
4	Summer Faculty Research Program Reports: Rome Laboratory
5A	Summer Faculty Research Program Reports: Wright Laboratory (part one)
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6	Summer Faculty Research Program Reports: Arnold Engineering Development Center; Civil Engineering Laboratory; Frank J. Seiler Research Laboratory; Wilford Hall Medical Center
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1992 HIGH SCHOOL APPRENTICESHIP REPORTS

Rome Laboratory

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4	Analysis of F-16 Shielding Effectiveness	Michael Decker
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10	Is Multi-Media the Answer?	Ray A. Liuzzi, Jr.
11	Artificial Neural Systems	Sean Menge
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13	Study of Parallel Distributed Processing	Anne E. Pletl
14	The Research of Different Samples Using the Scanning Electron Microscope	Anthony M. Richards
15	Laser Diode Array Testing	Eugene C. Salerno
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18	Noise Measurement of Interconnecting Coaxial Cable	Max Shapiro William J. Walsh

Effectiveness of Advanced Identification System and Lecroy Digitizer

Stephen A. Antonson

Final Report for:
Summer Research Program
Rome Laboratory

Sponsored by:
Rome Laboratory
Griffiss Air Force Base, Rome, New York

August 1992

The Effectiveness of Advanced Identification System and Lecroy Digitizer

Stephen A. Antonson

ABSTRACT

The effectiveness of the Advanced Identification System (AIS) and the Lecroy Digitizer was studied. To collect raw data, several excursions were made to Florida. Both systems were installed in a small plane and readings were taken and recorded. This data was then returned to Rome Lab where it was compiled and organized to make it computer presentable for automated input.

INTRODUCTION

My functioning in this project had two parts. The first objective was to retrieve the digital log information that was accidentally lost and reinsert it into the database. The second objective was to perform queries and make the information presentable.

METHODOLOGY

The first section of the project was tedious. I had to parse through two hard copy tables, each one approximately six pages long. It was necessary to compare the complete table to the partial table to find the missing entries. The complete table was the only copy of the now deleted entries. The partial table was the current table that had missing entries.

APPARATUS

Performing queries was the part of the project that posed the most problems. Paradox 3.5, the database application used to perform the queries, has a very specific syntax that was necessary to learn in order to properly perform the tasks. Approximately two weeks was spent on learning the intricacies of Paradox 3.5 to perform the queries and to find exactly the right questions to ask of Paradox.

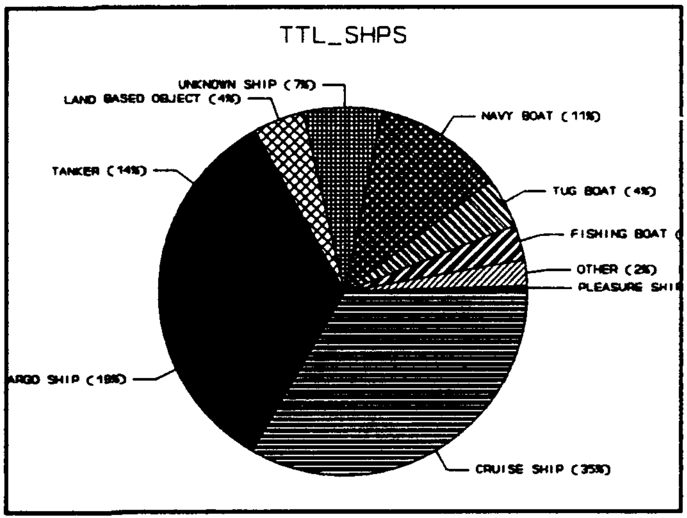

Figure 1 This graph shows how many different types of ships were encountered.

RESULTS

Basically, the queries produced just two graphs (Figure-1 and Figure-2). Figure-1 is a pie chart made with Paradox and it shows what kind of ships were encountered and what percent of the total each type of ship was.

Figure-2 is a stacked bar graph. It shows the total number of files collected and of which type they are. The graph also tells if the Lecroy data is burst or continuous. This graph illustrates the results of the entire project in one complete visual aid.

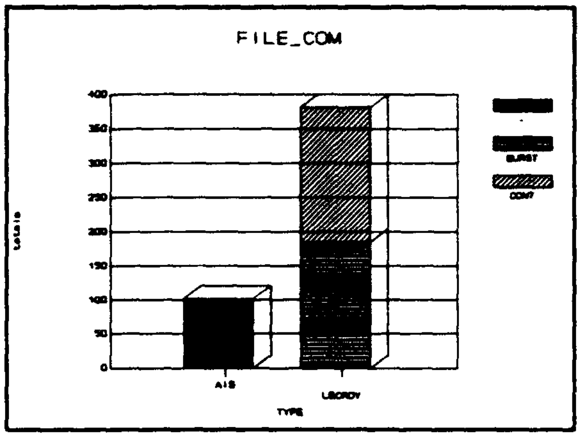

Figure 2 This figure shows how many files were obtained for each type.

The acceptable data needed to have both AIS and Lecroy readings. Of four hundred and ninety-two readings only three hundred and thirteen were available (Figure 3) because there was both AIS and Lecroy readings. The solid bar shows the total number of files that are usable for comparison. The bar with the diagonal stripes represents the total number of Lecroy files available. The bar with the horizontal stripes shows the total number of AIS files available. Notice that there are four times more Lecroy files than AIS files. That is because the AIS system only needs one reading whereas the Lecroy system needs as many as possible.

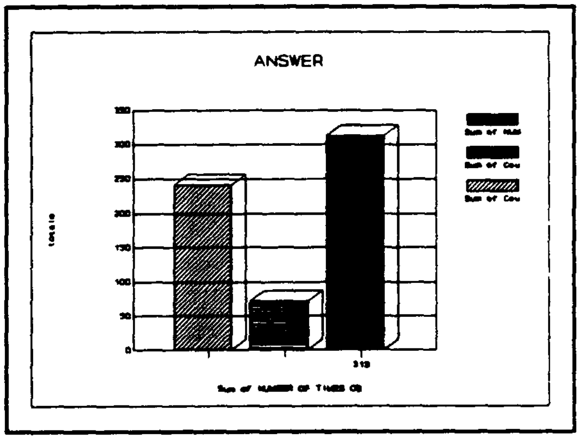

Figure 3 This graph shows the total number of available files.

CONCLUSION

The final results of this experiment are classified and have yet to be obtained. While working on this project I learned how to use the applications Paradox 3.5, Word Perfect 5.1, and Microsoft Excel 2.2. I also learned how to use a Macintosh IIx System VII. I was also exposed to Turbo Basic and Turbo C++ by Borland and wrote some small programs with both.

SOLID MODELLING USING NETWORK II.5

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Final Report for:
Summer Research Program
Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Griffiss Air Force Base, Rome, N.Y.

August 1992

SOLID MODELING USING NETWORK II.5

Matthew J. Bauder
Student
Sauquoit Valley Central School

ABSTRACT

Solid modeling is using computer graphics to represent the complete geometry of a product. Network II.5 is a solid modeling program that allows the user to model networks. This summer, I verified an already modelled network, with Network II.5, checking for data and simulation problems. This paper will describe solid modelling in more detail, describe Network II.5, and discuss the work I did and the network I worked on.

SOLID MODELING USING NETWORK II.5

Matthew J. Bauder
Student
Sauquoit Valley Central School

SOLID MODELING

Solid modeling is defined as using computer graphics to completely and unambiguously represent the geometry of a product. A solid modeling representation allows all points in space to be classified as inside, outside, or on the surface of an object. Solid modeling is important so that the production and modification of drawings can be easily improved. Before solid modeling technology, people used drafted drawings. The problems of this process was the preparation to certain standards was tedious, and was often filled with errors. Also, to modify these drawings, one had to usually totally rework the drawing. These obstacles considerably slowed down the design process, slowing the product development.

The first computer technology that aided in solid modeling was computer aided drafting. This was a considerable improvement from drafted drawings, but was still prone to errors. Also, the drafting data bases were not capable of supporting shaded images, hidden lines, and mass properties. Another problem, was that non-realizable geometry could be drawn mistakenly.

This is when the need for solid modeling came about. Solid modeling software can automatically shade images, hide lines and surfaces, and mass properties. With Solid modeling software, one can create a model, or solid modeling representation of a product. Unlike drafting and computer aided drafting, most solid modeling programs have the user enter data about the product into the computer, and the computer generates the drawing of the model. This automatic model generation is another advantage of solid modeling.

Solid modeling is used mostly in design and analysis of a product. Some solid modeling software, can model things that are not tangible like a products for manufacturing. The software, Network II.5, is used to model and simulate the running of networks.

NETWORK II.5

Network II.5 is network simulation and analysis software that is put out by CACI Products Company. To model a network for simulation and/or analysis, you enter certain data into the program and it creates the the model. It will run a simulation of the network if needed. No programming is needed.

Network II.5 has seven programs. NETIN and NETGIN are used for developing system descriptions. NETIN is text-based, while NETGIN is graphics-based program. For system simulation, Network II.5 has two programs. NETWORK is a text-based simulation program, and GWORK is the graphics-based version. NETPLOT, GPLOT, and NETAN interpret the simulation results. NETPLOT is text-based, GPLOT is graphics-based, and NETAN is a graphics-based post-simulation animation program.

The building blocks for a network in Network II.5 are Processing Elements (PE's), Transfer Devices (TD's), and Storage Devices (SD's). A PE is used to model a hardware component that is not only a data source or sink. TD's link the Processing Elements and the Storage Devices. A SD contains both user-named files and unstructured storage (General Storage). All of these blocks have different flag settings, and instructions, but I did not use this information in my modelling. Also, Network II.5 can model software, but again I didn't go into this much detail.

WORK EXPERIENCE

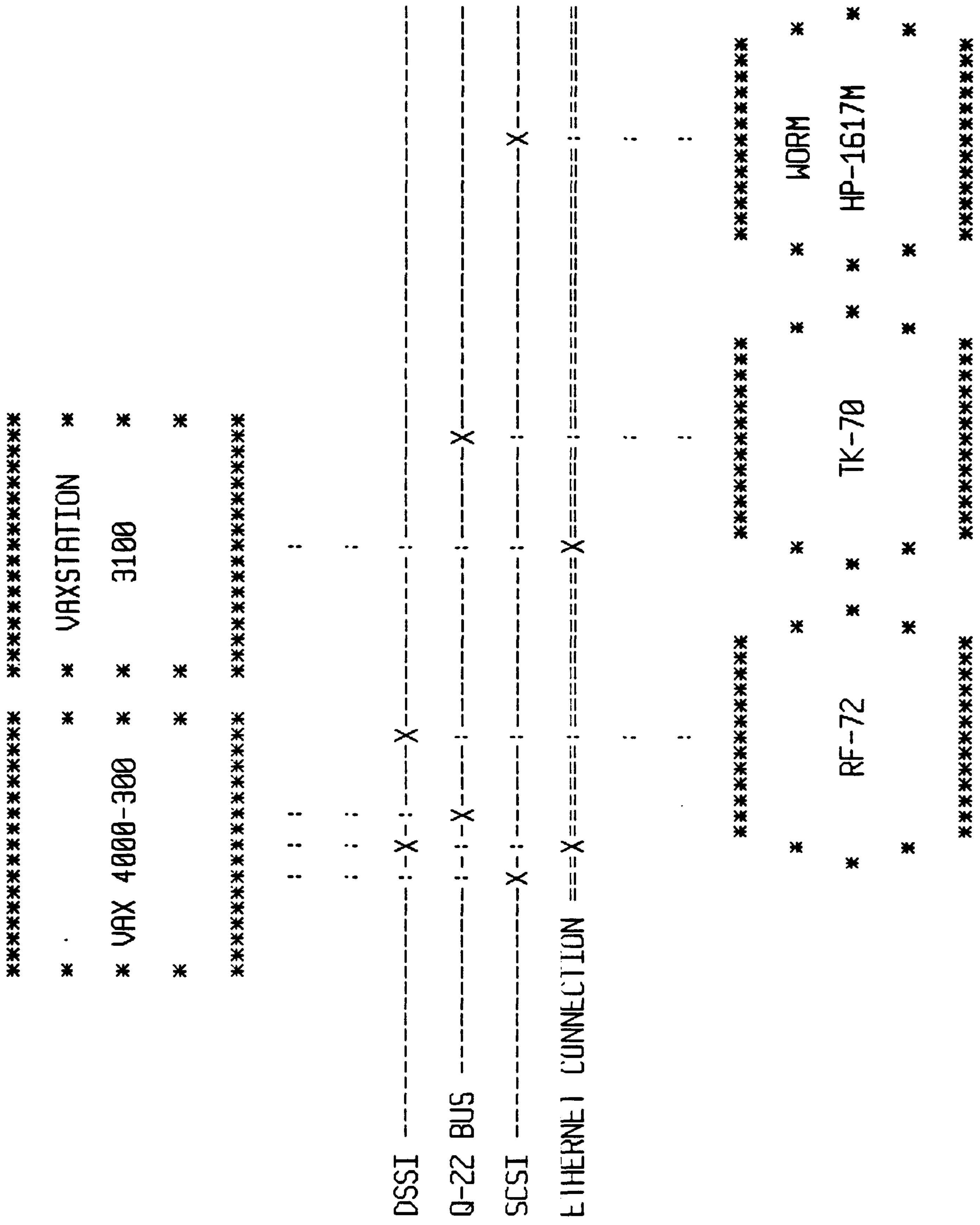
The task I was given, was to check over the information for the Communications Support Processor (CSP) Hardware model. I didn't have time to read any information on the whole system, but instead I read about the separate parts. The first thing I did to ready myself for the task was to read though parts of the Network II.5 manual. This went pretty slowly, because a lot of it was over my head, and I had to read it over a few times. After I felt ready, I started using Network II.5 by just playing with it to see what it could do. A college student, who was working for the summer, helped me get to know the DEC Workstation I was using. Then my mentor gave me some information about the CSP Hardware, and I read through it while checking the information in the model. I made a few changes with my mentor's approval and then documented all of the information. (See appendix A.) I ran a simulation of the network and printed out the results. The network simulated just fine with no errors. I made up briefing slides for interested parties.

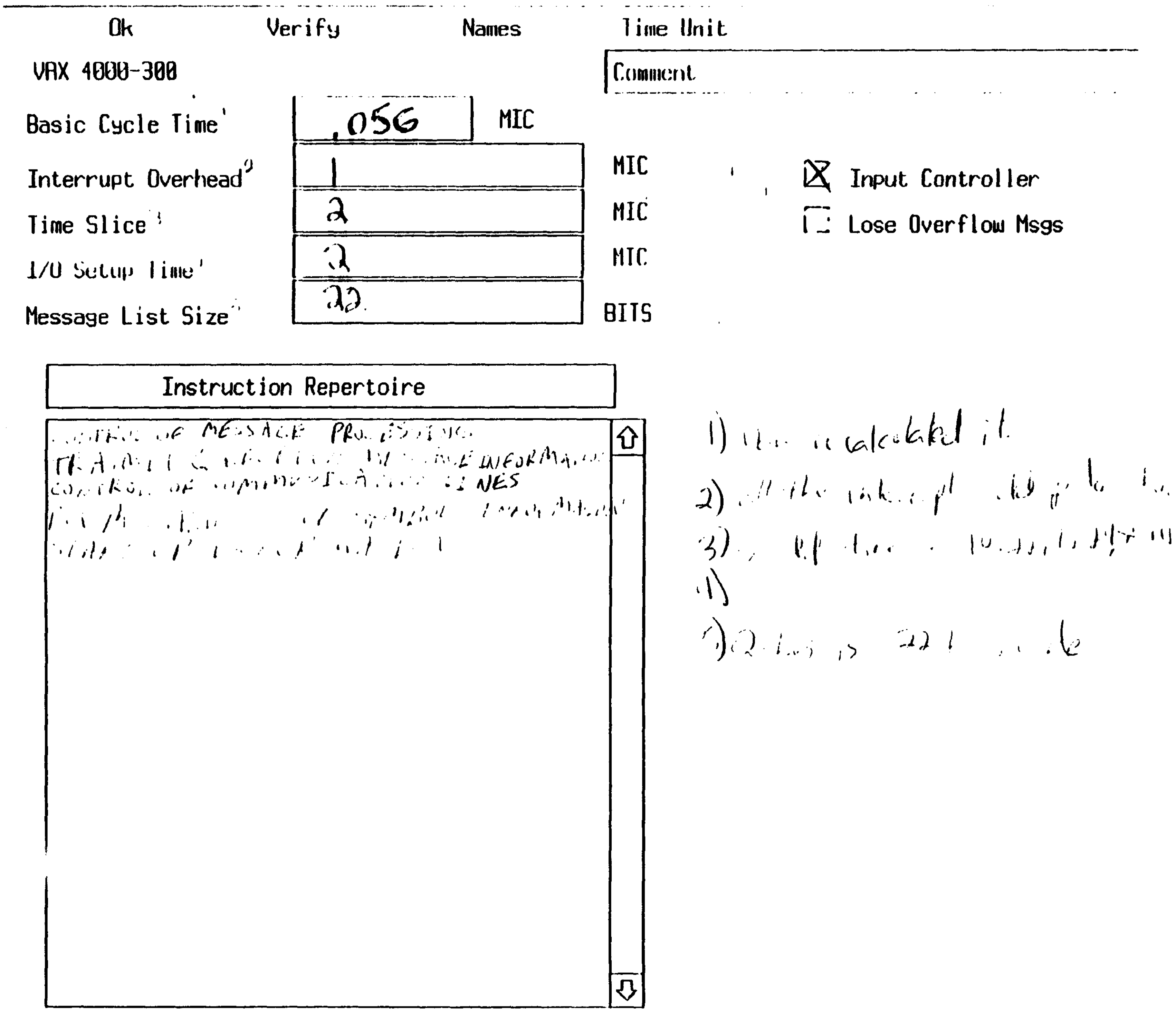
The CSP Hardware model had two PE's, four TD's, and three SD's. The PE's were a VAX 4000-300, and a VAXSTATION 3100. The four TD's were a DSSI, a Q-22 BUS, a SCSI, and an Ethernet Connection. An RF-72, a TK-70, and a WORM HP-1617M were the three SD's. (See Diagram 1 for a drawing of the model and Appendix A for the information for each device.)

CONCLUSION

This summer was a very rewarding one for me. I was able to learn about a topic that I had only heard about and learn how to use a specific program. This summer was different from my last experience as an apprentice because rather than a dry paper study. I got to do some work for the laboratory. This whole program was excellent, and I enjoyed both years I was in it.

Figure 1


VAX 4000-300
VAXSTATION
3100
DSSI
Q-22 BUS
SCSI
ETHERNET CONNECTION
RF-72
TK-70
WORM
HP-1617M


Ok
Verify
Names
Time Unit
Comment
Instruction Repertoire

VAX 4000-300

Basic Cycle Time[1] .056 MIC

Interrupt Overhead[2] 1 MIC

Time Slice[3] 2 MIC

I/O Setup Time[1] 2 MIC

Message List Size[5] 22. BITS

☒ Input Controller

☐ Lose Overflow Msgs

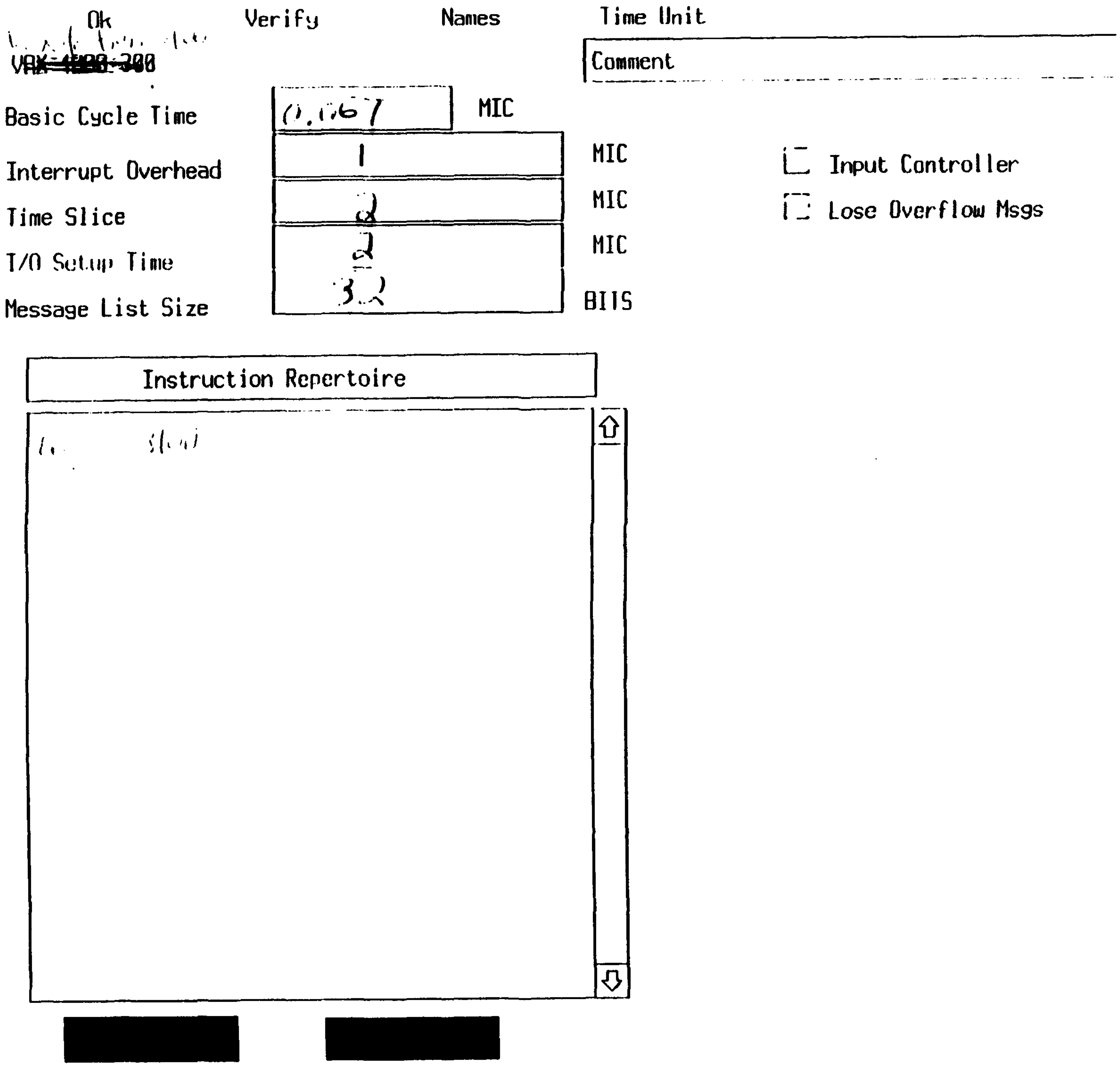
[illegible] OF MESSAGE PROCESSING
TRA[illegible] [illegible] INFORMA[illegible]
CONTROL OF [illegible] [illegible]NES
[illegible]
[illegible]

1) [illegible] calculated it.
2) [illegible]
3) [illegible]
4)
5) [illegible]

[redacted]

[redacted]

COPY AVAILABLE TO DTIC DOES NOT PERMIT FULLY LEGIBLE REPRODUCTION


Ok
Verify
Names
Time Unit
Instruction Repertoire
⇧
⇩

~~VAX-4000-300~~

Comment

Basic Cycle Time 0.067 MIC

Interrupt Overhead 1 MIC

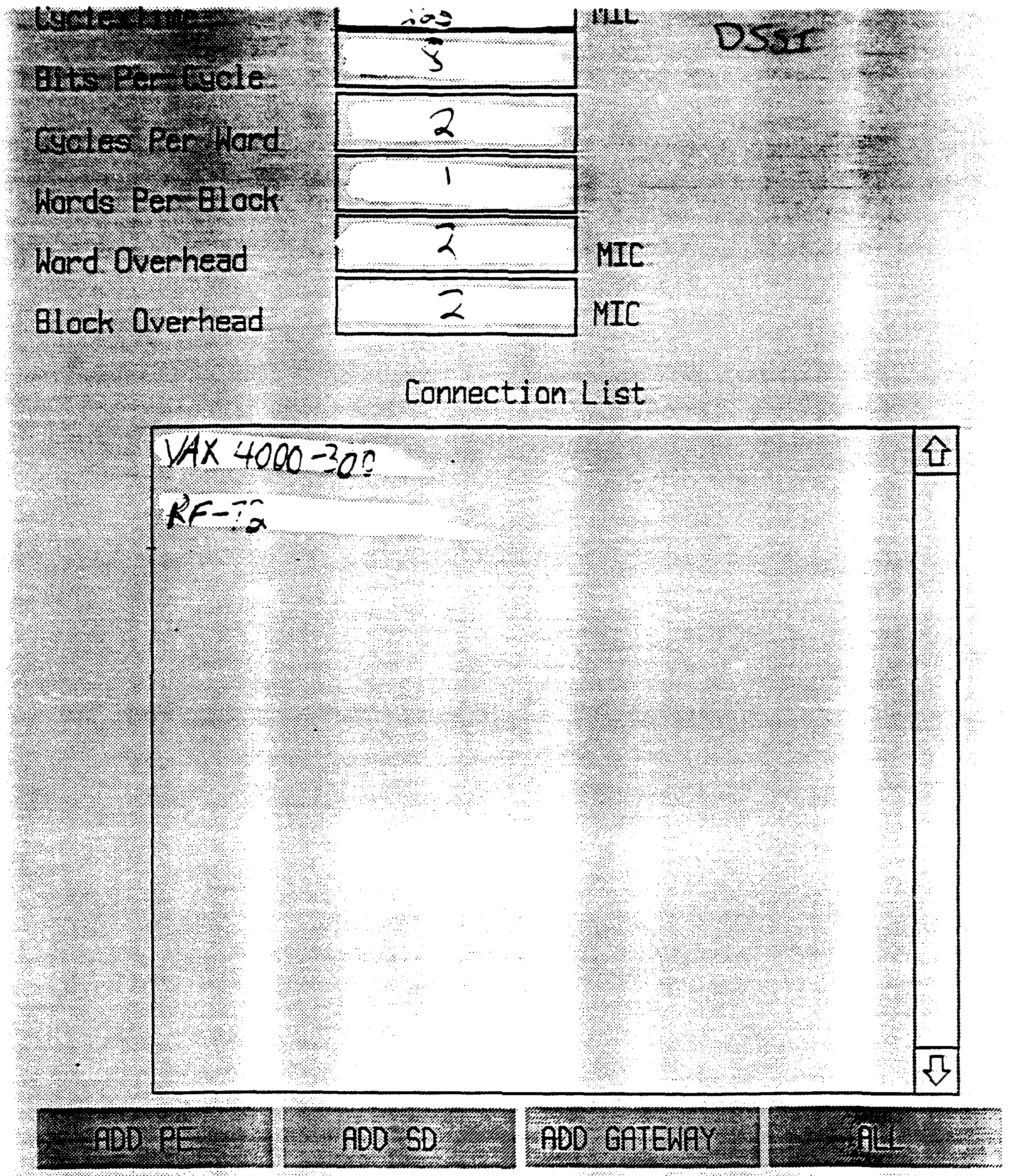
Time Slice 2 MIC

I/O Setup Time 2 MIC

Message List Size 32 BITS

☐ Input Controller

☐ Lose Overflow Msgs



DSSI

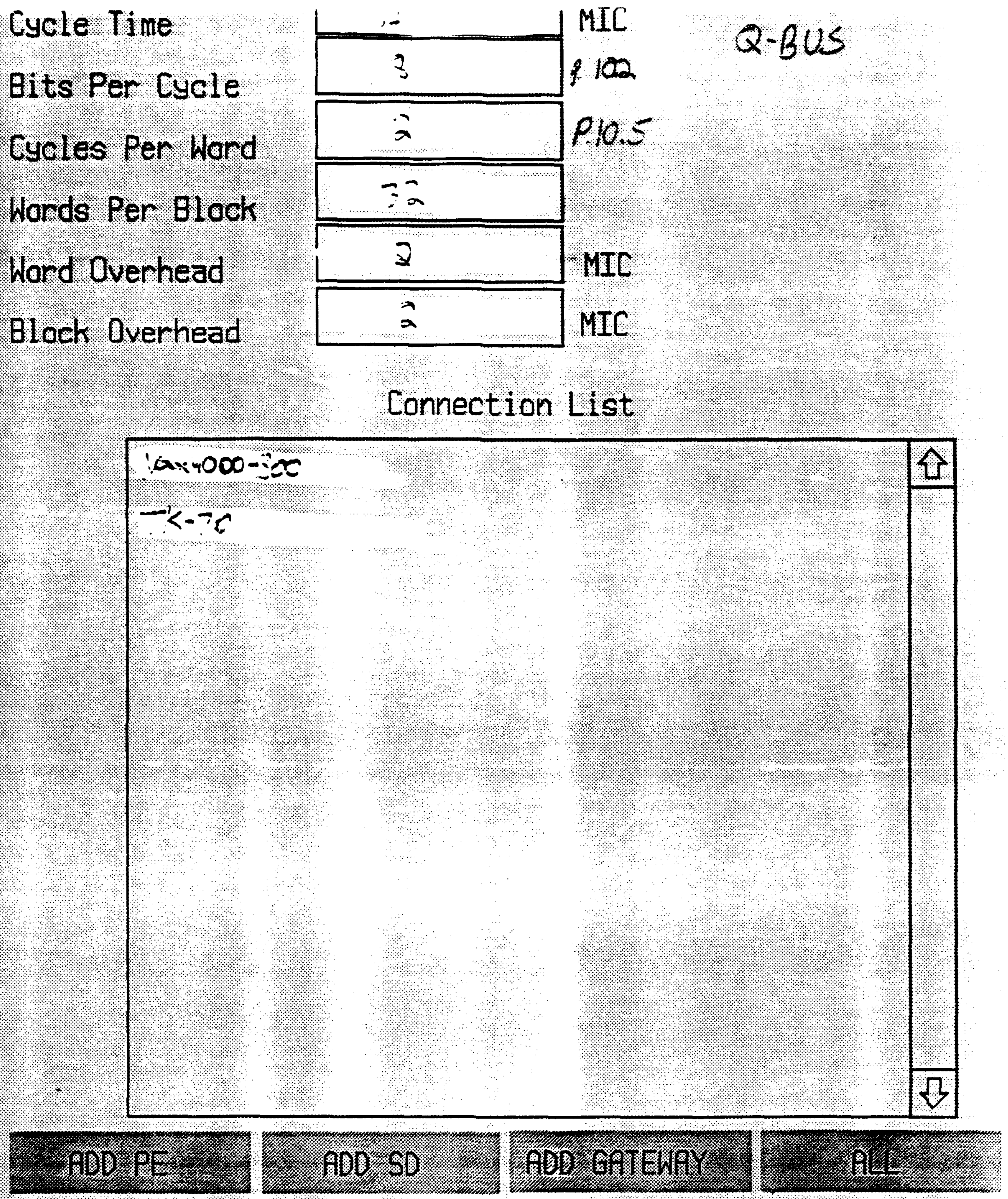
Cycle Time	103	MIC
Bits Per Cycle	8	
Cycles Per Word	2	
Words Per Block	1	
Word Overhead	2	MIC
Block Overhead	2	MIC

Connection List

VAX 4000-300

RF-72

ADD PE
ADD SD
ADD GATEWAY
ALL



Q-BUS

Cycle Time: [illegible] MIC

Bits Per Cycle: 3 P.102

Cycles Per Word: 2 P.10.5

Words Per Block: 32

Word Overhead: 2 MIC

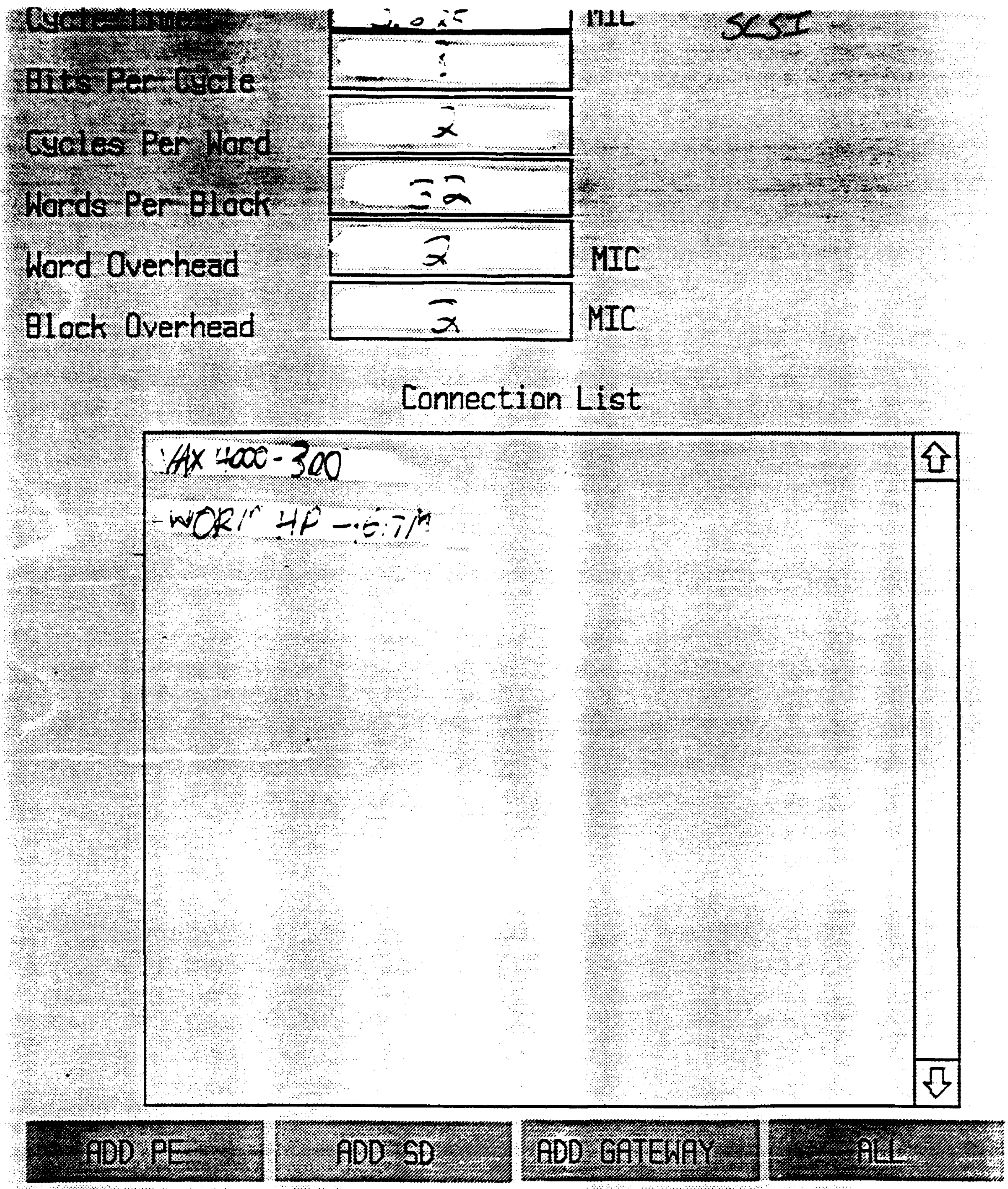
Block Overhead: 2 MIC

Connection List

Vax4000-300

TK-70

ADD PE
ADD SD
ADD GATEWAY
ALL



Cycle Time [illegible] MIC SCSI

Bits Per Cycle 1

Cycles Per Word 2

Words Per Block 32

Word Overhead 2 MIC

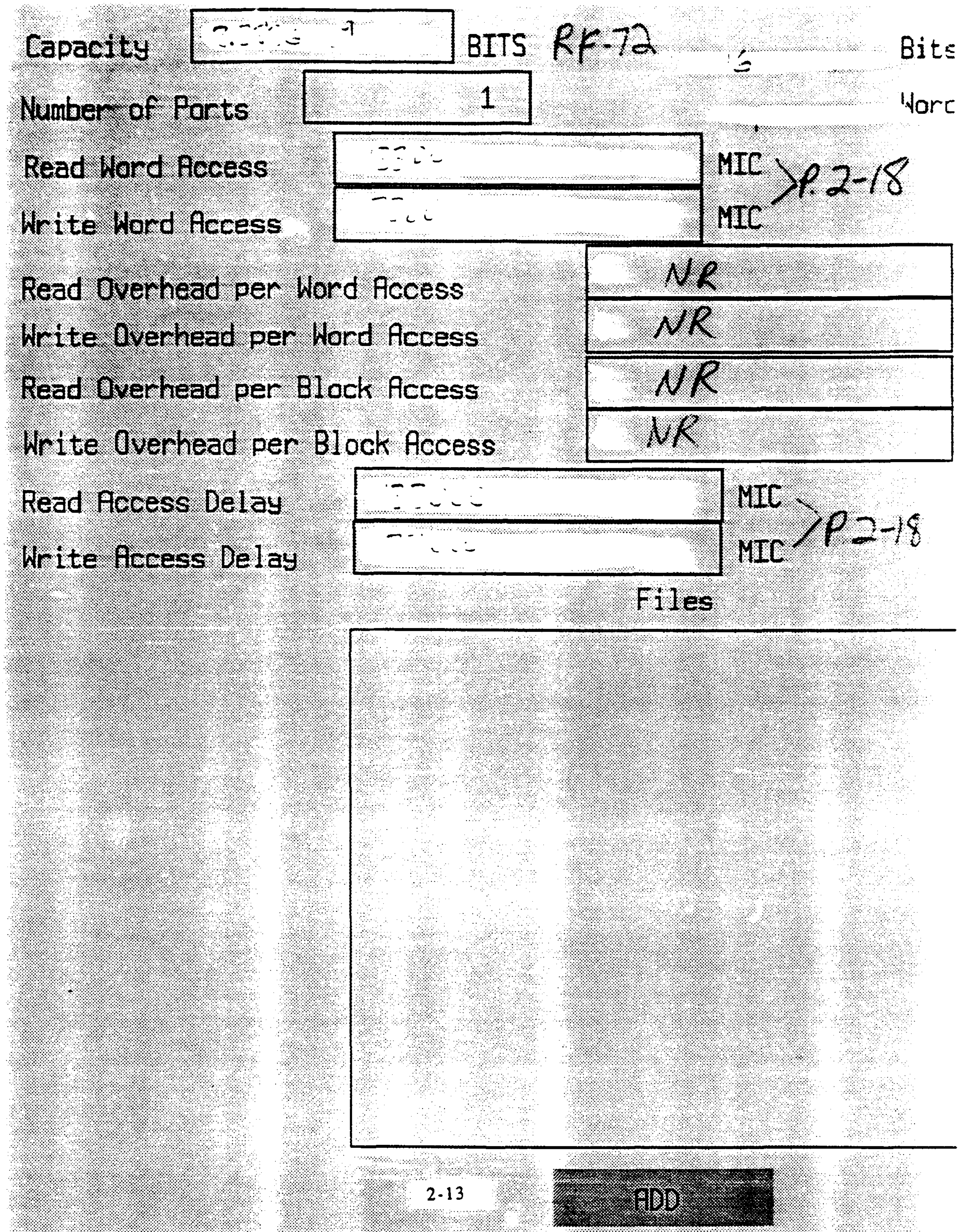
Block Overhead 2 MIC

Connection List

VAX 4000-300

WORK HP-6.7M

ADD PE
ADD SD
ADD GATEWAY
ALL



Capacity [illegible] BITS RF-72 Bits

Number of Ports 1 Word

Read Word Access [illegible] MIC

Write Word Access [illegible] MIC

p. 2-18

Read Overhead per Word Access NR

Write Overhead per Word Access NR

Read Overhead per Block Access NR

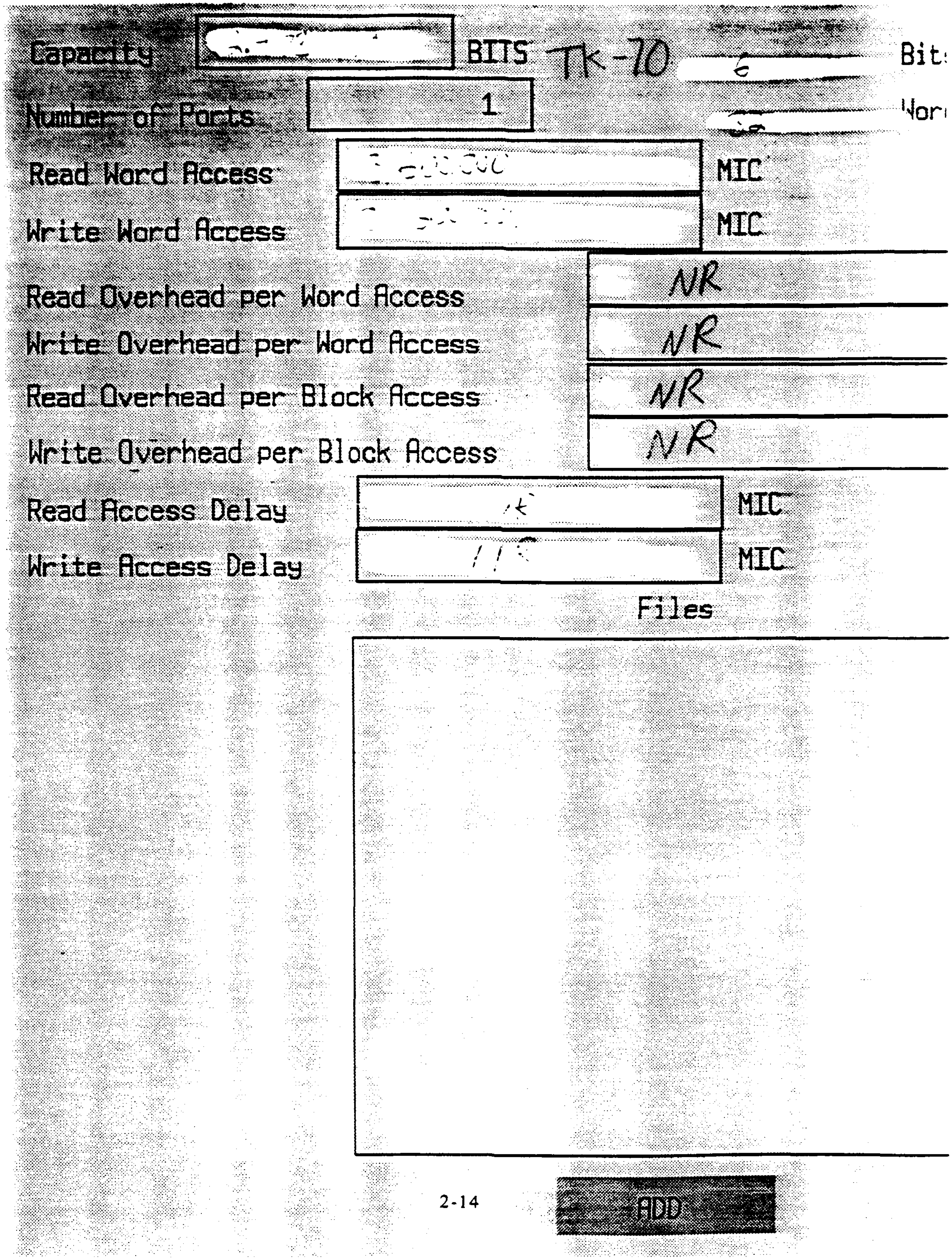
Write Overhead per Block Access NR

Read Access Delay [illegible] MIC

Write Access Delay [illegible] MIC

P2-18

Files



Capacity [illegible] BITS TK-70 6 Bit

Number of Ports 1 [illegible] Wor

Read Word Access [illegible] MIC

Write Word Access [illegible] MIC

Read Overhead per Word Access NR

Write Overhead per Word Access NR

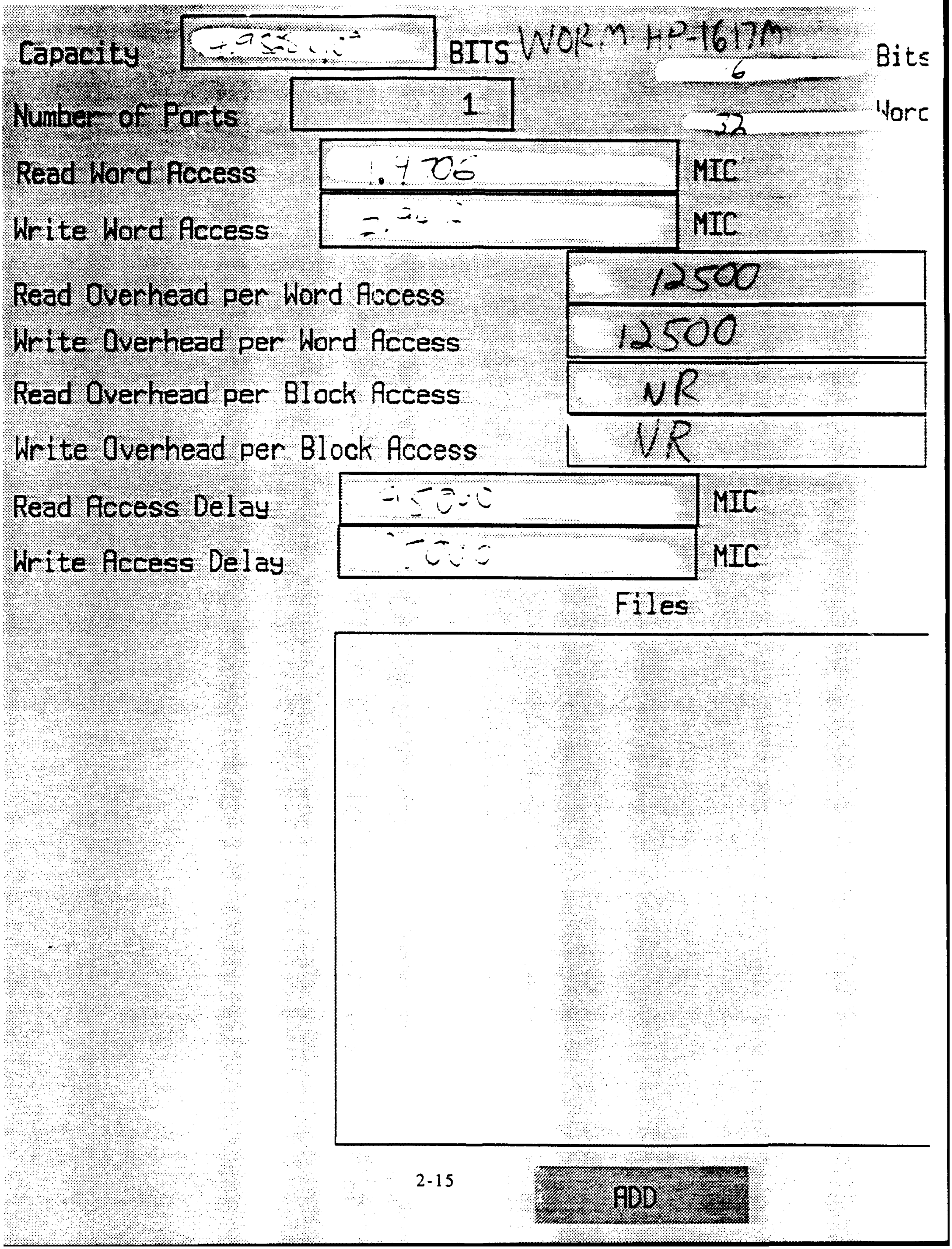
Read Overhead per Block Access NR

Write Overhead per Block Access NR

Read Access Delay [illegible] MIC

Write Access Delay [illegible] MIC

Files



Capacity [illegible] BITS WORM HP-1617M

Number of Ports 1

6 Bits

32 Worc

Read Word Access 1.4706 MIC

Write Word Access [illegible] MIC

Read Overhead per Word Access 12500

Write Overhead per Word Access 12500

Read Overhead per Block Access NR

Write Overhead per Block Access VR

Read Access Delay 45000 MIC

Write Access Delay 7000 MIC

THE INFLUENCE OF MODULATION ON SPECTRAL PURITY OF LASER EMISSION

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Laser Comm.

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Final Report for:
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Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
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August 1992

THE INFLUENCE OF MODULATION ON THE SPECTRAL PURITY OF LASER EMISSION

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Abstract

The influence of modulation on the spectral purity of the GaLa laser diode was studied. Optical spectra are classically measured using dispersive media such as prisms or diffraction gratings. These are characterized by dispersion and wavelength. For the measurement we make, we require dispersion sufficient to resolve slightly separated modulation sidebands about a carrier in the optical range. We made our measurements using three techniques. We used a prism, grating, and a pulsed spectrum laser analyzer to get our measurements. Experimental results indicate that when the laser is modulated the original peak decreases in height and widens out and sidebands are produced on both sides of the orginal peak.

THE INFLUENCE OF MODULATION ON THE SPECTRAL PURITY OF LASER EMISSION

Michele A. Bielby

INTRODUCTION

We studied of the influence of modulation on the spectral purity of the a GaAs/AlGaAs diode laser. The result was observation of sidebands when the laser was modulated. This is important because it is used for communication purposes. If a laser is modulated poorly the detector on the other end may interpret the message incorrectly. In communications you want a small light weight apparatus.

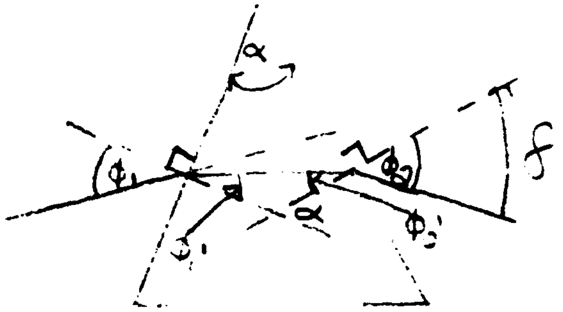
THEORY

A pulse-modulated carrier signal has sidebands located above and below the carrier center frequency with a distribution given by the expression (sinx)/x, where x is the frequency deviation from center. The location of the nulls in this expression is determined by the width of the pulse τ; nulls are located above and below center frequency by $1/\tau$.

Three experimental techniques for measuring this spread are:

1) Prism dispersion
2) Grating dispersion
3) Fabry-Perot Resonant cavity

PRISM



Snell's law

$\delta = \phi 1 - \phi 1' + \phi 2 - \phi 2'$

$(\sin \phi)/(\sin \phi 1)$

$= \phi 1 + \phi 2 - (\phi 1 + \phi 2)$

$= \phi 1 + \phi 2 - \alpha$

$\sin \phi 1 = n \sin \phi 1'$

$\sin \phi 2 = n \sin \phi 2'$

$\delta = \phi 1 + (\sin)^{-1}[n \sin (\phi - \phi 1')] - \alpha$

sincel $\sin \phi 2 = n \sin \phi 2'$

$= n (\sin (\alpha - \phi 1')$

then $\delta = \phi 1 + (\sin)^{-1}[(n^2 - \sin^2 \phi 1)^{1/2} \sin \alpha - \sin \phi 1 \cos \alpha] - \alpha$

but $n = \delta(\lambda)$

$\delta m = (n - 1)\alpha$ for small α x min deviation

therefore δm (red) $= (n \text{ red} - 1)\alpha = \delta r$

δ (blue) $= (n \text{ blue} - 1)\alpha = \delta\text{blue}$

and change in dispersion is $\delta r - \delta bl$

$= (nr - 1)\alpha - (nbl - 1)\alpha$

$= (nr - nbl)\alpha$

ex $= (1.523 - 1.515)\alpha$

$= (0.008)\alpha$

(angular dispersion $(\delta r - \delta b)$)/(wavelength diff.(λ(3000))) = specific disp.

eg. $r = 1$m

wavelength speraration = (20 GHz)

prism angle $\alpha = \pi/6$(30 degrees)

$z\phi(n) = (1n)(0.008/3000)(\pi/6)(20\text{GHz}) = 1.4\mu$

GRATING

The intensity scattered in direction θ is $I\theta = Io$. Maxima at $k\lambda = d \sin \theta$

eg. (10)3 lines/mm

$d = 1\mu$

at 1 meter $\sin \theta = (k\lambda)/d = \theta$

second order ($k = 2$)

$\lambda = 1$

$zd = r\theta = (1n)(2)(5000/1\mu) = 2((5000 \times 10\text{-}10)/1 \times 10\text{-}6)$

$= 1$

Resolving power $\theta 1$ = central max to first min Raleigh limit = $\theta 1$ (min angle of res.)

1) single slit 1st min @

$\alpha = (\pi a \sin \theta 1)/\lambda = \pi$

min $\theta 1 = \lambda/2d$

2) double slit $\beta = (\pi d \sin\theta)/\lambda = \pi/2$

min $\theta 1 = \lambda/2d$

3) prism resolving power λ/change $\lambda = \tau\,(dn/d\lambda)$

τ = base of prism (n) 3 x (10)4

eg. for 1 center prism λ/change λ – 300

4) grating resolving power λ/change $\lambda = kN$ 9N = # of elements

eg. 16000 line/in for 5" -> 160000

5) Fabry-Perot resolving power λ/change λ = -(k)/change k (k = order @ center)

-> = $(-k\pi)/(2(\sin)\text{-}1[0.367(1\text{-}r2)2/r2]1/2$

eg. r2 = 0.5 -> 142,000

r2 = 0.9 -> 985,500

PURPOSE

To determine experimentally the influence of modulation on the spectral purity of the GaLa laser diode.

EXPERIMENT

The experiment we performed involved using the cavity technique. The equipment involved using a GaLa laser diode, Burleigh pulsed laser spectrum analyzer (PLSA), Zenith computer, and a wavetek modulator.

The Burleigh PLSA was used to see the actual sidebands of the modulated laser. The PLSA has two etalons, Etalon A is wedged with its two flat surfaces inclined at a precise angle and Etalon B is fastened in a Fabry-Perot design, which are mirrors that are held fixed and adjusted for parallelism by screwing down on some sort of spacer (invar or quartz is commonly used). Etalon A is the coarse etalon and Etalon B is the fine etalon. The computer displays Etalons A and B in real time displays that are linear in frequency. Spectral measurements performed by the user are operationally identical for either etalon as the software keeps track of the differing algorithms for the two etalons. The PLSA software is based on peak finding algorithms. A peak is defined as the maximum found in a range between two signal crossings of a threshold level. The threshold level is adjustable by the operator. The operator can measure the wavelength, drift, shift, linewidth and halfwidth, integral, and ratio of the beam. The calculations are not dependant on the accuracy of the screen display or the cursor placement; they are always performed on the actual data from the CCD camera. The optical layout of the PLSA is found in Figures 1 and 2. When a collimated beam enters the PLSA through the 1.5 mm apertures it is split by reflection into two separate paths. Half of the beam enters Etalon A and the other half enter Etalon B. Before the beam enters the Etalons is passed through a variable attenuator and then through an alignment wedge. The purpose of the alignment wedge is to get a more precise measurement than just visually centering the beam on the apertures. The input attenuator is to simultaneously adjust the intensity of both etalon channels in order to keep the detectors from saturating. The variable attenuator is used to adjust the relative intensity between the A and B channels. The CCD linear array cameras record the intensity profiles transmitted by the etalons. There are two knobs on the back of the instrument labeled alignment, they control the voltages applied to piezoelectric beam steering elements in each of the two optical paths. These knobs allow for fine tuning to get the maximum signal for each Etalon separately.

In order for the Burleigh PLSA to work it had to be interfaced to the Zenith computer. To interface this the windows version 3.00 first had to be installed onto the computer. In order for the pulsed laser spectrum analyzer to run properly windows had to be programmed to run in standard mode. The PLSA software and simulation program, on floppy disk, also had to be installed on the computer. Before installing all of this the data acquisition card had to be installed in the computer programming unit To modulate the GaLa laser diode the wavetek modulator was used.

APPARATUS

The apparatus, shown in figure 3, was used to take measurements for the

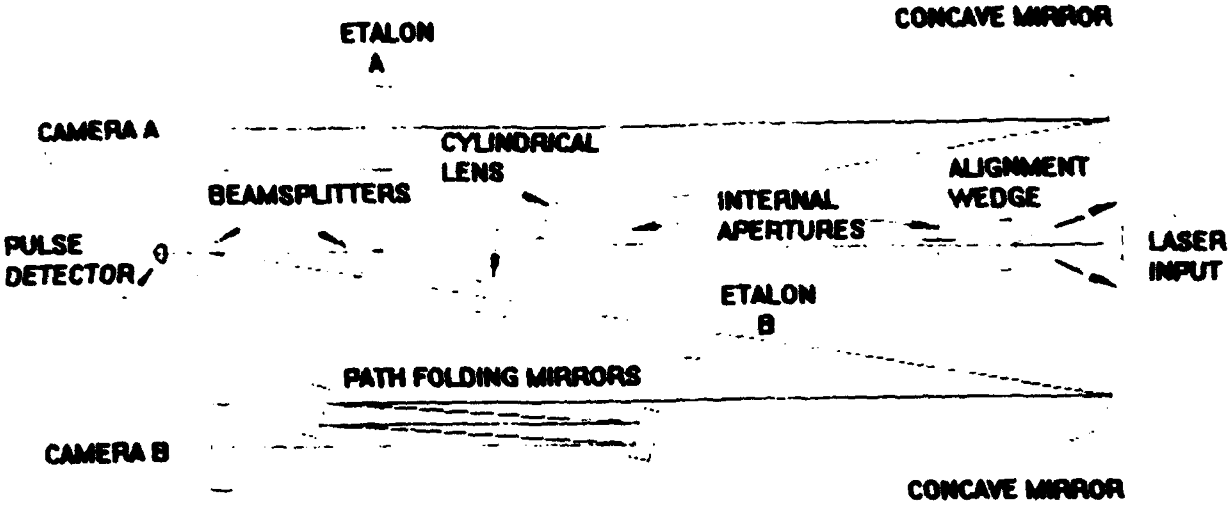

ETALON A
CONCAVE MIRROR
CAMERA A
CYLINDRICAL LENS
BEAMSPLITTERS
INTERNAL APERTURES
ALIGNMENT WEDGE
PULSE DETECTOR
LASER INPUT
ETALON B
PATH FOLDING MIRRORS
CAMERA B
CONCAVE MIRROR

Figure 1. PLSA-3600 optical layout schematic.

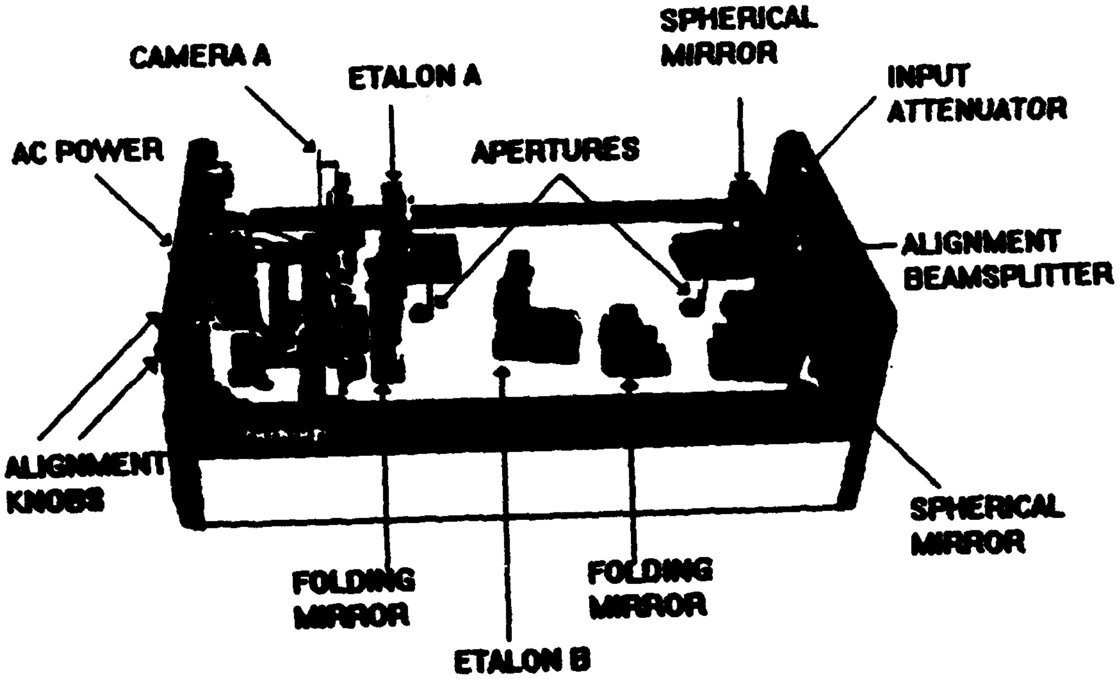

CAMERA A
ETALON A
SPHERICAL MIRROR
INPUT ATTENUATOR
AC POWER
APERTURES
ALIGNMENT BEAMSPLITTER
ALIGNMENT KNOBS
SPHERICAL MIRROR
FOLDING MIRROR
FOLDING MIRROR
ETALON B

Figure 2. PLSA-3600 instrument shown with the cover removed.

influence of modulation on the spectral purity of laser emission. The apparatus was constructed using a GaLa laser diode, mirror, filter, PLSA, computer, beam block, and a modulator. The mirror was used to help align the input beam into the PLSA. A filter was used, because the laser beam was to bright for the PLSA. If the filter was not used the laser beam could have damaged the etalons in the pulsed laser spectrum analyzer. The beam block was utilized to block the part of the beam that the filter reflected. The beam block serves two purposes; one is to block the beam from bouncing all around the room and the second purpose is to remind the person using the set up that there is a beam reflecting off of the filter in the direction that the block is setting. The PLSA was used to see the spectral purity. The modulator was used to modulate the laser. The computer was set up to run the PLSA. The computer monitor application was to view the modulation influence.

DATA

laser wavelength = 851 nm

laser linewidth = 6.6 34%

wavetek modulator - 20 ns period

location of sidebands = negative side of center amplitude

approximate size of sidebands = 25% of center amplitude

approximate reduction in center of amplitude = 5%

RESULTS

In order for the Burleigh PLSA to run correctly the laser beam had to be correctly aligned into the apperature. The GaLa laser diode had to be centered into the PLSA visually. Once the beam was visually aligned, to see if the beam

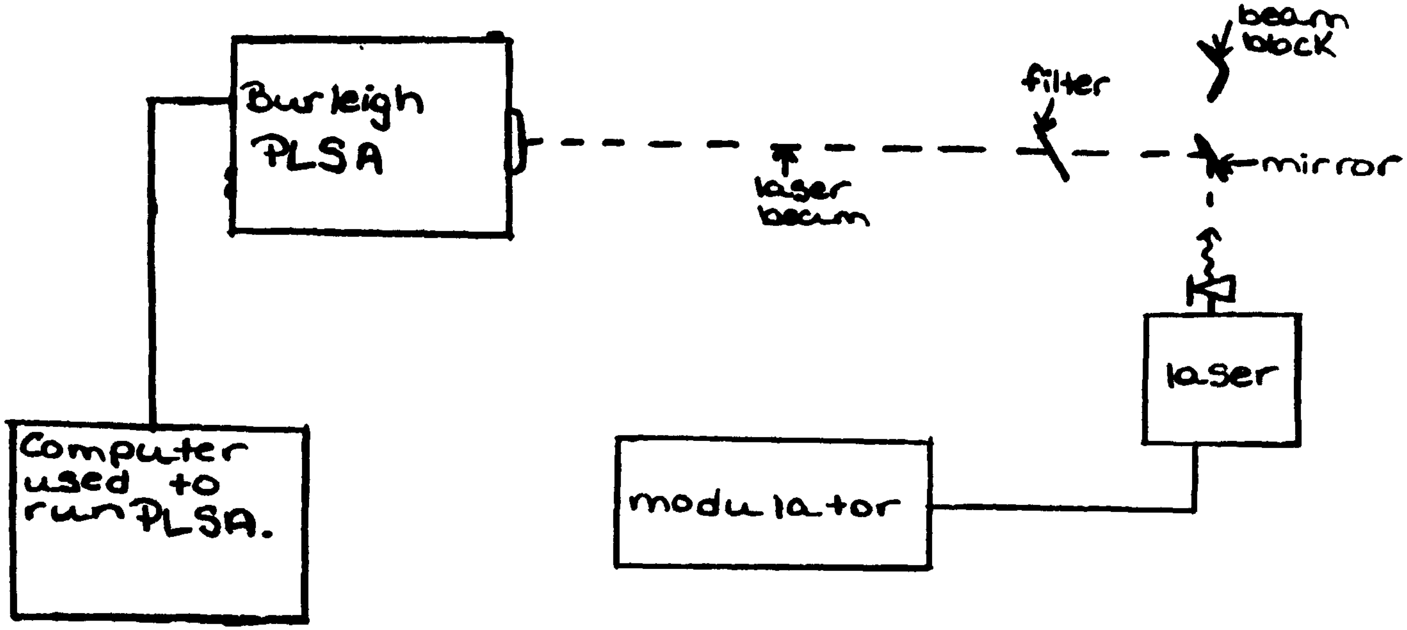

Burleigh PLSA
laser beam
filter
beam block
mirror
laser
Computer used to run PLSA.
modulator

figure 3

was correctly aligned part of the beam was reflected back towards the laser. To know if it was properly aligned there should be a reflection on both sides of the input beam, equal distances apart from one another and of equal height.

Before taking any measurements both etalons had to be calibrated. The calibrate mode is used to calibrate the pixel versus frequency scale of both etalons. It is also necessary to use this mode to align the PLSA with the laser diode. In this mode the threshold should be adjusted so that there is only one peak per free spectral range. This should be done for both etalons. Calibration shouldn't need to be done frequently, as long as the temperature of the environment doesn't change dramatically. This is because the calibration is quite stable as long as this doesn't change. Meaurements were taken from the measurement and options screen on the computer. This allowed us to measure the wavelength, drift, shift, linewidth, halfwidth, integral, and ratio of the input beam.

CONCLUSION

It was viewed that when the laser was modulated the original peak's height decrease slightly and sidebands appeared. The sidebands were shorter than the original peak. The center is always at frequency and the sidebands are (1/T, 2/T, 3/T, ...) one over the period (time the laser was turned on).

ANALYSIS OF F-16 SHIELDING EFFECTIVENESS

Michael Decker

Rome Laboratory

RL/ERPT
Griffiss AFB,NY 13441-5700

Final Report for:
High School Apprenticeship Program
Rome Laboratory

Sponsored by:
Research & Development Laboratory
5800 Uplander Way
Culver City, CA 90230-6608

August 1992

ANALYSIS OF F-16 SHIELDING EFFECTIVENESS

Michael Decker

ABSTRACT

The objective of this research project was to evaluate electromagnetic (EM) shielding effectiveness characteristics for two different F-16 aircraft, determine their maximum and minimum shielding effectiveness levels and establish a relationship between them. These Shielding Effectiveness measurements were performed on two F-16 aircraft during a previous Rome Laboratory research program, at the Newport Research Facility. The first aircraft was a F-16 empty shell which did not include any avionics equipment or wiring harnesses. The second aircraft was an operational F-16 ground test bed which was configured as close as practical to an operational F-16 Block 30. This aircraft included avionics equipment and wiring harnesses. These aircraft were instrumented with B-dot field probes to measure the EM field levels inside the equipment bays of both aircraft. These measurements were performed with the aircraft mounted on a 32 foot tower while the aircraft was rotated through a variety of azimuth and elevation angles.

ANALYSIS OF F-16 SHIELDING EFFECTIVENESS

Michael Decker

INTRODUCTION

Electromagnetic shielding effectiveness measurements were performed at Rome Laboratory's Newport Research Facility. This facility consists of several outdoor RF pattern measurements ranges with three-axis positioners capable of supporting a full sized aircraft. The location selected for these measurements was the site-x measurement range with a separation of 1840 feet between the transmit and receive sites. The transmit site consisted of various parabolic reflector antennas, cw signal sources and power amplifiers to cover the specified frequency range. The receive site consists of a 32 foot tower and three-axis positioner which is remotely controlled from the transmit site. Electromagnetic coupling measurements were performed on two different F-16 aircraft. The first aircraft was an empty shell which lacked all avionics equipment and wiring harnesses. The second aircraft was an operational F-16 ground testbed constructed of crashed damaged assets. This airframe was configured as close as practical to an operational F-16 Block 30 configuration including avionics equipment and wiring harnesses. Both aircraft were instrumented with B-dot field probes to measure the EM field levels inside the equipment bays. Figure 1 shows the locations of the equipment bays that contained the B-dot probes. These measurements were performed with the aircraft mounted on a 32 foot tower while the aircraft was rotated over a variety of azimuth and elevation angles. This data was used to compare the shielding effectiveness of the F-16 ground testbed and the F-16 empty shell for a variety of aircraft configurations, and determine if the F-16 shell could be used to accurately represent an operational F-16 aircraft during EM shielding effectiveness experiments.[1]

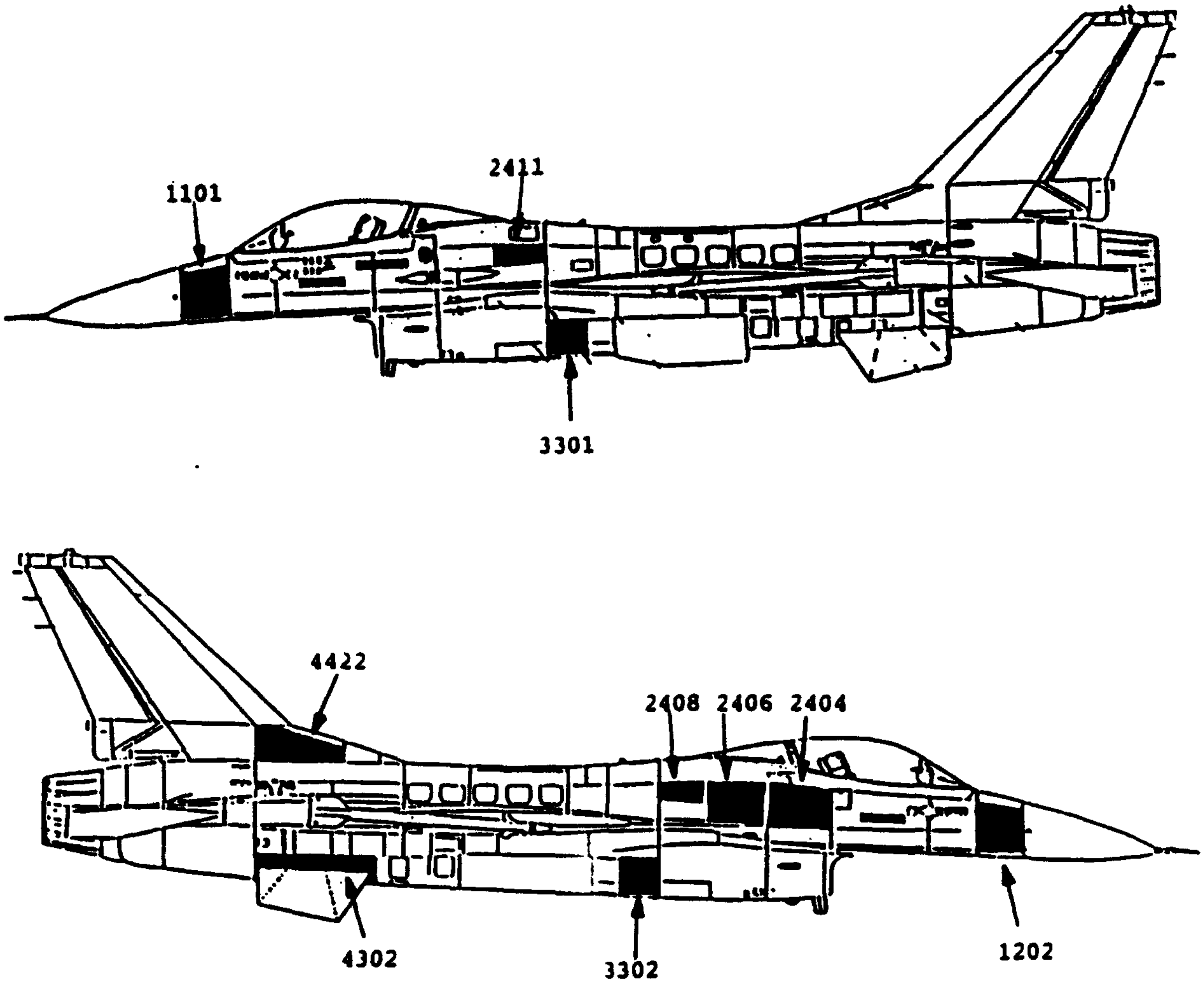


FIGURE 1 LOCATION OF EQUIPMENT BAYS WITH B-DOT PROBES

ANALYSIS PROCEDURE

The EM Shielding Effectiveness data was measured using both horizontal and vertical transmit polarizations, five aircraft elevations (0,+/- 15, +/- 30 degrees) and sixteen azimuth angles (o,+/-15, +/-30, +/-45, +/-60, +/-90, +/-120, +/-150, 180 degrees) were used. The data was reviewed to ensure it was complete and accurate. Once the review was complete the data was processed with the GRAFTOOL[2] analysis program. GRAFTOOL is a two and three dimensional graphics program which has integrated processing suitable for computer-aided analysis. It is also completely menu driven with an on-screen data interface for viewing and processing data on a graph. The data was processed to determine the maximum and minimum shielding effectiveness levels for a variety of aircraft configurations. This data was used to establish the relationship between the F-16 ground testbed and the F-16 empty shell. GRAFTOOL's built-in smoothing function was used to reduce the mode structure of the equipment bays. This allowed the data to be compared more accurately. The smoothing process on GRAFTOOL made it possible to identify the shielding effectiveness trends in the data. The majority of the analysis consisted of X-Y plots of vertical polarization with the same elevation and azimuth angles.

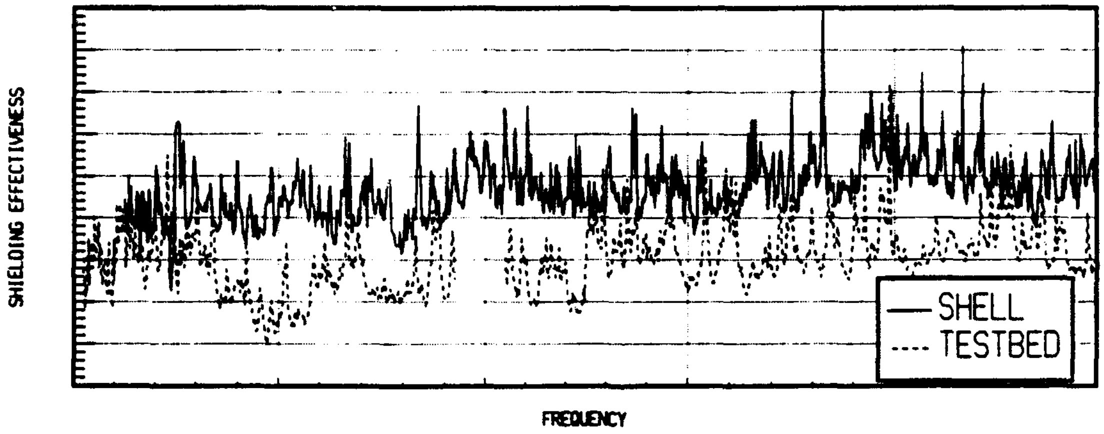


FIGURE 2 SHIELDING EFFECTIVENESS DATA FOR EQUIPMENT BAY 1101

Figure 2 shows the F-16 testbed and empty shell EM shielding effectiveness data in equipment bay 1101 for the zero azimuth and zero elevation configuration. The gap in the F-16 testbed data was due to a transmitting frequency restriction during the test program. Figure 3 shows similar shielding effectiveness data in equipment bay 2406 for zero azimuth and zero elevation angles.

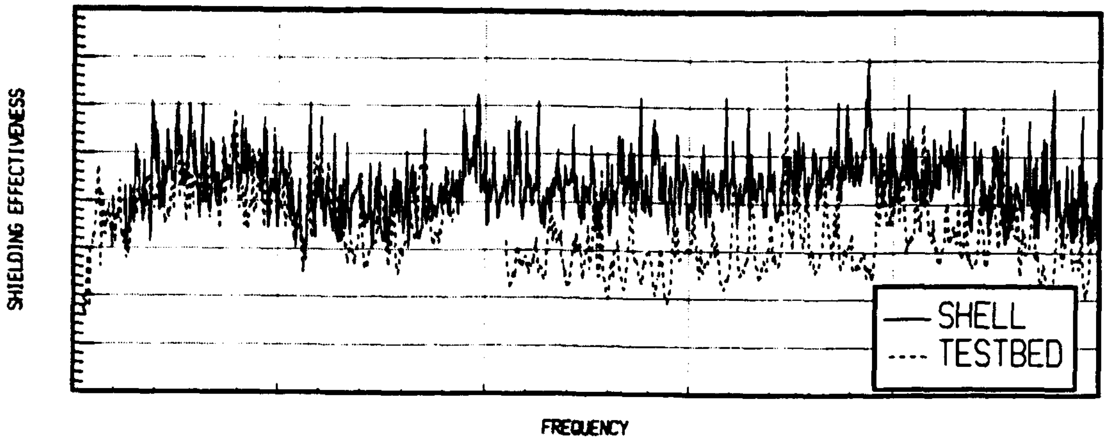


FIGURE 3 SHIELDING EFFECTIVENESS DATA FOR EQUIPMENT BAY 2406

CONCLUSIONS

The shielding effectiveness data were compared to identify any similarities, differences or trends between the F-16 ground testbed and the F-16 empty shell. There were twelve aircraft configurations which were used to compare the shell and testbed data, they included azimuth angles of 0, 45, 90, 180 degrees and elevation angles of 0, +30, -30 degrees. The data was smoothed to compare the results more easily for a given aircraft configuration. In most cases, the data compared very well, however the F-16 empty shell usually had a higher shielding effectiveness than the F-16 ground testbed. The testbed equipment bays were densely packed with avionics equipment and wiring harnesses while the equipment bays in the shell were empty. Therefore, the energy in the shell could propagate to other equipment bays and distribute itself over a larger space. This may result in less energy being measured by a given B-dot probe and would result in higher measured shielding effectiveness values for the shell. It was also observed that the shell data was packed together more tightly (more peaks and valleys) than the testbed data. This could be due to the absorption of energy by the avionics equipment in the testbed, while the shell had a larger volume for the energy to bounce around.

REFERENCES

[1] - Thomas Freeland, EME F-16 Measurement Low Power Coupling Program Test Report, RL/ERP-92-017, March 1992

[2] - GRAFTOOL user guide, 3-D VISIONS

THE TESTING OF VARIOUS OPTICAL LOGIC DEVICES

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Stuart Libby
Michael Parker

Final Report for:
AFOSR Summer Research Program
Rome Laboratory

Sponsored by:
Griffiss Air Force Base

August 1992

THE TESTING OF VARIOUS OPTICAL LOGIC DEVICES

Andrew Gerrard
Stuart Libby
Michael Parker

Abstract

This paper deals with the testing of Broad-Area Laser Memory elements and Surface-Emitting Laser Logic units, both of which will eventually be used in an optical processor. The devices were driven with direct current in a controlled environment in order to initiate lasing within the device, and therefore give off a measurable luminescence. The tests involved measuring response to varying voltages and currents, obtaining L-I and I-V characteristics, and characterizing the intensity vs. facet position. Equipment was controlled via the Asyst and Viewdac GPIB programs, both of which played an important role in the collection of data.

THE TESTING OF VARIOUS OPTICAL LOGIC DEVICES

Andrew Gerrard
Stuart Libby
Michael Parker

Introduction

For the past five years, research into optical devices has increased at a dramatic rate. With the combined ability to provide both accuracy and efficiency, optical units provide the stability needed in an ever more increasing technological society. As such, these devices will make the dreams of yesterday become the realities of tomorrow.

One such dream is the evolution of the electric processor to that of the optical processor, an idea never thought of ten years ago. However, with the increased research and fabrication into optical logic devices, the technology now exists that such an idea could soon become a reality. The devices exist, yet the problem now is that their capabilities and limitations are still unknown. As such, this paper deals with the testing of a number of devices that will eventually make their way into the theorized optical processor.

Equipment

In the experiment, two different types of devices were tested. The first type of device was Broad-Area Laser Memory elements that were fabricated at Cornell University in Ithaca, New York. There were two types of the memory elements: the gain-guided array and the uniformly pumped(Fig A.). The devices worked on the principal of representing a binary digit depending on the direction that it lased. If it lased horizontally, it would represent the digit 0, while if it lased vertically, it would represent the digit 1. The cause for the lasing would be due to current applied to specific pads on the device itself, and would therefore be easily controlled by the device. These would be the units that would eventually be put into arrays to form logical operations.

The second type of device was the Surface-Emitting Laser Logic (CELL) device fabricated by Photonics Research, Inc. This unit had a combined photo transistor on one side and a vertical cavity laser on the other (Fig B.). When the correct wavelength range was applied to the photo transistor, the cavity laser would lase and put out a set emission. Due to the ability of the photo transistor to accept a varying range of wavelengths, heating of the input laser (and the resulting shift in wavelength) would not affect the output wavelength of the vertical cavity laser. This aspect of the CELL device reduces heating problems faced in todays optical logic units.

Fig A.

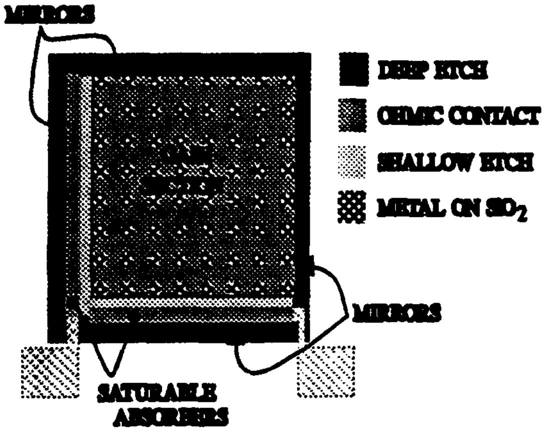
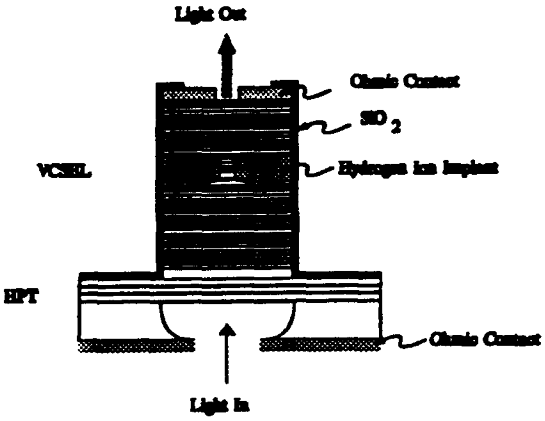

MIRRORS
DEEP ETCH
OHMIC CONTACT
SHALLOW ETCH
METAL ON SiO2
MIRRORS
SATURABLE ABSORBERS

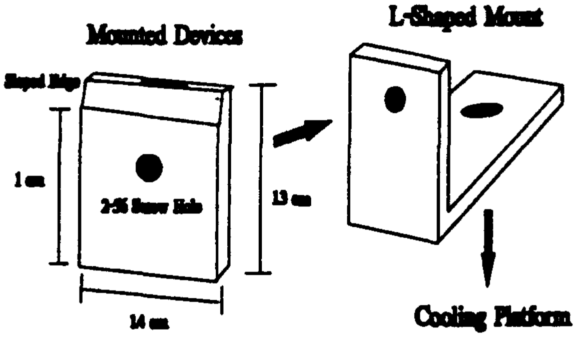
Fig B.


Light Out
Ohmic Contact
SiO2
VCSEL
Hydrogen Ion Implant
HPT
Ohmic Contact
Light In

Setup

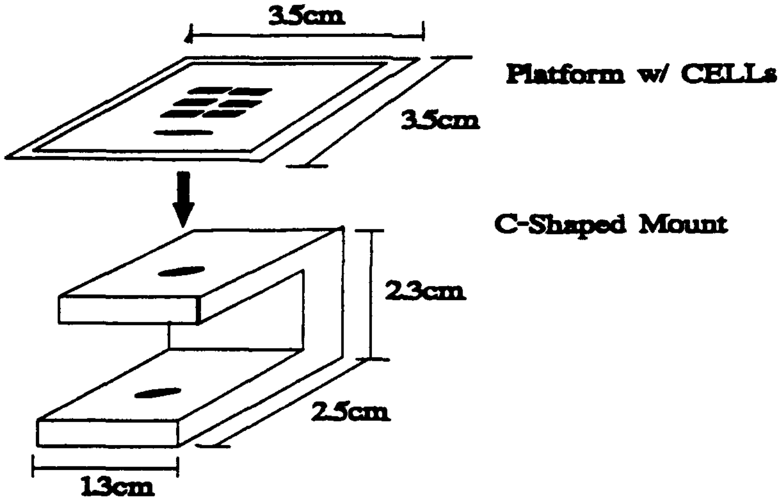
The layout and setup of the testing was fairly simple, though somewhat different depending on the device. The memory elements came together on a large array with other optical devices, and therefore had to be cleaved off. At a given time, about four to six devices were taken for testing. They were then mounted on a sloped copper mount (Fig C.) with silver epoxy. The mount was sloped in order to allow access for an optical fiber to be placed near the devices. The sloped mount was then attached to the L-shaped mount and placed on the cooled testing platform.

Fig C.


Mounted Devices
Sloped Edge
1 cm
2-56 Screw Hole
13 cm
14 cm
L-Shaped Mount
Cooling Platform

The CELL devices came on a thin square platform that had to be screwed onto the C-shaped mount (Fig. D). The platform was open on both the back and front, allowing access to the photo transistor and laser output.

Fig D.


3.5cm
Platform w/ CELLs
3.5cm
C-Shaped Mount
2.3cm
2.5cm
1.3cm

All told, copper mounts measured no more than 5cm cubed, and each had one or two 2-56 sized screw holes. There also were a number of other different shaped mounts, but their usefulness was rather limited. All mounts were attached to a cooling platform and were cooled throughout testing in order to prevent heating fluctuations. Electric probes were set on XYZ stages and placed on the devices to supply electric current. A microscope and light source were placed overhead in order to get a better view of the working area and to not cause damage to the devices when the probes were placed on the contact pads. More room was left open to allow an optical fiber and/or power meter to be placed near the devices, to be used when needed.

An HP 54111D Oscilloscope, Anritsu MS9701B Spectrum Analyzer, Tektronix 576 Curve Tracer, HP 8116A Pulse/Function Generator, IBM 386 16MHz personal computer with both Asyst and Viewdac programs, and other equipment were connected via GPIB and/or BNC cables on an equipment rack nearby. All equipment was grounded and held stable to a floating bench. During testing, all external light was switched off in order to prevent external luminescence from interfering with collected data.

Experiment

The testing was a straight forward process. First, the devices (on their mounts) were placed on the cooling platform and allowed to cool for thirty plus minutes. The probes, supplying the current, were then placed on the devices by use of the microscope and a curve tracer. Great care had to be taken during this procedure, as a slip of one of the probes could scratch and ruin a device. After being properly placed, a number of different test were initiated, again depending on the type of device.

For the memory elements, two main tests were done on both the gain-guided arrayed and uniformly pumped devices. The first test involved using the optical fiber to collect the optical spectrum when varying voltage biases were applied to the saturable absorbers (SA1 and SA2). The devices were driven at 200mA and 150mA, as well as when no voltages were applied and the current varied. These tests would involve placing the fiber very close to the devices, the reason for the sloped mount. The second test was to collect the spectrum at different positions along the device's facet. Again, this involved moving an optical fiber along the device's facet in quarter steps and taking a spectrum reading. All data was taken by Asyst from the spectrum analyzer.

For the CELL devices, testing primarily involved finding out if they worked, to what extent, and what kind of I-V and L-I curves could be taken from them. To do the curves, the Viewdac program, connected with a Kiethley 238 Source Measure Unit (SMU) and Newport 835 Optical Power Meter was used. This step involved writing a number of programs that would allow the SMU to output a current and then trigger the optical power meter to read and save the emitted power. The output current was sent out to be a pulsed linear stair, so as to allow the devices to not be affected by heating. The ultimate goal was to get the fastest pulses possible, and get the set reading while the current was supplied. However, Viewdac, along with the GPIB bus, was found to be too slow to read the power meter in such a short period of time. Therefore, an Asyst program had to be used in place of Viewdac. After this report, other tests continued on the CELL devices.

Results

The data that was collected shows a great deal about the properties of both the memory elements and the CELL devices. For the memory elements, Fig E. shows the shifts in wavelengths when the different voltages are applied on the two saturable absorbers. The loss of lasing is very apparent when voltage is applied to SA2, as are the shifts in wavelengths on SA1. This shows how lasing in the memory elements are affected by altering voltages on the two saturable absorbers.

Fig E: Waveguide Memory @150mA

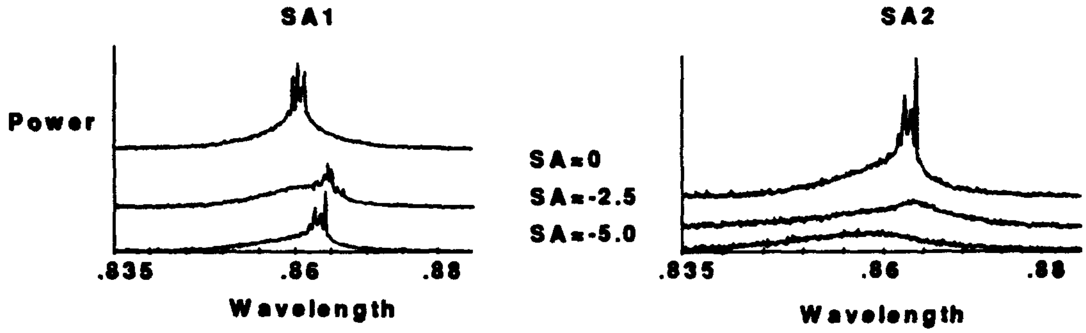
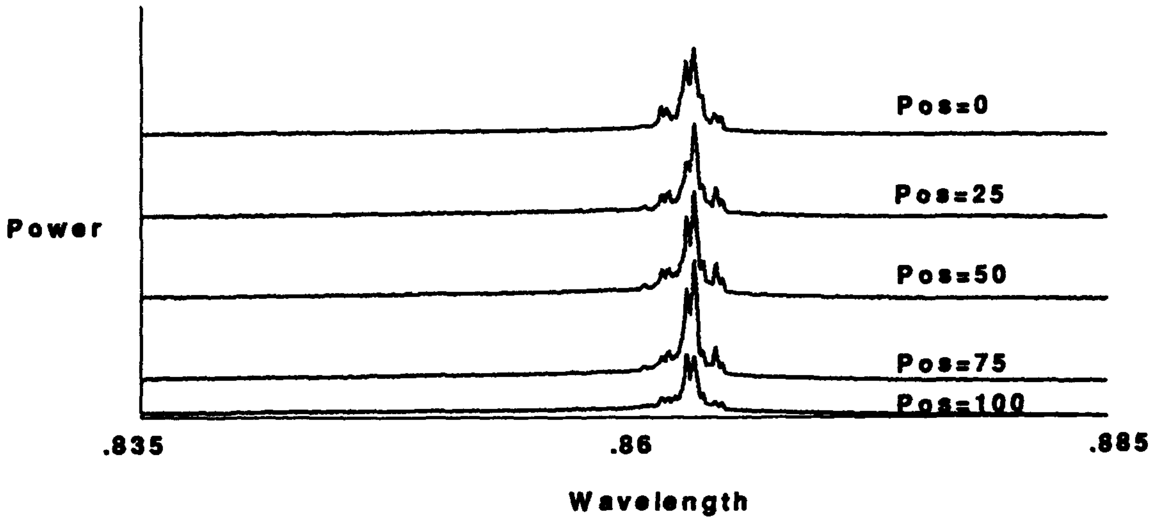


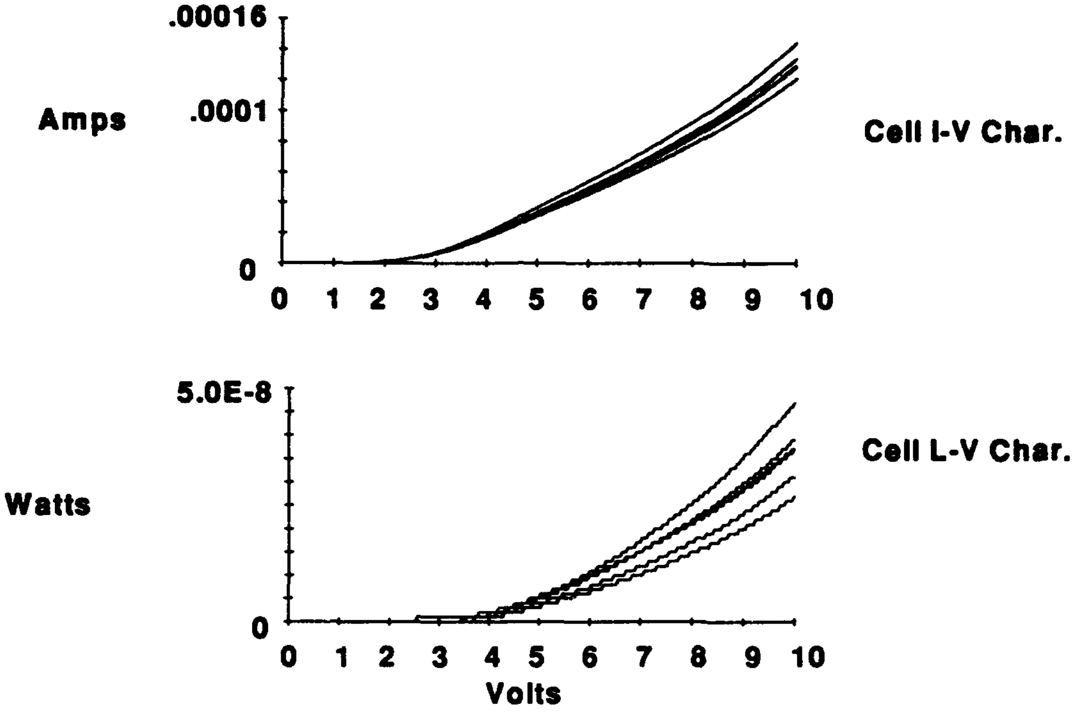
Fig F. shows the changes in the spectrum when the optical fiber is moved across the gain-guided device's facet. The fiber starts on the edge at 0 and goes to a full 100% across, with readings being every quarter. There is very little change in the spectrum, demonstrating that the output is constant along the edge.

Fig F: Spectrum vs. Fiber Position at 200mA



For the CELL devices, Fig G shows the collected I-V and L-V data. These graphs are the expected curves that were originally hoped for, and show that the devices are working in their normal context. However, at the time of writing this paper, not much had been done with the photo transistors, and work continues on their other properties.

Fig G: CELL Char.



Conclusions

The data that was taken in the testing fit the predicted expectations. The I-V and L-V curves were standard for the devices, but now they are known to a more precise degree. The spectrum curves for the memory elements also concluded with hypothesized results.

As a whole, the testing went along relatively smoothly, if somewhat slow. The main problems that were encountered had to deal with limited space within the lab, and well as other minor mechanical and electrical problems. The biggest problem was the "trial and error" method that had to be used with Viewdac. Although the program is defiantly easier to learn and use than any other GPIB program, it too has it's flaws. These problems, coupled with the very slow speed of the

GPIB Bus, made for quite a delay in the overall testing procedure. However, by switching between the Viewdac and Asyst programs, and learning to cope with the speed problems, the data that was collected was both accurate and complete. The testing was defiantly a success.

With this part of the testing of devices finished, it is time to move on to other parts of the theorized optical processor. Now that the properties of these components are known, they can be implemented in further experiments, or to undergo even more testing. If found suitable, they will be massed in great arrays, to ultimately form logic units with the computing power greater than several of today's electric processors.

Appendix

Viewdac Notes:

Throughout the testing procedures, the Viewdac program was extensively used to operate the equipment and to collect data. The program bridges the wide gap of the GPIB interface and gives the programmer a user-friendly, "Windows" approach to operation. It is because of the ease in learning Viewdac that we could write any program on a moments notice and use it immediately. Once learned (in about an hour), Viewdac use becomes quite amazing.

Other than it's ease of learning and usage, Viewdac supports a number of top-notch qualities. Among them are:

- The ability to multi-task
- Open, easy-to-use data lists
- Easy, structured programming style
- Graphics displays and graphs
- ASCII usage

However, even with the best of programs, there are apparent faults in Viewdac. Although these are minor, they can become a problem if not realized. Among them are:

- Inability to use two dimensional arrays
- Inability to cut and paste from one sequence to another
- Non-removal of variables within a program, even after closure
- Slowness
- DOS file management

In all, these faults are made up in ability. The next version of Viewdac is sure to patch these problems, as well as speed up operation. The program is better prepared for those who dislike GPIB programming, as well as for those who are tired of large, complicated programming languages. Viewdac is simple to learn and use, a plus in any GPIB programming.

Understanding C
and UNIX Networks

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Final Report for:
High School Apprenticeship Program
Research and Development Laboratories

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, Washington, D.C.

August 1992

Understanding C
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Abstract

This year's study focused on the theory of the C programming language under SunOS 4.1.1, in comparison with the accepted ANSI C standard. Additional study of the operation of UNIX, as well as in communicating with foreign hosts and in the understanding of USENET style domain names, was made. Many compatibility issues had to be resolved in order to transfer source code from books on the subject of C to an executable form on the Sun. Among these were function prototype reformatting, extraneous variable elimination, voided function location, location of libraries and include files, structure declarations, and memory allocation code portability. All problems except the last two were resolved to satisfaction.

Understanding C
and UNIX Networks

Todd C. Gleason

INTRODUCTION

There was no single aspect for me to study at the expense of gleaning other valuable information. I worked not only with C, but with many programs under the UNIX operating system, learning about programming skills in addition to gaining an insight into the operation of networks.

My discovery was that the SunOS version of C is not fully compatible with the generally accepted ANSI C standard; there are some differences, both trivial as well as fundamental, in the constructs used to achieve the same desired effect. Thus, even with many books on C, there was major difficulty in tracking down the cause of compiler failures. In writing my own programs, I of course found that many of the mistakes were my own, but as many were simply compatibility conflicts. These included primarily function prototype declaration, use of extended types for calling functions and for function return types, and pointer type inconsistencies.

An effort was also made to learn the X Window System and how to program for it. However, due to various reasons, programs would not compile. This led to an inability to use X Windows programs for quite some time, until the proper method to compile programs including X libraries was found. Because of the huge directory structure as well as inexperience with the compiler, very little was accomplished in this area.

On the other hand, networking is another useful facet of computing to understand. I learned a great deal with regard to the interactions between computers by exploring ways to communicate between local and remote machines. This will no doubt be invaluable to me in the future.

DISCUSSION OF PROBLEM

With computers becoming more and more complicated every day, there have to be people competent enough to perform a large-scale variety of tasks on a variety of platforms. These tasks may range from routine file management to data integrity, and from using existing applications to programming new ones. There are a myriad skills to be learned by one who goes into a field of work related to computers.

One large problem I encountered in programming was an inconsistency between a program listing in a book and what actually would compile on the Sun 4 SparcServer. It took a great deal of time to painstakingly search through books to find what the stylistic demands of the Sun's compiler were, and more to trudge back through each program, editing in such a manner as to suit the Sun's C compiler.

One major inconsistency was in the location of functions returning void types. In such situations, the C compiler for the Sun required that they be above the main program. This would seem to suggest that the Sun's compiler requires coding structured similarly to Pascal. One example of a program that did not originally work because of this principle follows.

```
/* Linear Sort Program
 * June 23, 1992
 * by Todd Gleason
 */

#include <stdio.h>
#define listsize 8

main()
{
  struct LISTTYP {
    int num [listsize];
    int temp;
  };
  struct LISTTYP list;
  int goodval, i, number;
  printf ("\n");
  for (i = 0; i < listsize; i++) {
    do {
      goodval = 0;
      printf ("%d:  ", (i + 1));
      if (1 == scanf ("%d", &number) ) {
        /* number read successfully */
        list.num[i] = number;
        goodval = 1;
      }
    }  while (goodval = 0);
  }
  sort (list);
}

  /* Insertion Sort */
  sort (list)
  struct {
    int num[listsize];
    int temp;
  } list;
{
  int lo = 0, hi = (listsize - 1), min, minpos, i, j, k, l;
  /* Outer loop (previously moved cells are successively hidden) */
  for (i = lo; i < hi; i++) {
    /* Initialize values of min and minpos */
    min = list.num[i];
    minpos = i;
    /* Inner loop (searches for smallest value) */
    for (j = i; j <= (hi); j++) {
      if (list.num[j] < min) {
        min = list.num[j];
        minpos = j;
      }
    }
    /* Now move cell to correct position */
    if (minpos > i) {
      /* Copy cell w/ value to be moved */
      list.temp = list.num[minpos];
      /* Cascade-copy cells to upper positions */
      for (k = minpos; k > i; k--) {
        list.num[k] = list.num[k - 1];
      }
      /* Copy original cell into its final place */
      list.num[i] = list.temp;
    }
  }
  /* Final output messages */
  for (l = 0; l < (hi + 1); l++)
    printf ("\n%d:  %d", (l + 1), list.num[l]);
    /* Test code:
     * printf ("\nMin is %d", min);
     * getchar ();
     */
}
```

Notice that the sort function is not preceded by any type declaration. This will compile on the Sun because the function defaults to the int type, which is allowed free placement. Originally, the function was coded in the void type, and many hours were spent on this trivial problem, as no books nor the Sun manuals revealed the answer. For the void to be returned to the function (it can be int type without any hazardous side effects), the sort function must be physically moved above the main. The reasoning behind this is unclear, as it only seemed to be a factor in void functions.

Following is another program which refused to compile. This program, unlike the first, came directly from a book on programming in C. Still, the Sun was unable to compile it.

```
/* Example program to show incompatibilities with ANSI C standard vs.
 * C on the Sun SparcStation 4
 * Taken from From C to C: An Introduction to ANSI Standard C
 * pp. 143-4
 */

#include <stdio.h>
#include <stdlib.h>
#define SIZE 15
extern void initit(int *,int);

int main(void)
{
  int i, x[SIZE];
  initit(&x[0],SIZE);
  for (i = 0; i < SIZE; i++)
    printf("%d ",x[i]);
  printf("\n");
  return EXIT_SUCCESS;
}

void initit(int *array, int length)
{
  for ( ; length > 0; length--) {
    *array = length;
    array++;
  }
}
```

To be more scientific, a breakdown of errors is given for this program. Upon an attempt to compile, this was the initial error list from the compiler:

```
"errors1.c", line 10: syntax error at or near type word "int"
"errors1.c", line 12: syntax error at or near type word "void"
"errors1.c", line 19: EXIT_SUCCESS undefined
"errors1.c", line 22: syntax error at or near type word "int"
"errors1.c", line 24: length undefined
"errors1.c", line 25: array undefined
```

To get this program to work took many hours of painstaking research into obscure manuals to find the Sun's conventions. Upon finishing, I learned that function prototypes are different (and in many cases, how they differ) in Sun C from ANSI C. In addition, many of the specialized variables and types referenced in books are not included in Sun C. Following is a commented version of the same program, this time edited to compile without a hitch.

```
/* Example program to show incompatibilities with ANSI C standard vs.
 * C on the SUN SparcStation 4
 * Taken from From C to C:  An Introduction to ANSI Standard C
 * pp. 143-4
 */

#include <stdio.h>
#include <stdlib.h>
#define SIZE 15
/* extern void initit(int *,int);
 * Removed for compatibility; the Sun cannot handle this form of
 * declaration.
 */

/* Voided functions must be moved above the main or put into external
 * files.
 */
void initit(array, length)
int *array, length;
/* Note the changed function declaration.  Sun C does not permit the
newer
 * form.
 */
{
  for ( ; length > 0; length--) {
    *array = length;
    array++;
  }
}

main()
void;
/* Other styles such as
 * int main(void)
 * will not work without being rewritten.
 */
{
  int i, x[SIZE];
  initit(&x[0],SIZE);
  for (i = 0; i < SIZE; i++)
    printf("%d ",x[i]);
  printf("\n");
  /* return EXIT_SUCCESS;
```

```
   * Removed for compatibility; the Sun has no EXIT_SUCCESS
   * defined in its stdlib.h file
   */
}
```

METHODOLOGY

In my research, it was necessary to develop a process by which I would first examine a new C statement and/or algorithm, then input into the computer an example from the book. When compiling errors came back, it was often more than a simple matter of correcting a typing error. I had to examine the UNIX man pages, search through indexes and appendices of various books on C, and ask associates to find the answers to some very simple questions. When this was complete, I recompiled and sometimes needed to edit the program to make various algorithms work properly (such as the insertion sort), or to add new features (such as the case changers). The second step--checking through manuals to find coding information--was noticeably more difficult than when I had programmed in Pascal.

This is not to say that C was the only subject I studied during my period of research. As different aspects of the UNIX operating system interested me, I would find time to get to know each better. I learned about using the **finger** command to look up users, both locally and remote, which helped me find E-mail addresses of people I wanted to contact. Then I became more familiar with the **mail** command, using its tilde-escapes to call up the **vi** editor for easier message entry. When I wanted to ftp a file and the network wasn't properly working, I could have previously used **nslookup** to find the numerical address for the remote host. I even learned about a few of the more trivial things one can do, such as making .plan and .project files so that other users who finger me will get a message about me. Later on, I learned how to uudecode news articles which had been converted into an ASCII-readable form, allowing me to access files posted as news articles. By concatenating separate parts and stripping header data, I was able to rebuild the binary files, which I could later ftp to, for example, a PC in the office.

RESULTS

With much experimentation, often in a trial-and-error fashion, I was able to find ways to take a program or program segment from a book and edit it to match what was required by the Sun C Compiler. This enabled me to learn about some of the more complicated aspects of C programming, such as pointer usage and memory allocation. Below is a program which uses pointers to transform a text file into upper case.

```
/* UPPER program
 * Reads a text file and writes the same file, all in upper case
 * Utilizes command line parameters via argc and argv
 * 07-08-1992
 * Todd Gleason
 */

#include <stdio.h>

main(argc, argv)
int argc;
char *argv[];                        /* or char *argv[] */
{
  int i;
  FILE *fp1, *fp2;
  if (argc == 3) {
    fp1 = fopen(argv[1],"r");
    fp2 = fopen(argv[2],"w");
    if ((fp1 != 0) && (fp2 != 0)) { /* NOT null (error) value */
      i = fgetc(fp1);
*      while (i != EOF) {
        if ((i >= 97) && (i <= 122))
          i -= 32;                  /* Convert to uppercase */
        fprintf(fp2, "%c", i);
        /* printf("%c",i); */       /* for testing output */
        i = fgetc(fp1);
      }
    }
    else {                          /* null (error) value */
      printf("Unable to access ");
      if (fp1 == 0)
      printf("input filename\n");
      else printf("output filename\n");
    }
    i = fclose(fp1);
    if ((i) && (fp1 != 0))          /* If file was actually opened */
      printf("Error closing file 1\n");
    i = fclose(fp2);
    if (i)
      printf("Error closing file 2\n");
  }
  else {
    printf("Syntax:  UPPER infile outfile\n");
    printf("   Where infile is the name of the existing file to be read
");
    printf("and converted into \n");
    printf("      uppercase to send to a new file by name of
outfile.\n\n");
  }
}
```

As the next example demonstrates, I also used pointers to perform string manipulation. This was not difficult after reading up on how C stores its strings (in virtually the simplest manner possible, consistent with most C) with a "\0" NULL character as terminator.

```
/* 7.4.2 Exercises in From C to C: an introduction to ANSI Standard C
 * Pointers
 */

#include <stdio.h>
#define arrlen 10

void copystr(destination, source)
char *destination, *source;
{
  while (*destination ++ = *source++);
```

```
}

void copyN(destination, source, N)
char *destination, *source;
int N;
{
  int i = 0;
  while ((i < N) && (*source != '\0')) {
    *destination = *source;
    source++;
    destination++;
    i++;
  }
  for (; i < arrlen; i++) {
    *destination = ' ';
    destination++;
  }
  *destination = '\0';
}

void strip(destination)
char *destination;
{
  int i = 0, lastchar = 0;
  while ((*(destination + i)) != '\0') {
    if ((*(destination + i)) != ' ')
      lastchar = i;
    i++;
  }
  *(destination + lastchar + 1) = '\0';
}

void printarrays(destination, source)
char *destination, *source;
{
  printf("\nSource:        ");
  printf(source, (arrlen));
  printf("|\nDestination:  ");
  printf(destination, (arrlen));
  printf("|\n");
}

int compare(s1, s2)
char *s1, *s2;
{
  int a;
  while ((*s1++ == *s2++) && (*s1 != '\0') && (*s2 != '\0'));
  if (*s1 > *s2)
    a = 1;
    else if (*s1 < *s2)
      a = -1;
      else a = 0;
  return(a);
```

```
}

void compprint(compresult)
int compresult;
{
  if (compresult == 1)
    printf("The second string is alphabetically first\n");
    else if (compresult == -1)
      printf("The first string is alphabetically first\n");
      else printf("Both strings are equal\n");
}

main()
{
  char dest[arrlen], *destination = dest, sour[arrlen], *source = sour;
  int comparison;
  source = "Greetings!";
  printf("\nArray Manipulation Demonstration, utilizing pointers\n");
  printf("-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-");
  printarrays(destination, source);
  copystr(destination, source);
  printarrays(destination, source);
  comparison = compare(source, destination);
  compprint(comparison);
  copyN(destination, source, 5);
  printarrays(destination, source);
  comparison = compare(source, destination);
  compprint(comparison);
  strip(destination);
  printf("\nStripped destination:  ");
  printf(destination, (arrlen));
  printf("|\n-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-\n");
  printf("End of Array Manipulation Demonstration\n");
}
```

To better understand this program, the following lines are the output from a sample run. The program copies a string, truncates a string with spaces, then truncates a string with the null character instead of spaces.

```
Array Manipulation Demonstration, utilizing pointers
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Source:       Greetings!|
Destination:  |

Source:       Greetings!|
Destination:  Greetings!|
Both strings are equal

Source:       Greetings!|
Destination:  Greet     |
The second string is alphabetically first

Stripped destination:  Greet|
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
End of Array Manipulation Demonstration
```

CONCLUSION

My summer was well spent learning C as well as other aspects of computer trivia which will no doubt be very useful in the future. In college I will therefore not have so much to worry about in the way of getting many things to work; my experience with the **Open Windows** program will aid universally with windowing systems, while my knowledge of UNIX operating systems and networking will allow me to more easily adapt to additional foreign operating systems. The experience of being around professional engineers and college students has also given me a feel for what life is like in the real world, an important factor for the future when I choose what specific career field to enter.

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Study of Crystals

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The Study of Crystals

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Abstract

At my time at Rome Laboratory, I learned a variety of interesting things. I learned how to grow, cut, polish, examine, and take pictures of crystals. When examining a crystal, you can use a number of different machines, and methods. And each one will show you a different aspect of crystals. I also learned to improve the quality of a machine, by making a new design for it by removing and/or adding parts to it.

THE STUDY OF CRYSTALS

Venus-Victoria Hammack

Introduction

There are many different methods to grow crystals. I used the Czovchralski experiment method. Once the crystal is grown, it is cut, lapped, and polished. There are two methods, I could use to lap and polish crystals. After they are polished, you are ready to examine the crystals. I used a Spectrophotometer, scanning electron microscope, and infra-red microscope. Some of these machines you can use to take pictures of the crystal wafers. I was introduced to varies procedures to of photography. I learned to be patient and to try to have steady hands when handling crystal wafers.

When I learned to grow a crystal, I used the Czovchralski experiment. I measured out 440.69gm of BiO_3 into a beaker, 8.825gm of SiO_2 into another beaker, and .465gm of Al onto a piece of paper. They were then mixed together in a large crucible. I placed the crucible into the pot and worked the temperature from room temperature to 900 degrees Celsius in eight hours. The seed which is on a rod is lowered down, so that it is just on top the liquid in the crucible.

The seed is slowly pulled up at a rotation set of 80 and a pull set of 4.5 inches per hour. For the first hour and half we check on it every ten minutes. Then we will check it every half hour. We record the distance and both power circuits(temperatu and percentage of power).

The seed was placed in at 8:30 am and pull ut of the melt at 4:00 pm. We let the crystal cool down to room temperature for forty-eight hours. When the crystal is cool we will take it out of the pot. And cut off the seed, then weight the crystal. It weights 154.7gm. The following page is the data sheet, that I fill out every time, we grow a crystal using this method. I took a picture of the crystal, which is on the next page.

To be able to polish a crystal, you must first have the crystal cut into wafers. I used a hot plate to heat up a piece of metal and glued two microscope slides onto it and glued the bottom of the crystal to the slides. Then I used a holder to take it off the hot plate. Once it is cooled, I screw it onto a low speed saw. It cuts the crystal into wafers. You set how thin or how thick you want the wafer, and where in the crystal that you want it from. Once the saw is turned on it we continue to cut the crystal until you turn if off. When you are down cutting the crystal, on screw the piece of metal from the saw. And place it on the hot plate.

Take apart and take off the hot plate, the bottom of the crystal, the microscope slides, and piece of metal. Now you can take the pieces of crystal wafers and polish them.

I learned two ways to polish wafers. The first one is using a Polishing machine. To polish a crystal, you must first heat up a hot plate, with a metal plate on it. Once it is warm, put enough glue on the metal plate to cover the bottom of the wafer(s). Take the metal plate of the hot plate and let it cool.

. . . CZOCHRALSKI EXPERIMENT DESIGN/DATA SHEET

RUN NO. [illegible] DATE. [illegible] SYSTEM [illegible] 3

SEED ORIENT [illegible] CRUSIBLE [illegible] CHARGE WT. [illegible]

Bi_2O_3 ________ PURITY ________ SOURCE ________

SiO_2 [illegible] PURITY [illegible] SOURCE [illegible]

DOPANT#1 [illegible] AMOUNT [illegible] SOURCE ________

DOPANT#2 ________ AMOUNT ________ SOURCE ________

ROTATION SET ________ PULL SET ________

TIME	TEMP/PWR#1	TEMP/PWR#2	POS	PYRO TEMP	RAMP SET
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]				
[illegible]	[illegible]				
[illegible]	[illegible]		[illegible]		
	[illegible]				
[illegible]	[illegible]				[illegible]
	[illegible]				
	[illegible]				
	[illegible]				

RAISE TO ________

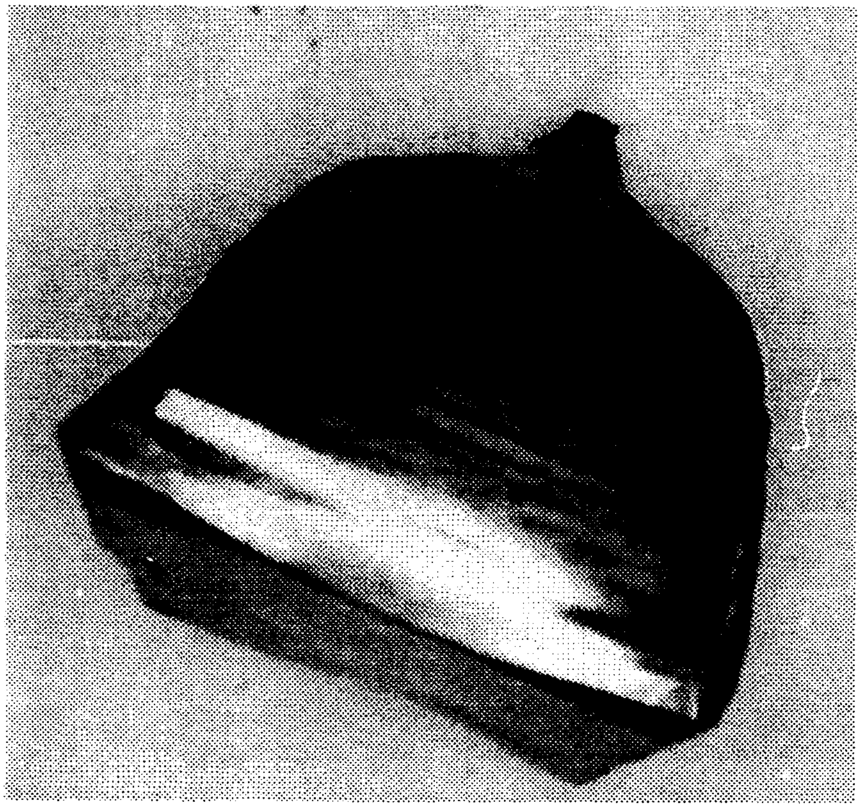
1st RAMP ________ ANNEAL ________ HRS 2nd RAMP ________

CRYSTAL WT ________ COLOR ________

PURPOSE OF EXPERIMENT ________

DISPOSITION OF CRYSTAL ________

COPY AVAILABLE TO DTIC DOES NOT PERMIT FULLY LEGIBLE REPRODUCTION



Next you will do hand lapping. Using a glass plate, put a teaspoon of 25.0 micron Aluminum Oxide powder(grit). With a little water mix it together on the glass plate. Put the metal plate wafer face down on the green plate. Then I lapped in figure eight for about three minutes. I washed and dried the green plate and metal plate. Now use 12.5 micron grit for three minutes. Repeat after washing and drying everything, use 5.0 micron grit. Wash and dry everything. Take and put another plate on the back side of the metal plate, that has a small hole in it. You place carefully wafer side down the metal plate onto the automatic polisher.

I mixed a solution of .3 micropolish II deaggomerated alumina and "DI" water in a beaker. Then I put the solution into an adjustable flow control beaker. I turned on the water that is on the polisher and the polisher. I set it at a fast drip and let it drip onto the pad on the polisher. I slowly let a solution drip into the pad. I let it run for twenty minutes. Turn off the polisher, when the twenty minutes is up. Remove the metal plate from the polisher and run it under water. Make up a solution with .05 micropolish. Put the metal plate back on the polisher. Turn on the water, then the polisher, and then the solution. Let it run for twenty-five minutes.

When the time is up, turn off the solution, polisher, and the water. Take the metal plate off the polisher and put it under running water. If all of the wafers are shiny, then dry off wafers and take off the plate on the back of the metal plate. If it is not down they let it run for five minutes, or until it is entirely shiny.

Turn on the hot plate, and put the metal plate on it. Take out three beakers. Fill two of them one-fourth of the way full with acetone and the third one one-fourth of the way full of methyl. Once the wafer can move freely on the metal, take one off the hot plate with tweezers and put it into the first beaker of acetone. A few minutes later, put into the second beaker of acetone, after a little while move it to the third beaker. Once the wafer has a clear surface, take it out of the beaker and dry it with lint free paper. Repeat with each wafer.

After you dry all the wafers, put the metal plate back on the hot plate. Glue shiny side down the wafers to the metal plate. Take the metal plate off the hot plate, once all the wafers are on the metal plate with glue. The lapping is the same as the first time. Three minutes with 25.0, 12.5, and 5.0 micron. Washing the green plate and the metal plate between each one. After the last one dry the plate and metal plate with wafers. Once that is done, put the other plate on the back side of metal plate. Polish with .3 solution for twenty minutes, proceed as the way in the beginning. Wash the plate and use .05 micron for twenty-five minutes as in the beginning.

Turn off the solution, polisher, and the water. Take the metal plate off the polisher and put the cover on the polisher. Rinse the metal plate with "DI" water. Take the plate off the metal plate. Turn on the hot plate and put the metal plate on it. Fill two beakers with acetone and one with methyl. Take one wafer carefully off and put into first beaker of acetone. Leave it in there for three minutes. Then move it to the second beaker of acetone with tweezers.

Leave in for three minutes, and then move it to the beaker of methyl with tweezers. Once the wafer is clear remove it from the beaker of acetone. And dry with a piece of lint free paper. Repeat these steps for each wafer. Place each wafer in a container, that has lint free paper at the bottom of it.

The other way to polish a crystal, is using a Precision Polishing Machine PM2. Using a hot plate, glue the wafers onto the piece of metal. Take the piece of metal off the hot plate once the wafers are glued on. When it is cooled, I will begin lapping. I used 200 micron sandpaper for 5 minutes in a figure-eight motion. Then I washed off the metal plate and dried it with a paper towel. Now I sprayed three pads with metadi diamond compound. The first one I sprayed on 45 micron compound, the second one 15 micron, and the third one 6 micron. I placed the pad onto the polishing machine. Then I placed a holder around the piece of metal onto the pad, and placed the ring around the holder. I pushed the ring into the polishing machine's holder. I first used the 45 micron for 30 minutes. Then I changed to the 15 micron pad, and let it run for 30 minutes. I changed to the 6 micron pad for 30 minutes. In between each pad the piece of metal, the holder, and the ring need to be washed and dried.

I turned on the hot plate, and placed the piece of metal wafer side up on it. Once the wafers become loose on the metal, I took them off with tweezers. I placed them into a beaker of acetone, enough just to cover the wafers. I reglued the wafers, shiny side down, onto the piece of metal. I used a pair of insolated holders to take the piece of metal off the hot plate. I repeated the lapping 200 micron compound sandpaper for 5 minutes.

I washed off the piece of metal and dried it with a paper towel.

I repeated the polishing the same as in the beginning. I used the same amount of time and compounds. Once the metal piece with the wafers is washed off after the third compound, I dried off and placed it one hot plate, wafer side up. Once the wafer is loose from the glue, I used tweezers to place the wafers into a beaker of acetone. Once the wafers are clear of glue, I took them out of the acetone and dried them with a paper towel. They were placed into a small box with lint-free paper on the bottom.

Once the polishing is finished, I can begin to analyze the crystals. There are many ways to find out different information about the crystal. I used the following machines to get a variety of aspects of the crystals: spectrophotometer, scanning electron microscope, infrared microscope, and taking pictures of the crystal wafers.

One of them was a Perkin-Elmer lambada 9 UV/VIS/NIR Spectrophotomer. It used a Epson monitor with epson equity III and hard drive; a epson ex-800 printer. The spectrophotomer measured light in three ways. The first one is transmission- how much light goes through the crystal. The second one is reflection how much light bounces off the crystal. And the third was, absorption- how much light is absorbed. The three of these put together made up 100% because all of the light will be either absorbed, reflected, or pass through. I mostly used transmission for measurement, when using the spectrophotometer. I would tell the computer to measure the percentage of transmission verses the wavelength.

I set it at 400 to 800nm. Inside a compartment of the spectrophotometer, I would put the crystal wafer. The computer would begin once it was a the correct wavelength. When it is running, a graph of percent transmission vs wavelength would appear on the screen of the computer. When the graph is finished I would get a print out of the graph.

Once the graph is printed out, I begin to take certain numbers which the graph is based on. I wrote down the transmission for every 10nm from 400 to 500nm and every 50nm for the rest. These number were placed into the data base of another computer to analyze. I also need the thickness of each crystal wafer. I used a caliper to find the thickness of it. Once these two things are placed into the computer, the computer can find the absorption coefficient for the wavelengths 400 to 800nm.

The scanning electron microscope ia another machine I used. It can be used to examine crystal, but also other objects. Like flies, flies, or other bugs, pollen,and leaves. I used it to find what alien elements may exist in the crevices of the crystal wafer.

The sample is placed into the microscope and then the microscope is shut. Then a pump located inside the microscope, removes all of the air and other material not including the crystal. Once this is finished, I can focus on a crack on the crystal wafer. When the picture is focus a computer will show what is in the cracks. There will be peaks of certain elements, because there is a high amount of it in the crystal. On the following page is the data sheet, I got from the computer on the crystal.

```
SQ: IDENTIFY

 QUALITATIVE ELEMENT IDENTIFICATION

SAMPLE ID:[7-29-92] VENUS & EILEEN

POSSIBLE IDENTIFICATION
    NI KA
    SI KA
    CU KA
    ZN KA OR  RE LA

              PEAK LISTING
         ENERGY     AREA  EL. AND LINE
    1     1.754     2684 SI KA
    2     2.454    31118 UNIDENTIFIED
    3     7.471     3097 NI KA
    4     8.026      307 CU KA
    5     8.628      263 ZN KA

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

[7-29-92] VENUS & EILEEN
Standardless Analysis
  20.0 KV    40.0 Degrees

Chi-sqd = 1.60

Element         Rel. K-ratio              Net Counts
   Ni-K     0.06067 +/- 0.00117       [illegible] +/-   [illegible]
   Si-K     0.01121 +/- 0.00073       2483 +/-   157
   Cu-K     0.02444 +/- 0.00148       1241 +/-    75
   Zn-K     0.00965 +/- 0.00121        397 +/-    [illegible]
   Bi-L     0.00767 +/- 0.00577         [illegible] +/-    [illegible]
   Bi-M     0.88607 +/- 0.00652      70505 +/-   267

ZAF Correction 20.00 kv  40.00 deg
No.of Iterations = 1

Element  K-ratio      Z        A       F        Atom%       Wt%
  Ni-K    0.059     0.771   1.084   0.97[illegible]   [illegible]      [illegible]
  Si-K    0.011     0.752   1.597   0.955    [illegible]      [illegible]
  Cu-K    0.024     0.802   1.165   0.965    [illegible]      [illegible]
  Zn-K    0.009     0.794   1.255   0.945    [illegible]      0.74
  Bi-L    [illegible]     [illegible]   1.001   [illegible]    [illegible]      [illegible]
  Bi-M    0.864     1.031   1.013   1.000    [illegible]     90.34
                                        Total = 100.00%
```

COPY AVAILABLE TO DTIC DOES NOT PERMIT FULLY LEGIBLE REPRODUCTION

I tried several procedures of taking pictures of crystal wafers. Every way was to show the patterns of striations in the crystal. Striations are lines that can only be seen once magnified. The striations will be unlike in different crystals, because of the way the crystal was grown.

I tried taking pictures of the crystal wafer in a dark room. There was a small light and a silicon wafer to cover it, with aluminum foil to hold the wafer over the bulb. The silicon wafer was there so not too much light would go through. There was a InP wafer glued into cardboard, which was placed a foot away from the light. The light went through the wafer and picked up by the camera on the other side of the InP wafer. From the camera the picture moves to the power box and then on to the picture screen. From there it goes to a video printer. Then in a few minutes you have a picture of the InP wafer. This is a god method of taking pictures.

The second way I used to photograph a wafer was using, a variable condenser with a timer, high speed infrared black and white negative film, and another timer. This procedure took place in a dark room. First I cut a piece of film and place it under the condenser on the table. I laid the InP wafer which was glued into cardboard onto the film. I set the timer for the light in the condenser. When the light shut off, I placed the film onto a clip and placed into a bin of developer for six minutes. It was then placed into the next bin of stopper chemicals for thirty seconds. This would rinse off the developer. It was placed in the third and final bin of fixer for four minutes. Once the film is taken out off the fixer I may turn on the lights. The film is taken off the clip and placed into a washer for twenty minutes.

Once this is finished the film can be placed onto a clip and hung to dry.

I used this procedure with different amounts of time of light exposure. When I tried two, five, ten seconds, one and half min, two, five, seven, eight minutes, I got film with not enough exposure to infrared light. I did not get a clear picture out of any of these. So, we try a different method.

The third method involved a regular light which shines down on to the wafer. There is a timer connected to the light. The film was exposed for only one, three, and five seconds. The entire shape on the film was black. I tried taking a picture again but this time put a 1.1 micron infrared filter over the light. Aluminum foil was placed entirely over the filter. A hole was made with a pin to allow a small amount of light through. The film was under exposed and no striation were visible on the film.

Another method was tried to get a picture of the wafer. The picture was taken from an infrared microscope, and a picture screen, with a color monitor attached to it. This did show the striations on the wafer, but only part of the wafer.

I took a vacuum spinner and made plans for it to be changed. I wanted it to be spinning while water drips onto it and cleans the wafer. The wafer is spinning at a fast speed, that the water is whisked off the wafer along with other materials that were on the wafer. The water will be collected on the box that was added to the spinner. It is made out of plexiglass. The water will then go down the drain, that is located at the side of the box.

I also improved a CRYO-TORR (R) High Vacuum Pump. I add two inch angle iron twenty inches long, to hold up the pump. I lower the pump closer to the top of the CTI-CRYOGENICS Box. I add three extra pieces on top of the pump. The three pieces added to the machine will make it work better than before.

Study of Crystal Growth

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Final Report for:
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Study of Crystal Growth

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Abstract

In this report I will try to sum up my last eight weeks at work. In thinking about my project and in putting the pieces together, I have come to realize the connections between each experiment. This report will hopefully carry you clearly and accurately through my experiences from crystal growing to analysis which when put together make a crisp picture.

Study of Crystal Growth

Eileen Harrington

Introduction

First I will describe a crystal I helped to grow and how the procedure went: measuring amounts of the melt for production, lowering the seed into the melt, watching and taking down data on the crystal, and eventually pulling the crystal out. The crystal to be described was grown by the Czochralski method. Also briefly written about will be the Light Emitting Diodes (LEC) method of growing crystals.

Then I will explain the many times I have polished such crystals. There are different kinds of polishes, different levels, and different machines for different types of crystals. Although not the most interesting part of the job, it was still necessary.

Finally there are the many ways to analyze the crystals. The machines hold such names as spectrophotometer, scanning electron microscope, and infra-red microscope. In trying many, many times to take a picture of a certain crystal sample I also learned many different ways of photography in the crystal world: color video printer, variable condenser with negative infra-red film, light with silicon wafer, and finally timed light with a infra-red filter. This and other procedures I had never heard of before beginning this job will be described.

The Czochralski method of growing crystals begins with the pot around which are wires to heat the pot from the power source. The way of knowing the temperature of the pot is through thermocouples. In the pot is put a crucible filled with the beginnings of a crystal. This substance is then melted to prepare for the initial growing.

Above the pot hangs a seed, that is, a piece of an already grown crystal. From this seed the crystal will grow. The seed is attached to a metal rod which, when the pot is at the correct temperature will be lowered down to the melt. The seed should just barely touch the melt so as to form a ring when it hits, that is, something that looks like a halo. It is at this instance that the crystal growing begins to take place.

The crystal which I helped to grow was labeled BSO154 and was made of 440.69 gm of Bi_2O_3 and 9.3 gm of SiO_2. This crystal was grown for eight hours at a temperature of about 900 degrees Celsius. Once the crystal hit the melt it was checked on every ten minutes for the first hour and a half. These initial checks were to make sure the seed did not fall into the melt. After that time it was checked on every half hour. At the same time that the crystal forms, the rod attached to the seed was pulling it up at a certain rate, in this case, 4.5 mm/hr. At this time the crystal is rotating at a constant rate. In this crystal growing it is 80 rotations/minute. When checking the crystal I would record the temperature as shown from the thermocouples and the power being used in the two power supplies and the position of the crystal. The position checks to make sure that the crystal is constantly being pulled out of the melt. On the following page is the data sheet used in this crystal growth run by the Czochralski method. From the data it can be concluded that the crystal grew 2.7 cm because it had started at a position of 8.4 cm and ended up at 11.1 cm.The resulting crystal is $Bi_{12}SiO_{20}$.

. . . CZOCHRALSKI EXPERIMENT DESIGN/DATA SHEET

RUN NO. BSO154 DATE. 7/8/92 SYSTEM Large TSS 6

SEED ORIENT ______ CRUSIBLE Lge Rt Angle CHARGE WT. 449.99 gm

Bi_2O_3 440.69 gm PURITY ______ SOURCE ______

SiO_2 9.3gm PURITY ______ SOURCE ______

DOPANT#1 ______ AMOUNT ______ SOURCE ______

DOPANT#2 ______ AMOUNT ______ SOURCE ______

ROTATION SET ______ PULL SET ______

TIME	TEMP/PWR#1	TEMP/PWR#2	POS	PYRO TEMP	RAMP SET
8:50	948/67	825/64	8.4	904	10° /1:30
9:25	945/63	825/69	8.5		
10:05	940/60	825/75	8.85		
10:30	938/61	825/79	8.9		
11:00	934/54	825/87	9.1		
11:30	933/56	825/87	9.35		
12:00	934/56	825/86	9.5		
1:10	934/57	826/84	10		
2:15	933/57	825/84	10.4		
3:12	934/57	826/82	10.8		
4:07	933/57	826/83	11.1		
"	Out of melting	11.25			

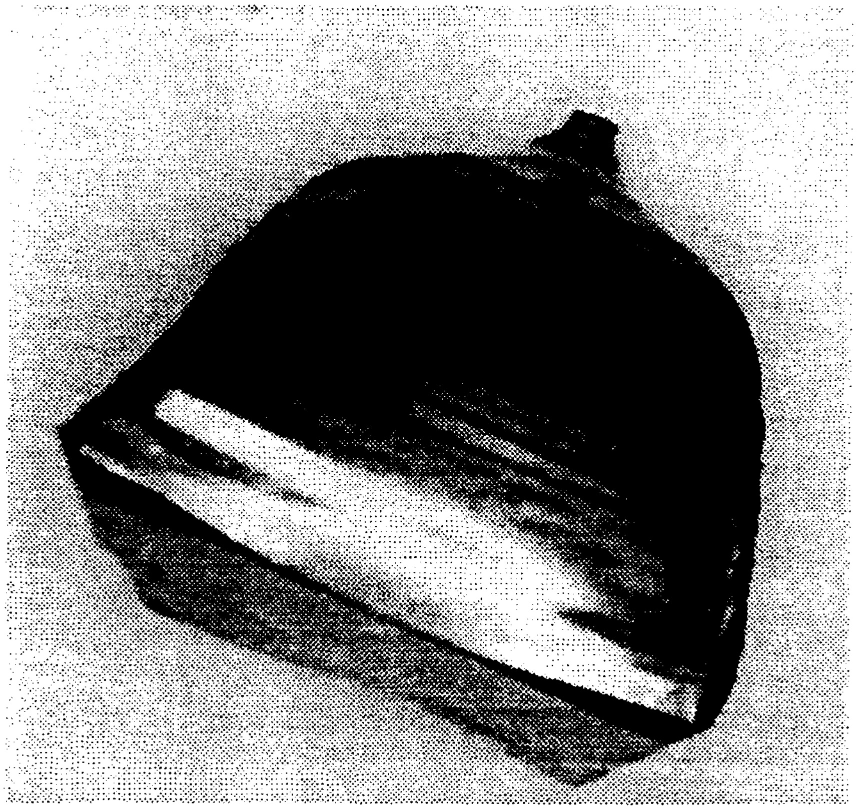
RAISE TO ______

1st RAMP ______ ANNEAL ______ HRS 2nd RAMP ______

CRYSTAL WT 310.6 COLOR typical straw

PURPOSE OF EXPERIMENT ______

DISPOSITION OF CRYSTAL ______



Once the crystal had finished these eight hours it was pulled out of the melt and for the next 24 hours the pot cooled down to 200 degrees Celsius. After that, it reduced its heat to room temperature in 48 hours.

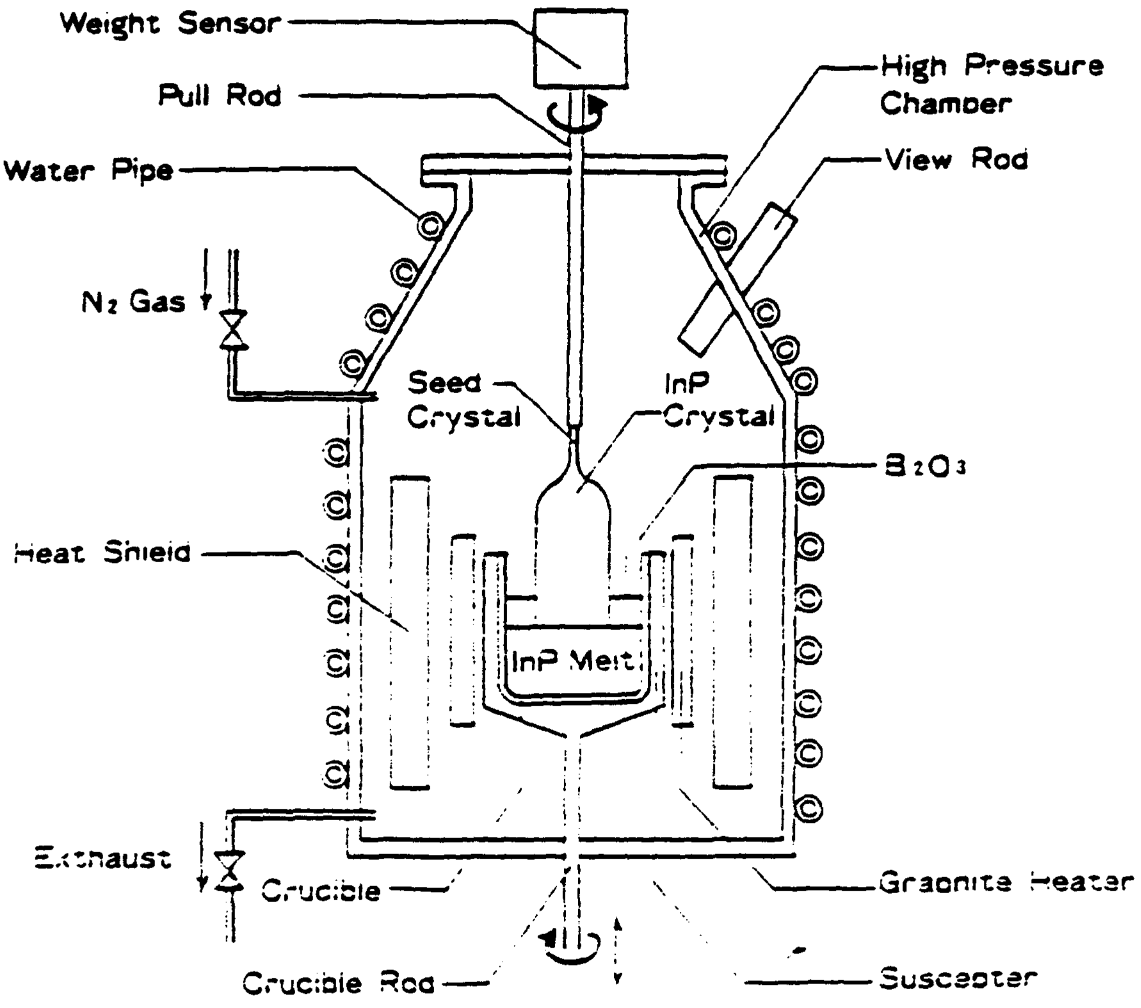
This entire process began on a Thursday. At 11:40 the next Tuesday the crystal had sufficiently cooled to be taken out of the pot. It is a fairly large BSO crystal with one side shaped irregularly and weighs 310 g. The previous page show a picture of the described crystal.

Another type of crystal growth which I observed is called Light Emitting Diodes (LEC). This is a high-pressure furnace in which InP crystals are grown. Inside this furnace is a crucible made of quartz and charged InP materials. The chamber in which it is held is pressurized to 35-60 atmospheres with inactive gas. The furnace is then heated by coils which wrap around it. Through the coils run cold water, although the coils are what is actually heating the pot. That is, the coils emit the heat, but in order to keep the coils from cracking and breaking under the extreme temperatures they need the water to cool them.

Inside the furnace is a crucible containing InP material which is being melted. Once at the correct temperature, a seed crystal is dipped into the melt. As in the other method of crystal growing, the seed is being constantly pulled up with rotation and the diameter is also increasing while being pulled.

The time I observed part of this kind of experiment, the process began at 8:30 in the morning, and the crystal began to be pulled out at 3:00. The rotation rate began at 30 rotations/minute, and went up to 100 rotations/minute at 10:55. The pull rate on the crystal was 12mm/hour.

On the following page is a diagram of this method of crystal growth.


Weight Sensor
Pull Rod
Water Pipe
N_2 Gas
Seed Crystal
InP Crystal
High Pressure Chamber
View Rod
B_2O_3
Heat Shield
InP Melt
Exhaust
Crucible
Crucible Rod
Graphite Heater
Susceptor

The next step is to prepare the crystal so that it may be analyzed. This begins with slicing the crystal into wafers by use of a low speed saw. With the crystals I mostly dealt with, the BSO ones, a sample was cut from the top portion, three were cut from the center, and three were cut from the bottom.

Now that the crystal samples are in fairly small pieces they are ready to be polished and cleaned. In polishing the BSO crystals I would begin the polishing process be lapping them on a 400 micron paper. First I took a metal plate on to which the crystals will be attached. The plate is put on a hot plate until it is hot enough to melt wax onto it. The wax is used to make little puddles onto the plate. Next the crystal wafers are placed in the middle of these puddles and pressed softly down to rid itself of all air bubbles under it. The plate is then taken off the hot plate to cool to room temperature.

It is only now that the wafers are ready to begin lapping. The lapping paper is put on a flat surface so that no bumps will cause damage to the wafers. A small amount of water is then added to the paper. Now the paper is ready for the wafers to be lapped by hand in circular or figure-eight motions. In the case that I am writing about the lapping took about 6 minutes to complete. The plate is then washed off with soap and water and is dried.

After the hand lapping is done, it is time to move on to the automatic polisher. This polisher has a spinning table and the holder for the plate also spins. Onto the table is sprayed 45 micron diamond compound. In this polish are little bits of diamonds which cut away at the wafer to form a flat surface. The plate is put onto this surface and is tightened into the holder. The timer on the machine is then set for 30 minutes. When this is completed, the plate with the wafers attached is removed and washed again. This same process is done again on 15 microns and 5 microns for 30 minutes each and washed after each polishing.

Now it is time to remove the wafers from the plate and then reattach them flipped over to do the other side. The plate is placed on the heating pad and once it is hot enough for the wafers (there are usually three wafers polished at one time) to slide off they must have the wax cleaned off. This is done by soaking the wafers in acetone. As each wafer is taken off it is put into a beaker of acetone and gently rubbed to remove the wax. Once most of the wax is off it is put into another beaker of acetone to get off all other dirts that the wafer may have picked up. Finally, to remove the acetone from the wafers' surface, they are placed into a beaker of methanol. They are then removed from this last beaker and dried with lint free paper.

That was only the first half of the polishing. Now the other side of the wafers must be done. The process of above is repeated to the other side: waxed onto the plate, lapping for 6 minutes, automatic polishing for 30 minutes on the 3 polishes, and then finally removing the wafers and cleaning them off. Now they are done.

There was a second way of polishing which I also did. The beginning of the process is the same, that is, the waxing the wafers onto the plate is the same. However, the types of polish are different and the ways they are used are also different.

The types of grits used in this polishing are called aluminum oxide powder. First I began with a glass plate onto which I put about two teaspoons of 25 micron aluminum oxide powder. A little water is then added so that the plate will be able to move freely. The plate is faced down and is hand-polished for about 3 minutes. When done, both the plate and the glass plate are washed with soap and water and are dried. The same process is then repeated with the 12.5 and then 5 micron grit and washed between each polishing.

Now I am ready to move onto the automatic polisher. First a solution must be made for it to use in the polishing. The solution is made from water and a polish called micropolish deagglomerated alumina. The ratio of water to polish is about 4:1. This solution is placed into a container which will regularly drip onto the pad of the polishing machine. The plate with the wafers are placed face down onto the pad. There is also a faucet above the pad to drip water onto it to keep the pad moist so the wafers do not scrape on the pad. Now the faucet and the solution are turned on just enough to drip on the pad. The holder of the plate is turned on to spin the wafers and finally the pad is turned on to spin.

The level of the micropolish on the first polishing is .3. The second level in this polishing is .05. The automatic polishing must always be watched to make sure the dripping of the water or solution does not stop. Also, between each polishing the plate must be washed off with water and a wet paper towel.

Once this side of the wafers are done they must be removed and cleaned in the same fashion as described in the first polishing example. They are then turned over and waxed to the plate to repeat the process. The kinds of crystals I polished this way were grown in the LEC method while the wafers of the first polishing example were mainly grown by the Czochralski method.

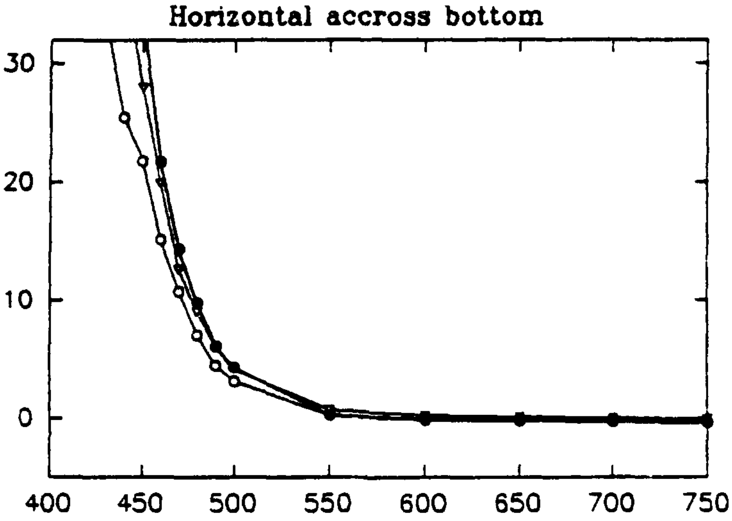
Now that the wafers are polished they are ready to be analyzed. There are several ways to find out different information about these crystals. Some which I was able to take part in are as follows: spectrophotometer, scanning electron microscope, infra-red microscope, and the taking of pictures of these wafers.

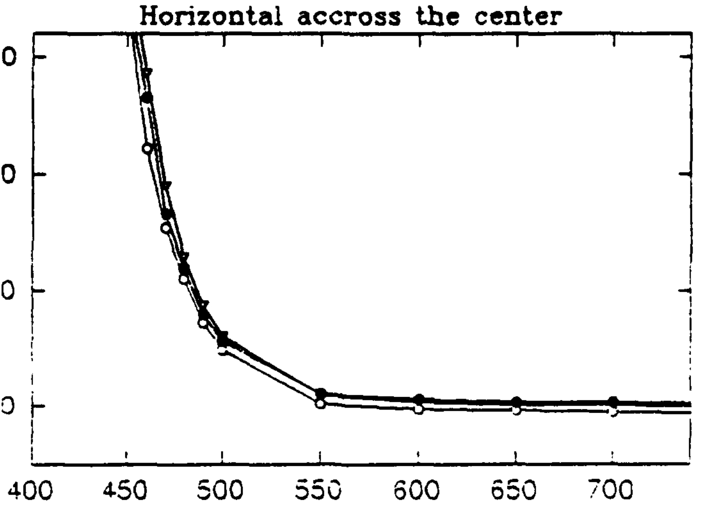
The spectrophotometer is used to measure the transmission (how much light goes through), reflection (how much light bounces off), and absorption (how much light is absorbed) of the crystal. Together these three things equal 100% because all light will be either absorbed, reflected, or the light will pass through. The cases in which I used the spectrophotometer I mostly used the transmission for measurement.

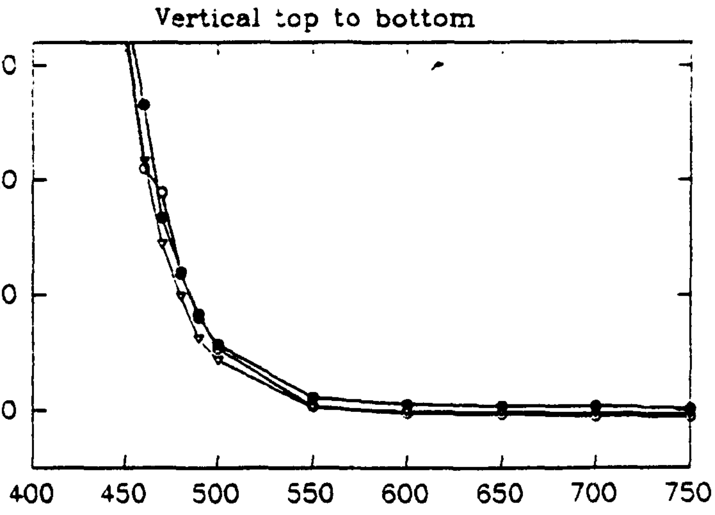
When setting up the spectrophotometer, I had to tell it exactly what wavelengths of light I wanted it to analyze. In most cases I would have it run from 400 to 800 nm (wavelengths). Inside a little compartment I placed the sample of the crystal. Once the computer is set to the correct wavelengths, the process begins. While the run occurs, a graph of % transmission vs. wavelength appears on the computer screen. In the end I am left with a computer print-out of this graph.

Now it is time to take specific numbers on which to base the graph. I wrote down the transmission of the crystal for every 10nm from 400-500 and every 50nm for the remaining. These numbers were then punched into a computer to analyze. Also needed in this analysis is the thickness of the sample. This can be acquired with the use of a caliper. Once these two things are plugged in, by use of the computer, the absorption coefficient can be found along the wavelengths from 400-800nm.

On the following page are three graphs obtained through the computer for the absorption coefficient. This sample had been grown by the Czochralski method and had been cut into 7 samples (one from the top, three from the center, and three from the bottom). The three graphs show the difference between the absorption through 1. the three bottom samples, 2. the three center samples, and 3. the top, center, and bottom center samples. It can be concluded from this information that the crystal is most uniform across the center three samples because the curves of these three are most alike. In a different crystal the same data was taken and it also showed that the crystal is most uniform in the three horizontal center samples.


Horizontal accross bottom
30
20
10
0
400
450
500
550
600
650
700
750


Horizontal accross the center
30
20
10
0
400
450
500
550
600
650
700


Vertical top to bottom
30
20
10
0
400
450
500
550
600
650
700
750

A scanning electron microscope is another machine I used to examine crystals, among other things. It can be used to find out what foreign materials may be in the crevices of a crystal sample. The sample is put into the microscope and then the microscope is closed. Next by a pump the air inside the microscope is removed along with all other materials besides the crystal. Once this has occurred it is time to focus in on a crack in the crystal sample. While the crystal is in focus, a picture screen projects a picture of what will be analyzed.

At this point the elements which I want the computer to search for are plugged into it. Once ready the machine will show what is in these cracks on a computer. It will show certain peaks of these different elements.

Pages 8-15 and 8-16 are an example of a scanning electron microscope print-out. About half the way down page 8-15 it has the equation "Chi-sqd=2.62." This number shows how accurate the percentages of the different elements are. If this number is below 5, it is fairly accurate. Ideally this number should be around 1.

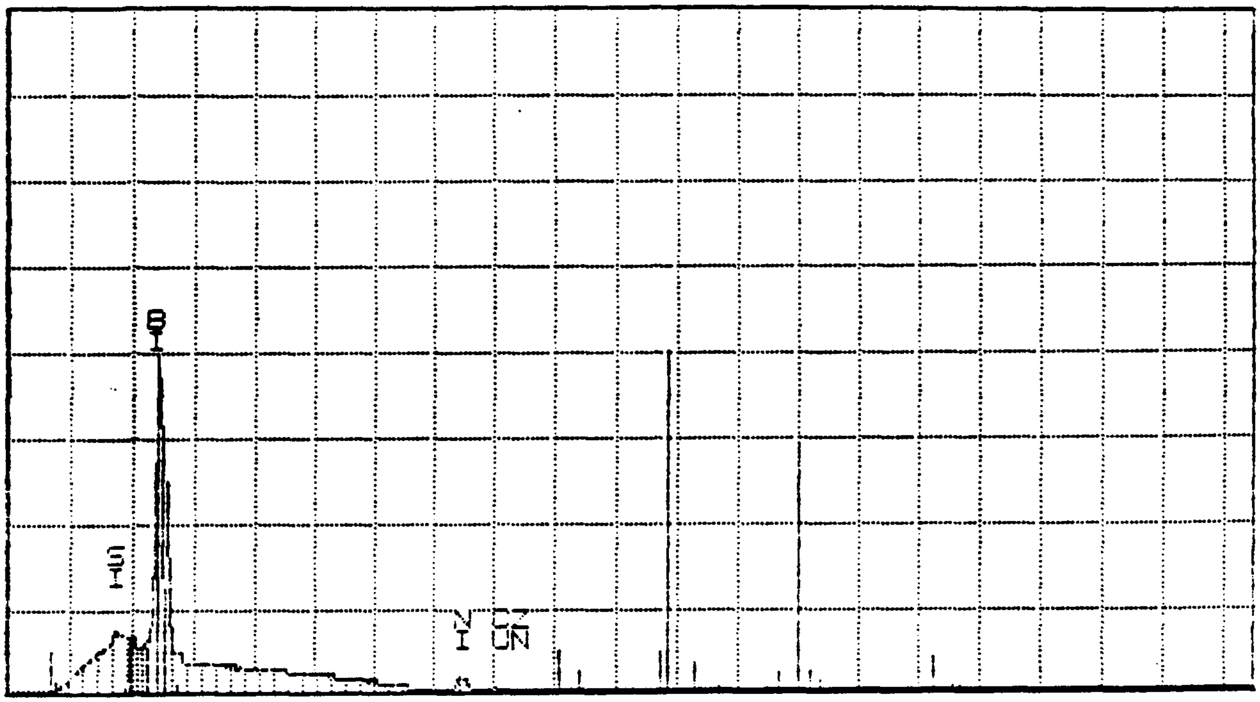
Below the "Chi-sqd" number are the percentages of the elements in the samle being analyzed. According to this chart there are large deposits of Bi-M and also Ni-K, Si-K, Cu-K, Zn-K, and Bi-L. Considering the sample being looked at is $Bi_{12}SiO_{20}$, it is not all that surprising that bismuth is the prodominate element. The labeling for these elements, i.e., "K", "L", and "M", are the different levels of the electron shells.

The graph on page 8-16 shows these high and low peaks of the different elements. Not suprisingly high is the bismuth peak way above the others.

```
SQ: IDENTIFY

 QUALITATIVE ELEMENT IDENTIFICATION

SAMPLE ID:[7-29-93] VENUS & EILEEN

POSSIBLE IDENTIFICATION
   NI KA
   SI KA
   CU KA
   ZN KA OR  RE LA

           PEAK LISTING
       ENERGY     AREA  EL. AND LINE
   1    1.754     2634 SI KA
   2    2.454    51118 UNIDENTIFIED
   3    7.471     3097 NI KA
   4    8.026      307 CU KA
   5    8.628      263 ZN KA

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

[7-29-93] VENUS & EILEEN
Standardless Analysis
  20.0 KV    40.0 Degrees

Chi-sqd = 1.60

Element          Rel. K-ratio              Net Counts
  Ni-K     0.05967 +/- 0.00157        27[illegible] +/-    [illegible]
  Si-K     0.01121 +/- 0.00075        2483 +/-    [illegible]
  Cu-K     0.02444 +/- 0.00133        1241 +/-     75
  Zn-K     0.00953 +/- 0.00123         397 +/-     [illegible]
  [illegible]-L     [illegible] +/- [illegible]          [illegible] +/-     [illegible]
  [illegible]-K     0.35637 +/- 0.00653      90535 +/-    [illegible]

ZAF Correction 20.00 kV  40.00 deg
No.of Iterations = 1

Element  K-ratio       Z       A       F        Atom%      Wt%
  Ni-K    0.059     0.771   1.094   0.97[illegible]     10.47      4.3[illegible]
  Si-K    0.011     0.772   1.697   0.935      3.5[illegible]      1.2[illegible]
  Cu-K    0.024     0.802   1.[illegible]   0.9[illegible]      7.8[illegible]      1.[illegible]
  Zn-K    0.009     0.794   1.055   0.949      1.37      0.7[illegible]
  [illegible]-L    [illegible]     [illegible]   [illegible]   [illegible]      0.[illegible]      0.[illegible]
  [illegible]-K    0.350     1.021   1.013   1.000     71.[illegible]     90.[illegible]
                                                   Total = 100.00[illegible]
```

COPY AVAILABLE TO DTIC DOES NOT PERMIT FULLY LEGIBLE REPRODUCTION

Series II RL/Material Characterization   WED 29-JUL-92 13:32
Cursor: 0.000KeV = 0   ROI   (1) 1.970: 2.230



0.000   BI-93   VFS = 8192   20.480
190   [7-29-92] VENUS & EILEEN

I also tried other ways of taking pictures of crystal samples. Each way was used to show the pattern of striations in the crystal. The striations are lines which can be seen only when magnified. They will be different in different crystals depending on the way the crystal was grown, whether the lines are more uniform or not.

The first time I tried to take a picture of a wafer the experiment was set up in a dark room. First there was a light source (a regular light) and a silicon wafer to cover it so as not to allow through too much light. Over that was aluminum foil to hold the wafer in place. The light then shone though the InP wafer which is glued into a cardboard. This image is then picked up by a camera. (The light, wafer, and camera all run perpendicular to the ground.) From the camera the image moves to the power box to a picture screen. It then goes to the color video printer. This method of picture taking worked fairly well on one of the two examples of which I was trying to take pictures.

To have a picture of the other crystal wafer, a second method of taking pictures involving a variable condenser, a timer for the light in the condenser, and high speed infra-red black and white negative film was tried. This procedure all took place in the dark room. First I cut a strip from the film and placed it flat on a table. Over that I lay down the wafer and the variable condenser stood above that. I then set the timer for the light in the condenser. When the picture was finished I took the film over to a bin of developer and let it develop for 6 minutes. The film then moved to the next bin filled with stopper chemicals for 30 second which rinse off the developer. The final bin is called the fixer, and the film was in this for 4 minutes. When this was done the lights were able to be put back on, and the film would rinse itself off in the print washer for 20 minutes. Once that is done the film can be hooked into a hanger and left to dry.

This procedure was tried for different lengths of time of exposure. The following times were tried but in each one the film had a positive exposure: 2 sec., 5 sec., 10 sec., 1 min., 1.5 min., 2 min., 7 min., and 8 min. In this method not enough infra-red light was able to get through so a new method was applied.

This third way involved a regular light which shines down of the wafer as the condenser had. Likewise, a timer was attached to the light. For this method the film was over exposed where it was exposed only for 5, 3, and 1 seconds. The entire shape of the wafer on the film was black, where as with the variable condenser they were clear.

Taking pictures of this wafer was tried one last time. This time I still used the light but put over it a 1.1 micron infra-red filter. Over that was aluminum foil with a pin hole in it. This was tried on the timer for 5 and 20 seconds. Now the filter allowed too little light through. The film was again under exposed and no striations were visible.

After this did not work the pictures were taken from an infra-red microscope which had a picture screen attached to it and a color printer attached to that. This way did show the striations of the wafer but was not able to show the entire wafer as had been wanted.

Through these procedures I was able to more than just touch upon these topics as most students do. I was able to learn by experiencing rather than reading about such experiments. The experiments may not have always turned out the way I had wanted, but I suppose that was all apart of the learning, too.

PROGRAMMING OF THE C3 BACKUP UTILITY

Jason D. Kowalczyk
Student
Engineering Science
Mohawk Valley Community College

Final Report for:
AFSOR Summer Research Program
Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, Washington, D.C.

PROGRAMMING OF THE C3 BACKUP UTILITY

Jason D. Kowalczyk

INTRODUCTION

The Backup Utility was written for the purpose of conforming to the RISK requirements. It involved the use of MS-DOS BATCH commands and the use of NETWORK commands to provide a complete and reliable backup procedure. In the next few pages it will describe the program and include all of the source.

The C3PC network for which the tape backup utility was developed presently consists of thirty-two 286/386 PC's configued in an Ethernet Lan. Each PC workstation hosts a number of user application programs and is interfaced to the LAN environment using the 10NET Lan management software.

The C3 Backup Utility is activated on a peticular schedule as determined by the network administrator. Once activated the utility squencially accesses each of the nodes configured in a table which is also established by the network admistrator. Each of these table entries contian the node name and the specfics as to which sets of files are to be backed up. The files from each node are first collected on the servers hardrive. After all nodes are interogated, the files are archived on an backup tape.

Recovery of the can be accomplished by the network administrator using procedures outlined in the users guide.

The user guide follows this introduction:

PROGRAMMING OF THE C3 BACKUP UTILITY

Jason D. Kowalczyk
Student
Engineering Science
Mohawk Valley Community College

Abstract

The design, development and programming of the C3 Backup Utility, was performed, for the RL/C3 Directorate. Programming the utility included the knowledge of BATCH file processing and NETWORKING experience. It was written to backup the C3 network to conform to the RISK requirements.

C3 Network Backup Utility

Written by: Jason D. Kowalczyk

For Rome Laboratory

This documentation is a step by step process for running the C3 Network Backup Facility and changing all options associated with it. The program was limited to Ms-Dos Batch commands and 10Net commands so that it can be easily modified when needed to on short notice with only spending little time on the actual programming of it. Also, It was written in module form so in the future it could be modified easier.

This backup utility is made to backup user data files from workstations on the C3 Network. The program backups up all the data files for the following programs:

Wordperfect V5.1	?:\wp51\wpdata
Wordperfect for Windows	?:\wpwin\wpdata
Freelance Graphics	?:\fl\fldata
Freelance Graphics for Windows	?:\flw\fldata
Reflex	?:\reflex\data
Quattro Pro.	?:\qpro\qdata
Excel	?:\excel\*.xls
Microsoft Database for Windows	?:\database\data
Harvard Graphics	?:\hg\hdata
Quattro	?:\quattro\qdata
Powerpoint	?:\prwpoint\pdata

Also, even though the program will only backup the files in certain directories, it will backup files in subdirectories underneath those directories. For example; if there was a directory called *c:\wpwin\wpdata\jon*, it would get backed up. But, if it was *c:\wpwin\jon*, it would not be backed up. Due to tape control problems, the program copies the files to the server's hard drive and then streams them off using the tape drive.

The backup files are stored on the tape drive in succession so that a specific volume can be recalled by searching for the date. When restoring files they can be selectively restored trough the Unisys Tape backup program.

Most of the docs will explain what the user will have to enter to run the batch files and what the user would need to modify in certain instances.

The user on the server side of the program first has to enter nothing.... unless it is desirable to modify either what network assets are wanted or what files on the network stations they want to backup. Here is a list of files included in the package:

$$backed.bat ---- Copies the file $$backed.up$ to c:\
$$backed.up$ ---- Tells RADCNET.BAT to type NOTBACK.ANS
$radc.bat ----- The Modification nessary to RADCNET.BAT
backup.bat ----- The basic backup file witch is called by call2bac.bat
bcopy.bat ----- the first of two copy utilities
ccopy.bat ----- the second of two copy utilities
call2bac.bat ----- calls backup.bat with parameters to backup certain network assets
copytape.bat ----- copies files under f:\backup to the tape drive
dismount.bat ----- unmounts the drives that mount.bat mounted
mount.bat ----- mounts the drives nessary for the copy utilities
*.ans ----- files that display now coping XXXX files from net.asst.

These are the batch fileswhich are located in *F:\BACKUP* needed to run the backup program. The program also relies on the *NET* command from *10NET*, which is located in *G:\10NET*, and the Unisys backup utility,which is located in *F:\UNI_TAPE*.

The program starts to backup when the *AUTORUN* program, part of the Unisys backup program, calls the *CALL2BAC* file at the appropriate time. The time table for backups is set by, the system administrator by specifying a parameter in the *AUTOSET* program.

Then the *CALL2BAC* file calls the *BACKUP* file one by one for each station and then it calls the *COPYTAPE* file to copy the files to a buffer area used by the tape backup system. NOTE: Please refer to the tape backup documentation to get further help on this utility. The *BACKUP* file calls the *MOUNT, BCOPY, CCOPY, DISMOUNT* files.

The *MOUNT* batch file mounts the remote station and returns the control to *BACKUP*. The *BCOPY* copies the first set of files to the server. The *CCOPY* copies the next set of files to the server. The *DISMOUNT* file removes the connection to the workstation and copies the file *$$BACKED.UP$* file to C:\ .

The first thing that you will see is the *AUTORUN* dialog. Which asks you if you want to cancel or postpone the appointment. Next after 10 seconds you will see is the *BACKUP.BAT* file being called. That will put

```
*********************************************************************
****            STARTING TO BACKUP NETWORK ASSET "XXXX_S"
*********************************************************************
```

on the screen. Then *BACKUP.BAT* will call *MOUNT.BAT* mount will put

```
*********************************************************************
****            MOUNTING NETWORK ASSET "XXXXX_S"
```

```
*******************************************************************
```

mount will then mount the drives of the remote station. Then after *mount* has been completed it will return control to *backup* and *backup* will call *bcopy.bat* bcopy will put

```
*******************************************************************
**********          NOW COPING WP51 DATA FILES
*******************************************************************
```

and other similar messages. In between these messages *bcopy* is going to XCOPY the files to the server over the network. *ccopy* does essentially the same thing. Then *backup.bat* calls *dismount.bat* that will show

```
*******************************************************************
****                     DISMOUNTING NETWORK ASSET "XXXX_S"
*******************************************************************
```

dismount also copies the file *$$backed.up$* to c:\ to notify radcnet.bat that network asset was in fact backed up. This completes the *BACKUP.BAT* file

To add a new node or delete a node first you need edit the *call2bac.bat*. In the file there is a multitude of lines all containing the general things. The first thing you need to do is go to the end of the call statements and before the echos, and type *call f:\backup\backup.bat,* then a space then the node name. Next comes the drive specifications. To specify the drives on which the program reside you need to put in with spaces inbetween either Y or Z. Please note Y: is equal to C: on the remote side and Z: is equal to D: on the remote side. If the program is nonexistant please place any other letter in the space. After the node name you need to place the Wordperfect idenifier, then Wordperfect for Windows, Freelance, Freelance for windows, Reflex, Quattro Professional, Excel , Microsoft Database, Harvard Graphics, Quattro, Powerpoint.

```
call f:\backup\backup.bat c3ba1 y y z y y z z z y y z
call f:\backup\backup.bat c3d3  y y z y y z y y y y z
call f:\backup\backup.bat c3das y z z y y z y y z y y

call f:\backup\backup.bat c3bs  y y z y y y y y y z z

call f:\backup\backup.bat dclt1 y y z z y z z z y y z

call f:\backup\backup.bat c3db2 y y z z y z z z y y z

call f:\backup\backup.bat c3ds  y y z y y z y y y y z
```

To restore files from the tape drive you will need to run *TAPE.EXE*. The program comes up with VERIFY DATE, please verify date and type enter. Then the main menu will appear then you need to select RESTORE. Then SELECTIVE. Then POSITION BY DATE. Then type in date, followed by return. Go to the drive selection and type the drive that you want to restore to. Then SELECT FILES, select the files that you want and then select RESTORE FILES.

Here is a source listing of the needed batch files. Standard C notation is used within the file please EXCLUDE this from the source.

```
************$$backed.bat:

                @echo off

                cls

                copy f:\backup\$$backed.up$ y:\

************$radc.bat:
```

```
@echo off
cls
if not exist c:\$$backed.up$ goto error
goto del

:error
Type notback2.ans
pause Please press enter
goto end

:del
del c:\$$backed.up$

:end

************backup.bat:

@echo off
cls
f:
cd\backup
echo [34m╓──────────────────────────────────────────────────────────────╖
echo [34m║   [36mSTARTING TO BACKUP NETWORK ASSET "%1"
echo [34m╙──────────────────────────────────────────────────────────────╜
echo
```

```
call mount %1
call bcopy %1 %2 %3 %4 %5 %6 %7 %8 %9
SHIFT
SHIFT
SHIFT
SHIFT
SHIFT
SHIFT
CALL CCOPY %1 %2 %3 %4 %5 %6 %7 %8 %9
call dismount %1
echo
echo [32m ╔══════════════════════════════════════════════════════════════╗
echo [32m║ [33mFINISHED BACKINGUP NET WORK ASSET "%1"
echo [32m ╚══════════════════════════════════════════════════════════════╝
echo
call $$backed.bat
f:
cd\backup
tree /f > f:\backup\tree.inf


*************Bcopy.bat


@echo off
set netname=%1
echo %netname%
echo ************************************************************
echo **   NOW PROCESSING NETWORK ASSET "%netname%_S"

echo ************************************************************************

Echo

type wp51.ans

Xcopy %2:\wp51\wpdata\*.* f:\backup\%netname%_S\wp51\wpdata /m /s /e

if not errorlevel 0 goto error

type wpwin.ans

Xcopy %3:\wpwin\wpdata\*.* f:\backup\%netname%_S\wpwin\wpdata /m /s /e

if not errorlevel 0 goto error

type fl.ans

Xcopy %4:\fl\fldata\*.* f:\backup\%netname%_S\fl\fldata /m /s /e

if not errorlevel 0 goto error

type flw.ans

Xcopy %5:\flw\fldata\*.* f:\backup\%netname%_S\wp51\fldata /m /s /e

if not errorlevel 0 goto error

type reflex.ans

Xcopy %6:\reflex\data\*.* f:\backup\%netname%_S\reflex\data /m /s /e

if not errorlevel 0 goto error

type qpro.ans

Xcopy %7:\qpro\qdata\*.* f:\backup\%netname%_S\qpro\qdata /m /s /e

if not errorlevel 0 goto error

type excel.ans

Xcopy %8:\excel\*.xls f:\backup\%netname%_S\excel /m /s /e

if not errorlevel 0 goto error

type database.ans

Xcopy %9:\database\data\*.* f:\backup\%netname%_S\DATABASE\DATA /m /s /e
```

```
if not errorlevel 0 goto error

shift

TYPE HG.ANS

XCOPY %9:\HG\HDATA\*.* F:\BACKUP\%netname%_S\HG\HDATA /M /S /E

IF NOT ERRORLEVEL 0 GOTO ERROR

TYPE QUATTRO.ANS

shift

XCOPY %9:\QUATTRO\QDATA\*.* F:\BACKUP\%netname%_S\QUATTRO\QDATA /M /S /E

IF NOT ERRORLEVEL 0 GOTO ERROR

shift

TYPE PRWPOINT.ANS

XCOPY %9:\PRWPOINT\PDATA\*.* F:\BACKUP\%netname%_S\PRWPOINT\PDATA /M /S /E

IF NOT ERRORLEVEL 0 GOTO ERROR

shift

shift

shift

type single.ans

xcopy %7:\%8\%9 f:\backup\%netname%

echo ****************************************************************

echo ** NOW FINISHED PROCESSING NETWORK ASSET "%netname%_S"

echo ****************************************************************

goto end


:error

type redblink.ans

echo ******************************************************************
echo ** THIS NETWORK ASSET HAS FAILED THIS PROCEDURE ("%netname%_S")

echo ****************************************** *******************************


:end


**********ccopy.bat


TYPE HG.ANS

XCOPY %4:\HG\HDATA\*.* F:\BACKUP\%netname%_S\HG\HDATA /M /S /E

IF NOT ERRORLEVEL 0 GOTO ERROR

TYPE QUATTRO.ANS

shift

XCOPY %5:\QUATTRO\QDATA\*.* F:\BACKUP\%netname%_S\QUATTRO\QDATA /M /S /E

IF NOT ERRORLEVEL 0 GOTO ERROR

shift

TYPE PRWPOINT.ANS

XCOPY %6:\PRWPOINT\PDATA\*.* F:\BACKUP\%netname%_S\PRWPOINT\PDATA /M /S /E

IF NOT ERRORLEVEL 0 GOTO ERROR

type single.ans

xcopy %7:\%8\%9 f:\backup\%netname%





*************call2bac.bat
```

```
\* NOTE: Y=C: Z=D: in order of placement...

Syntax:

        Backup NETNAME (w/o _S) WP51 WPWIN FL FLW REFLEX QPRO EXCEL DATABASE HG
QUATTRO POWERPOINT DRIVE PATH SELECTION

( If there is no program of the drive, place any letter in that position )

*\

  call f:\backup\backup.bat c3db1 y y z z y z z z y y y
  call f:\backup\backup.bat c3da1 y y z y z z z y z y z
  call f:\backup\backup.bat c33   y y z y y y z y y z z
  call f:\backup\backup.bat c3dt1 y y z z z z z y y z z y \norm\ *.*
  call f:\backup\backup.bat c3ba5 y y z y y z y y y y z
  call f:\backup\backup.bat c3bas y y z y y y y y z z z
  call f:\backup\backup.bat c3d2  y y z z y y z y y z z
  call f:\backup\backup.bat c3da3 y y z z z z y y z y z
  call f:\backup\backup.bat c3db5 y z z y y y y y y z z
  call f:\backup\backup.bat c3bb1 y y z y y y y y y z z
  call f:\backup\backup.bat c32   y z z y y y y y y y z
  call f:\backup\backup.bat c3ba1 y y z y y z z z y y z
  call f:\backup\backup.bat c3d3  y y z y y z y y y y z
  call f:\backup\backup.bat c3das y z z y y z y y z y y
  call f:\backup\backup.bat c3bs  y y z y y y y y y z z
  call f:\backup\backup.bat dclt1 y y z z y z z z y y z
  call f:\backup\backup.bat c3db2 y y z z y z z z y y z
  call f:\backup\backup.bat c3ds  y y z y y z y y y y z
  call f:\backup\backup.bat c3da6 y y z y y z y y y z z
  call f:\backup\backup.bat c3ba3 y y z z z y z z z z z
  call f:\backup\backup.bat c3bbs y y z y y y y y y z z
  call f:\backup\backup.bat c3d1  y y z y y z z y y y z
  call f:\backup\backup.bat c3s   y y z y y z y y y y z
Echo
echo
echo
echo ****************************************************************************
echo *****  Now Copying files to tape backup system
echo ****************************************************************************
call f:\backup\copytape.bat    \* Copies files to tape drive *\
```

***********copytape.bat

```
@echo off
cls
Echo
echo
```

```
echo

echo ***********************************************************************

echo ******                    Starting tape backup

echo ***********************************************************************

f:

cd\uni_tape

tape SBK F:\BACKUP /S /A /D /V /C+ /E /O


**********dismount.bat


@echo off

echo[0;32m ╔══════════════════════════════════════════════════════════════════════╗

echo [0;32m║   [1;37mDISMOUNTING NETWORK ASSET "%1"

echo[0;32m ╚══════════════════════════════════════════════════════════════════════╝


net use z: /d

net use y: /d


**********mount.bat


@echo off

Echo[0;36m ╔════════════════════════════════════════════════════════════════════╗

echo [0;36m║   [1;37mMOUNTING NETWORK ASSET "%1"

echo[0;36m ╚════════════════════════════════════════════════════════════════════╝


net use y: \\%1_s\c_disk c_access
net use z: \\%1_s\d_disk d_access
```

Is Multi-Media The Answer?

Ray A. Liuzzi Jr.
Summer Apprentice
Rome Lab

Griffiss Air Force Base
Rome, New York

Final Report for:
AFOSR Summer Research Program,
Rome Lab

AFOSR Sponsorship

July 1992

Is Multi-Media The Answer?

Ray A. Liuzzi Jr.
Summer Apprentice
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Abstract

The power of the personal computers is resulting in a new era of software development, an era dominated by Multi-Media. The Macintosh II represents one of the best platform available today for Multi-Media creation and interaction. The usefulness of Multi-Media presentations for training purposes was studied and tested during my tenure as a summer Apprentice at Rome Laboratory. The results showed that with the access of modern Multi-Media technology, Multi-Media training can provide the neccessary advancements for effective learning. After working with Multi-Media productions for six weeks I would highly recommend it to anyone wishing to create a training document with high quality.

ACKNOWLEDGEMENTS

The opportunities given to me by RDL, Rome Lab, and Joe Cavano are greatly appreciated. I learned many values that will help me out in the future and I am grateful for that. Since working with other lab technicians and other apprentices was a part of my everyday job I managed to get along with everyone. I adapted well to my new environment and learned how to organize a well rounded day. I learned research methods, filing methods, and proper usage of equipment. The Multi-Media project that this report is based on was put together with the help of another apprentice Mike Panara. I also received help from many other engineers in the building. Thanks to RDL I feel that this summer was a success.

Is Multi-Media The Answer?

Ray A. Liuzzi Jr.

INTRODUCTION

The incorporation of graphics, text, audio, animation, and video into one complete document is called Multi-Media. This software application was the basis of my summer project. I became the director and creator of a training film in less than six weeks. Multi-Media software has a numerous range of options available and by applying the proper data and a little imagination one can arrive at a creation that is simply unheard of in this day and age.

My project as a high school apprentice was to arrive at this final training document, learn the Macintosh, be able to teach the excel spreadsheet to my mentor, and work with the software Microsoft Word. After weeks of learning the Mac,Excel spreadsheet, and Multi-Media my project was complete. I created an Excel spreadsheet tutorial that used Multi-Media to display the proper procedures and many options available to a spreadsheet operator. I became experienced with Microsoft Word by storing data such as my final report on it day after day.

OBJECTIVE

To decide whether or not Multi-Media is a worthwhile piece of software for training purposes or any other project, I came up with a research objective to concentrate on: How effective is a Multi-Media based approach for teaching a spreadsheet? To answer that question I designed a simple experiment, collected data, evaluated results, and arrived at conclusions.

BACKROUND

Before I could start using the Multi-Media software my goal was to become very familiar with Macintosh procedures. I was exposed to new hardware and I needed to learn how each piece operated. I received experience with the Mac,hard disc drives, mouse, big screen and color display monitors, laserwriter printers,VCR outputs,microphones,CD players,videodisc players connected to computers,and scanner converters. The Multi-Media software at my disposal went hand in hand with all of the hardware products that I was working with.

Two Multi-Media software packages were needed to complete my project of creating a spreadsheet tutorial. I used Macromind Director and Macromind MediaMaker to put together and produce a finished product after the proper combination of the two. Macromind Director is used to make each separate clip and each one of these clips is stored in a collection. Macromind MediaMaker takes each clip from the collection and produces an entire sequence adding audio or background to the final production.

Macromind Director was the first piece of software I used in Multi-Media applications. This software package consists of the program itself, a help file,utilities to ease your work, an animated guided tour, tutorial files, and examples of finished presentations. In the Macromind MediaMaker package I found special artwork features and sounds in addition to the program, help files, utilities, tutorials, and example presentations.

APPROACH

My approach to the project changed slightly as I went on experimenting and learning everyday. At first I just wanted to learn Multi-Media procedures but later I wanted to find out if Multi-Media equipment could be used to teach someone an Excel spreadsheet. I designed a tutorial for teaching how to use a computer based spreadsheet and then developed an experiment for testing the quality of my Multi-Media production and the effectiveness of the tutorial.

First I'll explain how I went about making my production and then I'll explain how my experiment was run. Multi-Media software Director allows the user to import clip art, text, and sounds from other Macintosh files. It also provides a paint screen where the user can add or delete animation and sound. The user is also able to create his or her own animation and text. I used both options to create all my own text but I imported things like a spreadsheet, pictures, sounds, and charts. I also used a microphone when taping my production from the computer to videotape to add a vocal description of proper spreadsheet programming.

I used a sample golf database to demonstrate the use of a spreadsheet. In my tutorial I had a column labeled PGA money leaders. Under that column I had several PGA golfers and right next to that I had the number of tournaments each golfer played in this year. In another column I had each players total earnings for the year. I then showed how the Excel spreadsheet could find the average for each player with two simple commands. The use of sum functions and other functions were shown on my tutorial to provide sums, averages, products, and disqualifications.

The production also showed the correct way to create charts from the data on the worksheet. Many chart options are available to an Excel spreadsheet operator and proper way to view and read these charts is explained in my tutorial.

EXPERIMENT

To obtain the best results from my experiment I created a second Multi-Media video. This second video was a direct recording of an Excel spreadsheet operator performing the identical tasks as the first video was explaining. The actual experiment consisted of three engineers with no prior knowledge of Excel spreadsheet to attempt a problem. I gave each engineer the same problem which asked them to enter data into a blank spreadsheet, perform an average and a sum using excel functions, and create three charts.(see Appendix 1) Engineer 1 watched video 1, Engineer 2 watched video 2, and Engineer 3 read an Excel manual. After the engineer's worked on the assigned problem, each was given a questionnaire to fill out.(see Appendix 2)

RESULTS

Although the sample size in the experiment was too small for conclusive results, the evidence seemed to indicate that Multi-Media was an effective training aid. The two engineer's that were trained by Multi-Media productions had more insight of what to expect and they were finished in less time with more accuracy. The engineer using the manuals had trouble finding ways to solve problems and he had no insight of how to organize the material on the spreadsheet.(see Appendix 3a, 3b, and 3c) The Multi-Media production concentrated directly on the tasks in the problem and this is most likely the reason why the egineers who watched the videos were able to generate spreadsheet charts.(see Appendix 4)

CONCLUSIONS

My overall experience was one of great learning and enjoyment. I was pleased with the basis of my project and with the environment I was working in. I concluded from my research that Multi-Media is an effective training aid for teaching someone to use an Excel spreadsheet. Multi-Media certainly taught me how to utilize a spreadsheet and it also showed me the many options and equipment available today for processing many types of data. My experience with the Macintosh taught me that anything can be created, all it takes is a little time and a lot of imagination. In utilizing the Director and MediaMaker software packages I was offered the opportunity to create video movies using animation, graphics, text, and voice. I feel Multi-Media technology will grow in the future and be an effective aide in many other application areas.

APPENDICES

(6 PAGES)

Appendix 1

Experiment Problem

Given the following...

Wayne Levi-8 Tournaments-$400,000 Earned

Fred Couples-10 Tournaments-$500,000 Earned

John Daly-7 Tournaments-$490,000 Earned

Greg Norman-12 Tournaments-$240,000 Earned

Enter the data into an excel spreadsheet

Using the features of Excel find...

1) The average earnings for each player? (366,374) (24)

2) The total earnings of each player combined? (366,375) (81)
(must use sum function)

3) Create a bar chart from the information you found and the information that was given? (378) (247)

4) Make a pie chart?

5) Make a 3-D chart?

Appendix 2

Blank
Questionaire

1) Did you finish the problem? (Y or N)

2) If not why not?______________________________________
____

3) What training material did you use? (manual,video 1,video 2)

4) Usefulness of training grid:

Not useful		Somewhat useful		Very useful
1	2	3	4	5

5) What critisms do you have?________________________________
____

6) What complements do you have?____________________________
____

7) How could this be improved?______________________________
____

8) For training do you see a future in Multi-Media? (Y or N)

9) What is your overall opinion?______________________________
____
____

Appendix 3a

Questionaire I

1) Did you finish the problem? ([✓ Y] or N)

2) If not why not?

3) What training material did you use? (manual,video 1,[✓ video 2])

4) Usefulness of training material:

Not useful		Somewhat useful		Very useful
1	2	[✓ 3]	[✓ 4]	5

5) What critisms do you have? Too many summptions

6) What complements do you have? Good overview of excel

7) How could this be improved? Need a little more vocal tutorial

8) For training do you see a future in Multi-Media? ([✓ Y] or N)

9) What is your overall opinion? Good Job

Appendix 3b

Questionaire II

1) Did you finish the problem? ([✓ Y] or N)

2) If not why not?

3) What training material did you use? (manual,[✓ video 1],video 2)

4) Usefulness of training material:

Not useful		Somewhat useful		Very useful
1	2	3	[✓ 4]	5

5) What critisms do you have? Too fast at times

6) What complements do you have? Nice voice tutorial

7) How could this be improved? Go more in detail and don't assume

8) For training do you see a future in Multi-Media? ([✓ Y] or N)

9) What is your overall opinion? Impressive video

Appendix 3c

Questionaire III

1) Did you finish the problem? (Y or [✓ N])

2) If not why not? Never used excel, could not find charts in book

3) What training material did you use? ([✓ manual],video 1,video 2)

4) Usefulness of training material:

Not useful		Somewhat useful		Very useful
1	[✓ 2]	3	4	5

5) What critisms do you have? Could not find things quickly

6) What complements do you have? Nice idea of experimentation

7) How could this be improved? Collect more opinions and ideas

8) For training do you see a future in Multi-Media? ([✓ Y] or N)

9) What is your overall opinion? Multi-Media looks very impressive

Appendix 4

EXPERIMENT RESULTS

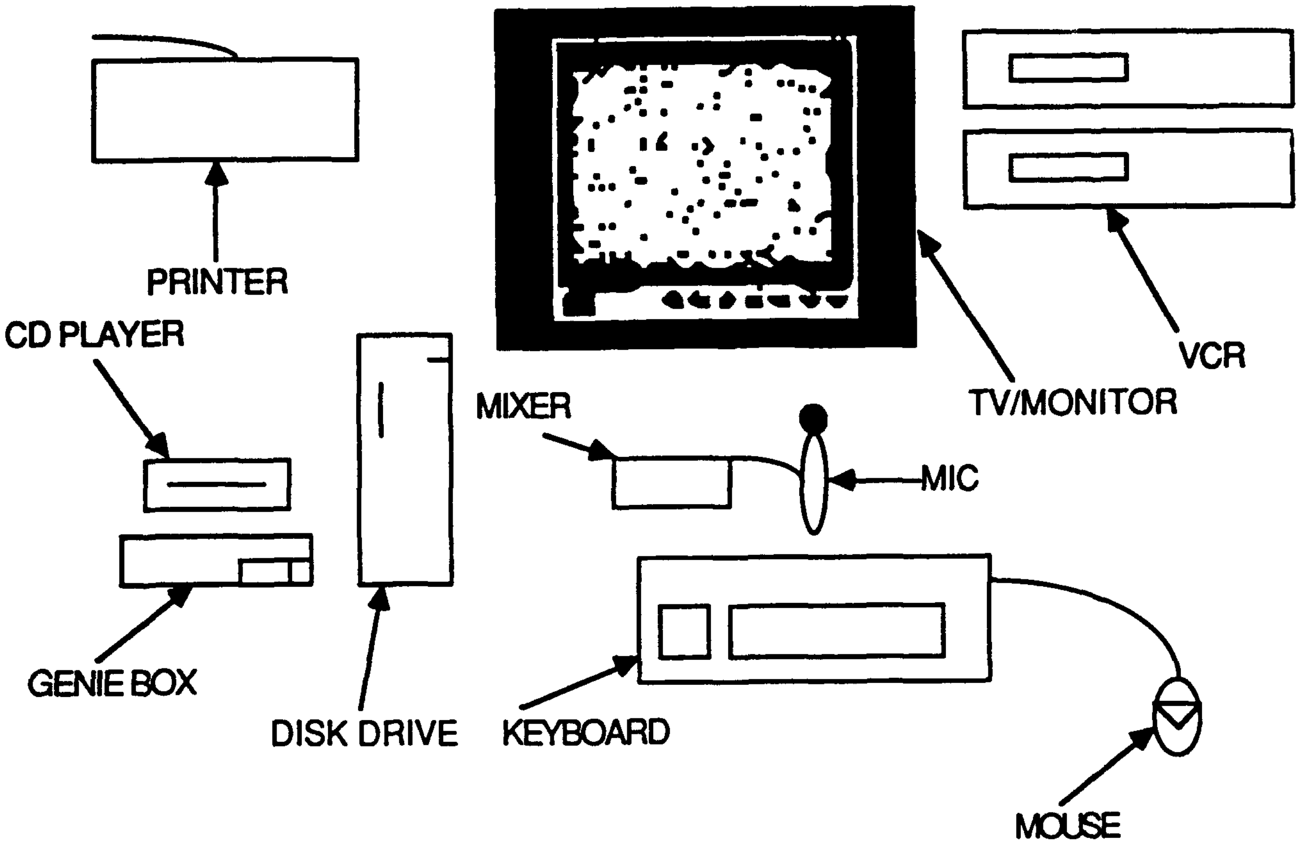
Novice users	Training material	Completed(Y/N)	Time
Engineer 1	Manuals(excel)	N	30 MIN
Engineer 2	Multi-Media video 1	Y	15 MIN
Engineer 3	Multi-Media video 2	Y	20 MIN

	Entered data	Found average	Used SUM function	Created Bar Chart	Pie	3D
Engineer1	*	*	*	–	–	–
Engineer 2	*	*	*	*	*	*
Engineer 3	*	*	–	*	*	*

Completed *

Incomplete –

EQUIPMENT AVAILABLE


PRINTER
CD PLAYER
GENIE BOX
DISK DRIVE
MIXER
KEYBOARD
MIC
TV/MONITOR
VCR
MOUSE

Artificial Neural Systems

Sean Menge
Communications Technology Branch
Rome Laboratory

Final Report for:
Research & Development Laboratory
High School Apprenticeship Program

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Bolling Air Force Base, Washington, D.C.

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Artificial Neural Networks

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Abstract

Artificial Neural Networks were studied over the term of the research period. Areas of study included, what an artificial neural network is, the history behind it, explanations of several general problem domains, and a discussion of possible applications of Artificial Neural Networks. Research was conducted in Rome Laboratory's Technical Library. This report gives a general introduction to Artificial Neural Networks and discusses several potential applications for future research. The research performed over the course of this eight week apprenticeship has generated a better understanding of what Artificial Neural Systems are and how they may be applied to future military communications development programs.

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1.1 INTRODUCTION

Over the past few years interest in artificial neural networks has grown rapidly. Professionals, mainly in the field of engineering, are amazed about the potential offered by this technology and are constantly looking for new applications.

Artificial neural networks are biologically inspired; that is, they are composed of elements that perform similar to the functions of the biological neuron. The similarity is so close that there has often been an analogy drawn between the two. Despite this superficial resemblance, artificial neural networks exhibit a surprising number of the brain's characteristics. One example, of these characteristics is repetitive learning which is to say the neurons learn from experience. Through repetive presentations of the input data the network is able to match the correct pattern with the correct output pattern with a lesser percent of error.

Artificial neural networks can modify their behavior in response to their environment. Because of this ability the neural net is receiving much enthusiastic attention. If shown a set of training inputs, the networks have the ability to self-adjust in order to produce consistent responses. That is where the learning algorithm comes into play. Once trained, a networks response can be insensitive to minor variation in its input. Neural networks display a high degree of proficiency in the ability to recognize patterns that have been corrupted by noise and distortion.

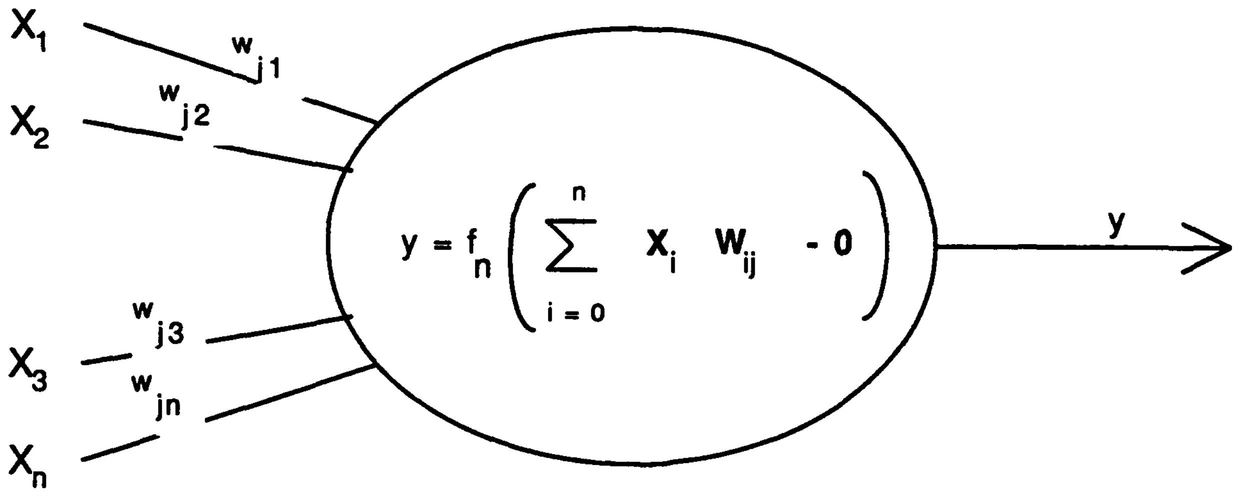
Some artificial neural networks are capable of abstracting the essence of a set of input. For example, a network can be trained on a sequence of distorted versions of a number. After adequate training, application of such a distorted example will cause the network to produce a perfectly formed number. The ability to extract an ideal from imperfect inputs brings back into play the common analogy of neural networks theoretically modeling to the human brain.

The artificial neuron was designed to mimic the first-order characteristics of the biological neuron. In essence, a set of inputs are applied, each representing the output of another neuron. Each input is then multiplied by a corresponding weight, analogous to a synaptic strength, and all of the weighted inputs are the summed to determine the activation level of the neuron.

A neural network is a computational model that is a directed graph composed of neurons (sometimes called nodes or units) and connections. A rule that updates the activation is typically called the update rule. Typically, all the activations would be updated simultaneously. The simultaneous updating of all the activation weights illustrates the inherent parallelism exhibited by neural networks. The neural network architecture is an attractive candidate for implementation on parallel hardware such as the connection machine, Intel I860, Hypercube and the DAP processor. But due to the lack of availability of parallel computers neural networks are typically simulated on conventional serial computers utilizing the Von Neuman architecture.

Learning in a neural net generally occurs by adjustment of the weights via a learning rule. The network is typically trained to either complete an input pattern, classify an input, or compute a function of its input. During initial training, with the weights incorrectly set the network will perform badly. By gradually adjusting the weights to reduce the error between the desired output and the actual output, the networks performance will start to improve. After the weights have converged and the desired output equals the actual output, it is not necessary to continually adapt the weights.

A critical fact about neural networks is that they are statistical associative models. A typical network model has a set of input patterns and a set of output patterns. The role of the network is to perform a function that associates each input pattern with an output pattern. A learning algorithm, such as backpropagation, uses the statistical properties of a set of input/output pairs to derive general outputs from novel inputs. Without the ability to generalize, neural network models would be like look-up tables which have no ability to derive solutions from uncertain data or formulate a solution apart from seemingly unrelated inputs. A connectionist system either classifies the input or performs some function of it. In either case the function computed tends to be a continuous one, with relatively similar outputs being assigned to similar inputs.



Basic Neuron

Fig. 1.

1.2 History of Artificial Neural Networks

The task of painstakingly mapping out the structure and function of the human nervous system has allowed researchers to develop a good understanding about the anatomical composition of the human brain. Unfortunately, little has been revealed as to the actual operation of the seemingly infinite interconnections of neurons. The improved understanding of the functioning of the neuron and the pattern of its interconnections has allowed researchers to produce mathematical models to test their theories. Experiments can now be conducted on digital computers. From early work it became apparent that these models not only mimicked functions of the brain but that they were capable of performing useful functions in their own right. Therefore two mutually reenforcing objectives of neural modeling were defined and remain today: first to understand the physiological and psychological functioning of the human neural system; and second to produce computation systems (artificial neural networks) that perform brainlike functions. It is the latter objective which draws so much attention to neural networks.

In 1949, D.O. Hebb proposed a learning law that became the starting point for artificial training algorithms. Augmented today by many other methods, it showed scientists of that era how a network of neurons could exhibit learning behavior. The first artificial neural network was produced in the 1950's when researchers combined biological and psychological insights. This neural network was initially implemented through the use of electrical circuits but was later converted to computer simulation, which is still commonly used today. Early success by Marvin Minsky, Frank Roseblatt, Bernard Widrow, fueled much optimism in the development of single layer artificial neurons. These single layer neurons often called perceptrons, were applied to such diverse problems as weather prediction, electrocardiogram, and artificial vision.

Neural Networks failed to resolve some problems that appeared very similar to other problems that the networks had previously solved. These unexplained failures launched a period of intense analysis. Marvin Minsky, carefully applying mathematical techniques, developed rigorous theorems regarding network operation. His research led to the publication of the book Perceptrons (Minsky and Papert 1969), in which he and Seymore Papert proved that the single-layer networks then in use were theoretically incapable of solving many simple problems, including the function performed by a simple exclusive-or gate.Minsky was not optimistic toward progress. Minsky's brilliance,rigor, and prestige gave the book great credibility: its conclusions were unassailable. Discouraged researchers redirected their efforts towards areas of greater promise, government agencies redirected their funding, and artificial neural networks lapsed into obscurity for nearly two decades.

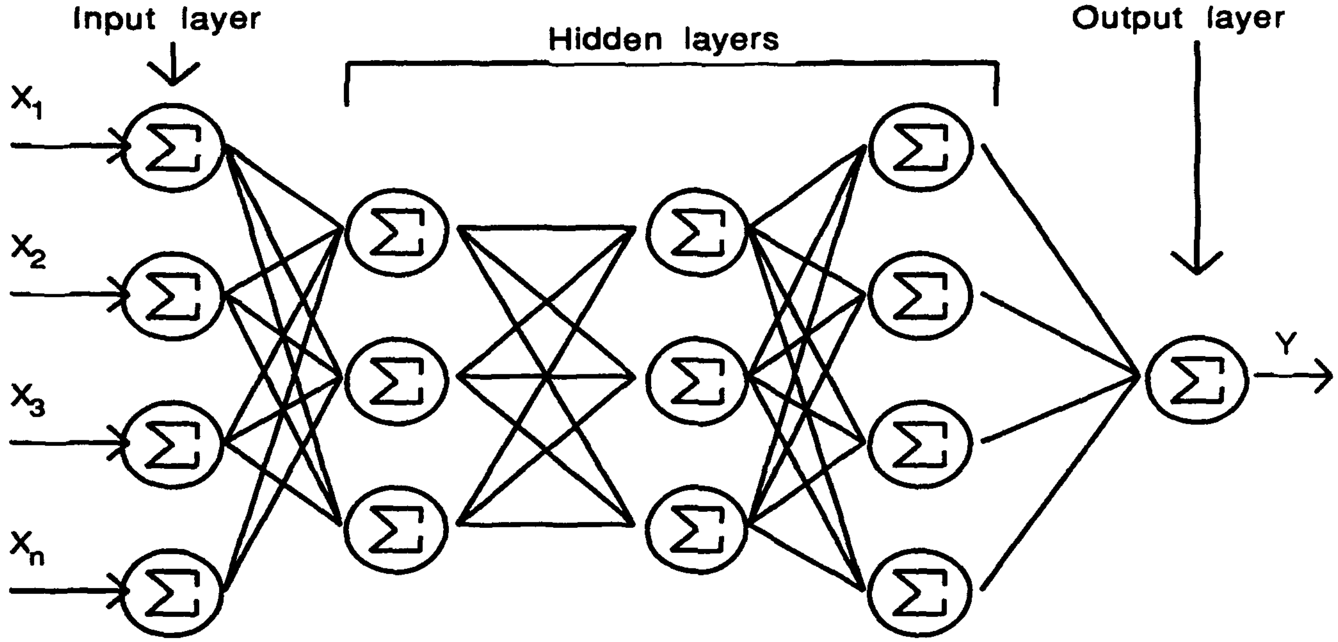
Nevertheless, a few dedicated scientists such as Teuvo Kohonen, Stephen Grossberg, and James Anderson continued their efforts. Often underfunded and appreciated, some researchers had difficulty finding publishers. Research published during the 1970s and early 1980s is found scattered among a wide variety of journals, some of which are rather obscure. Gradually, a theoretical foundation emerged, that was based on utilizing multilayer networks to determine non-linear separation boundaries in a given solution space. This breakthrough allowed neural networks to solve problems that Minsky and Papert felt were unsolvable through the use of this technology. Minsky's appraisal has proven excessively pessimistic; networks are now routinely solving many of the problems posed in his book.

In 1985, a special issue Cognitive Science was devoted to the subject of "connectionism", which was one of the new names for the field of neural network modeling. This new name emphasized the idea that the orientation of the synaptic connections provide critical information as to the behavior of the network.

Another reason for the renewed popularity of the connectionist models was the fact that parallel computers began to become available. Connectionist models are one important variety of parallel computational models

An important lesson to be learned can be found in Clark's Law, which states that if a respected senior scientist says a thing can be done, he or she is almost always correct; if the scientist says it cannot be done, he or she is almost always wrong. There has been an explosive increase in the amount of research activity.

Large corporations regularly exercise internal funds in excess of millions of dollars towards developing real world applications of this neural network technology. Thousand of University thesis and dissertations are produced every year exploring the multi-faceted world of "connectionism." Current areas of applied research for neural networks include: time variant multi-speed spectral analysis, handwritten character recognition, underwater sonar signal recognition, speech processing, image analysis and a multitude of other varying applications. The number of potential application areas is phenomenal.



Parallelism exhibited by Neural Networks

Fig. 2.

1.3 General Application Domains for Neural Networks

Seven high level domains that account for most of more popular applications for Neural Networks include 1.) multi-sensing, 2.) nonlinear mapping, 3.) sensory data processing, 4.) computational problems, 5.) self organization, 6.) classification, 7.) associative memory.

Multi-Sensing Automata. A number of complex, multi-module neural network automata have been built with visual input and a robot arm to manipulate objects in an environment. These automata demonstrate how an eye or camera can learn to scan a scene using self-supervision, and then how the eye and hand can be coordinated to perform simple tasks. These automata also demonstrate how inputs from multiple sensors can be fused to provide classification performance better than could be achieved with a single sensor.

Nonlinear Mapping. The use of non-linearity mapping occurs throughout with parallel distributed processing systems. An example, a perpendicular line drawn to a weight vector. Since all vectors on the line project to the same point on the weight vector, their inner products within the weight vector are equal. Sometimes called a logistic, or simply a squashing function, the sigmoid compresses the range of NET so that OUT lies between zero and one. *Multilayer networks have greater representational power than single-layer networks only if a* nonlinearity is introduced. The squashing function produces the needed nonlinearity.

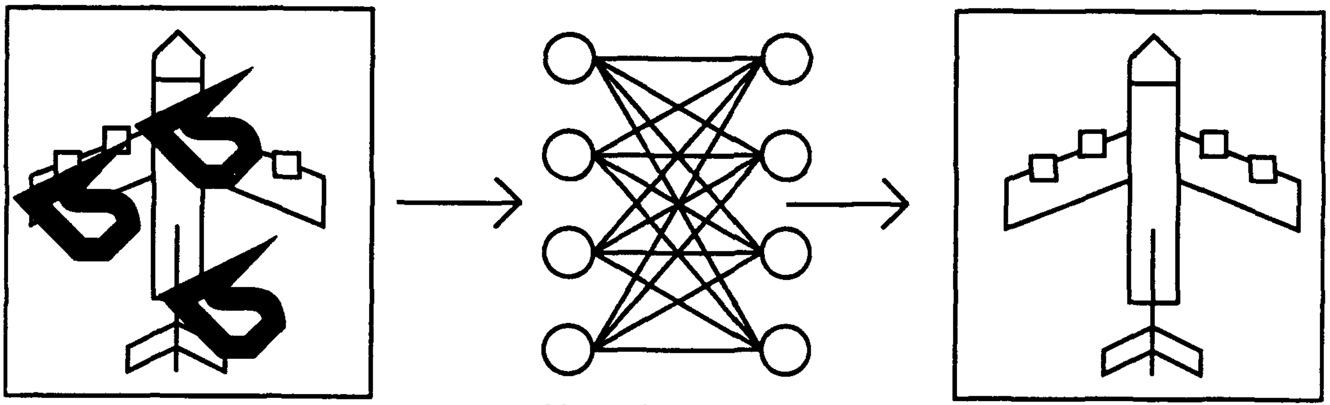
Sensory-Data Processing An enormous amount of real time preprocessing is formed in the peripheral vision and hearing centers. Neural networks can perform this function in real time using massive parallelism.

Computational Problems. Custom neural network architectures can be designed to solve specific computation problems, such as the "traveling salesman problem" and other constrained optimization problems, using nonlinear analog computation. The "traveling salesman problem" attempts to find the shortest route between some number of cities and generates an efficient route for the salesman to travel. That is not to go into the same city twice if possible. The neural network is able to find the best route available.

Self-Organization. Sensory systems have to go through brief critical periods in post-natal development in which the circuits are fine tuned in response to environmental exposure. Recent work by the Defense Advanced Research Projects Agency (DARPA) is determining the internal biochemical mechanisms. Network models are needed to explain how all these factors work together to produce the appropriate adult circuits. In addition to brief periods of self-organization during critical periods, there is strong evidence for reorganization in adult brains as well. Recent work in the somatosensory system has demonstrated such processes of recovery at the neuronal level. The cortical topographic map of the skin is dynamically regulated by the differential use synaptic nerve stimulation. By exciting or inhibiting nerve endings associated with specific regions of the skin, the affected regions will tend to shrink or expand, consequently affecting the sensitivity of neighboring epidermal regions. Mcdels seeking to explain how this self-regulation arises from neuronal mechanisms are clearly needed, and several have been proposed. Understanding of neuronal self-organization phenomena could lead to neural networks whose internal presentations of sensory information would be maximally efficient and adaptive to changes in the environment.

Classification. The classification paradigm also can be considered as variant on previous learning paradigms. There is a fixed set of categories into which the stimulus patterns are to be classified. There is a training session in which the system is presented with the categories to which each stimulus belongs. The goal is to correctly classify the stimuli so that in the future when a particular stimulus or a slightly distorted version of the one of the stimuli is presented, the system will classify it properly.

Associative Memory Associative memory is just like memory recollection in humans. It is the ability to see a face from across a crowded room. Associative memory is important to neural because conventional computers cannot give information back with only little input. Neural networks can give an output with little input and be right about ninety percent of the time. Associative memory is in fact when we learn to produce a particular pattern of activation on one set of units whenever another particular pattern of activation on another set of units. In general, such a learning scheme must allow an arbitrary pattern on one set of units to produce another arbitrary pattern on another different set of units. Associative learning is employed whenever we are concerned with storing patterns so that they can be re-evoked in the future.



Corrupted Input Pattern

Neural Network

Restored Output Pattern

Neural Networks working as an Associative Memory

Fig. 3.

1.4 APPLICATIONS OF NEURAL NETWORKS

There have been many impressive demonstrations of artificial neural capabilities: a network has been trained to convert text to phonetic representations, which were then converted to speech by other means (Sejnowsky and Rosenburg 1987); another network can recognize handwritten characters (Burr 1987); and a neural network-based image-compression system has been devised (Cottrell, Munro, and Zipser 1987).

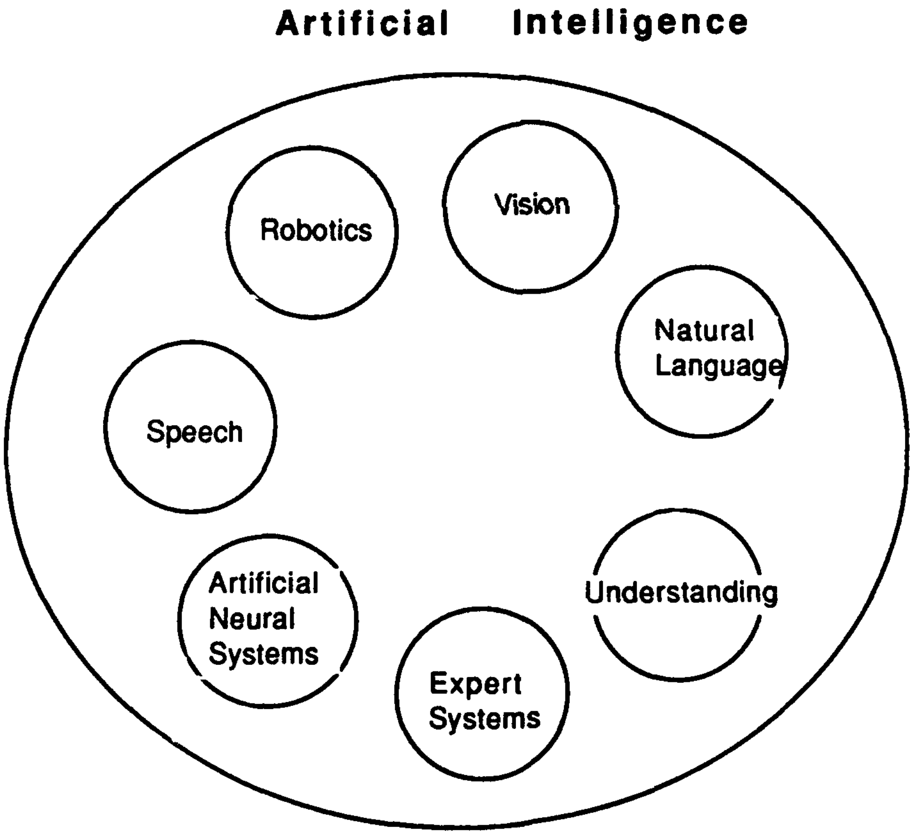
These all use the backpropagation network, perhaps the most successful of the current algorithms. Backpropagation, invented independently in three separate efforts (Werbos 1974; Parker 1982; and Rumelhart, Hinton, and Williams 1986), provides a systematic means for training multilayer networks, thereby overcoming limitations presented by Minsky.

Artificial neural networks have been proposed for tasks ranging from battlefield management to minding the baby. Potential applications are those where human intelligence functions effortlessly and conventional computation has proven cumbersome or inadequate. This application class is at least as large as that serviced by conventional computation, and the vision arises of the artificial neural networks taking their place alongside of conventional computation as an adjunct of equal size and importance.

This will happen only if fundamental research yields results at a rapid rate, as today's theoretical foundations are inadequate to support such projects.

The field of artificial intelligence has been dominated in recent years by the logical and symbol manipulation disciplines. For example, expert systems have been widely acclaimed and have achieved many notable successes, as well as many failures. Some say that artificial neural networks will replace current artificial intelligence, but there are many indications that the two will coexist and be combined into systems in which each technique performs the task for which it is best suited. Figure 4, shows that Artificial Neural Systems are a strong contributing technology to the overall "world" of artificial intelligence.

The second biggest application of neural networks is in pattern recognition. Pattern recognition can be applied to speech recognition, Industrial inspection, target recognition, medical imaging, and also image analysis, which includes: seismic data, earth satellite images, and handwritten character reading. Recognizing human speech is a challenge that makes the computer identify speech, convert it to phonetic representations, and translate it into written text. Other promising applications include: radar, sonar, electronic warfare signal identification, adaptive systems ranging from flight to manufacturing controls, image compression, detection of strategic weapons by means of satellite sensors, stealth aircraft detection by infrared search and track systems, and photo interpretation.


Artificial Intelligence
Robotics
Vision
Natural Language
Speech
Understanding
Artificial Neural Systems
Expert Systems

Some Areas of Artificial Intelligence

Fig. 4.

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A MULTI-MEDIA ENVIRONMENT:
IS IT FOR EVERYONE?

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Final Report For:
AFOSR Summer Research Program
Rome Laboratory

Sponsored by:
Rome Laboratory/C3CA
Rome, NY

June-August 1992

A MULTI-MEDIA ENVIRONMENT: IS IT FOR EVERYONE?

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Abstract

The goal of this project was to evaluate and demonstrate if available multi-media technology, including hardware and software could create a multi-media environment.

To test this, a multi-media video tutorial for using the Excel Spreadsheet was created on a Macintosh Computer using the MacroMind Director and the MacroMind MediaMaker software. The project, like all true multi-media productions incorporated text, graphics, sound and animation into a single project.

The overall report describes the multi-media environment created, the interfaces that were utilized and specific actions taken to incorporate and use multi-media in the environment. In addition, results were evaluated, recommendations for additional tools were made and a multi-media architecture is described. Results using the multi-media environment indicated that this technology will influence the use of computers in the next decade.

A MULTI-MEDIA ENVIRONMENT: IS IT FOR EVERYONE?

Michael Panara

INTRODUCTION:

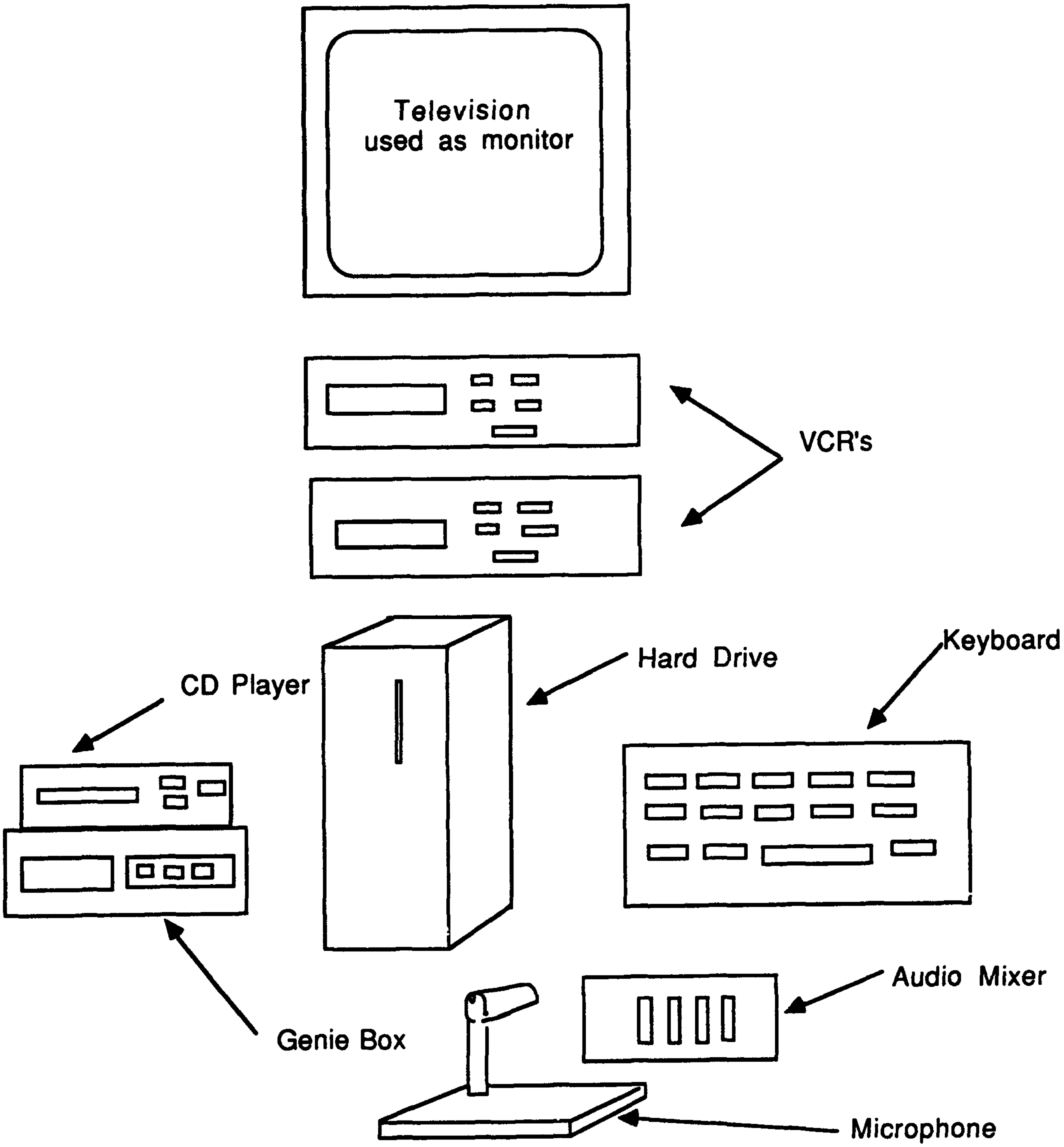
Multi-media incorporates many different types of media into a single production. These include sound, text, graphics, animation, and video. It allows the user of the program choose the pace and path that the program follows. For a true multi-media production graphics and sound are key elements.

The use of multi-media is becoming more and more popular. As more and more uses are found for multi-media, more people and corporations are considering multi-media as a possible alternative for many projects. It is being used for training, as well as in trade shows to help sell new items. Multi-media allows consumers to test products, and to see things about the products with just a press of a button.

OBJECTIVE:

The objective of this project was to learn and evaluate current multi-media software, that includes the MacroMind Director and the MacroMind MediaMaker. As part of the project , I began a research effort to assess the development of multi-media programs. For my research, I used an overall research environment that I created to evaluate the effectiveness of multi-media tools. (See Diagram p. 12-4). This environment consisted of a television, Macintosh computer, two VCRs, a hard drive, a keyboard, genie box, audio-mixer, and a microphone.

Diagram


Television
used as monitor
VCR's
Hard Drive
Keyboard
CD Player
Genie Box
Audio Mixer
Microphone

The multi-media software was used to create a tutorial for the Excel Spreadsheet. This production incorporated many forms of media and was used to teach the basics of the Excel Spreadsheet, to a viewer After the production was completed on the Macintosh computer, it then was to be transferred to videotape.

Once the videotape was created, I used the video as a training aide for people with no knowledge of how to use the Excel Spreadsheet. My overall project then centered on evaluating the multi-media tools and software that were used to create the training video, and assess which tools had the greatest impact.

BACKGROUND:

During the project, many different types of equipment were used. The most important of these being the Macintosh computer. This was the computer system used to create the project. The system was hooked up to a large screen display television set. (See Diagram p 12-4 and wiring diagrams pp 12-14 to 12-16). This made multi-media available for viewing, and gave it the look and feel of a real movie.

Two programs were used to create the project. The first was the MacroMind Director. This was used to make small parts of the entire movie, and to create the basic animation. The Director was originally created as an upgrade from MacroMind's first multi-media program Videoworks. The Director was designed to put the power of multi-media production on a desk-top computer. (MacroMind Director, Interactivity manual)

After the small clips were created used the Director, they were pieced together using the MacroMind MediaMaker. MediaMaker was created in 1988 by Apple Computer and the British Broadcasting Corporation. They were exploring the link between computers and television. This research led to the program Sequence Editor. This allowed children to create their own television shows. A few years later the group which had created Sequence Editor made a partnership with MacroMind and created MediaMaker. I used this program basically used for editing. Using the MediaMaker the smaller clips were put together in their proper order. While the graphics were being edited, music and other sounds were added to the project.(MacroMind MediaMaker, User's Guide).

However, I had no way to make a music score available able to last the entire duration of the presentation. Many different musical scores were needed to last the entire presentation.

While the presentation was being recorded to tape, voice was added. This was done using a microphone and an audio mixer. The microphone was hooked up to the audio mixer, which was in turn hooked up to the VCR. This was the only time voice was able to be added because of the tremendous amount of memory that voice takes up on the computer.

All sounds were either put into the presentation using the microphone or by importing them from another source. Neither the Director, nor the MediaMaker were able to create their own sounds. Sounds could also be taken from a compact disc player, but, this option was not used in the project. Sounds greatly added to the quality of the project.

APPROACH:

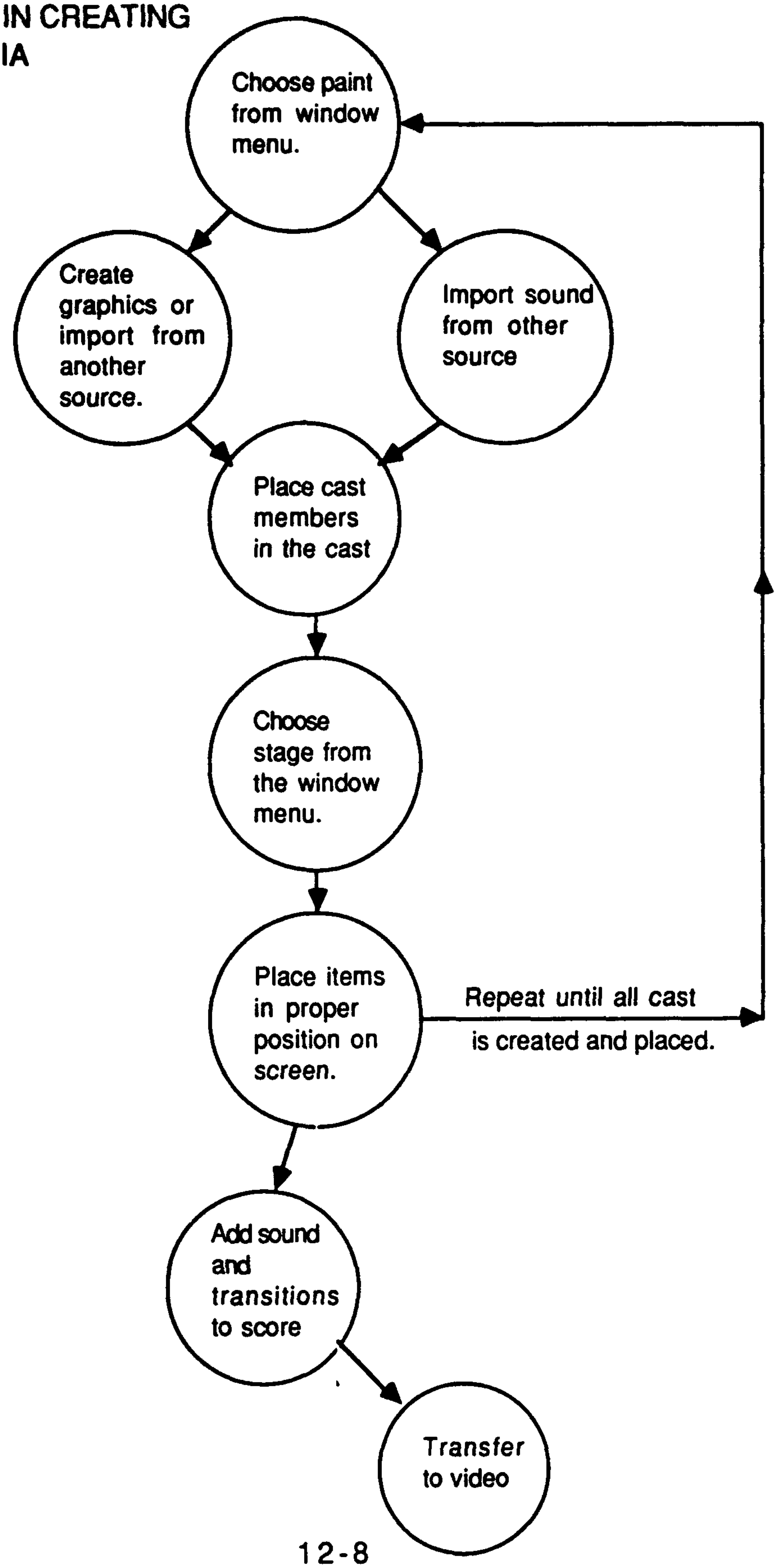
In order to use the multi-media software a tutorial was created on how to use the Excel Spreadsheet. Because of the tools available this presentation became easier to make as the project went on. I learned how to use the multi-media software, and the time needed to create certain tasks was enhanced.

Upon executing the Director program, many options are available. These options include paint and stage. Paint allows one to create new graphics, as well as modify existing graphics. Stage permits graphics to be organized on the screen and allows one to create animation. As the project progressed the steps involved became more and more routine. (See Diagram p.12-8)

To understand how the tutorial was made one must first understand the basic concepts used in creating a multi-media project using the Director program. The first of these concepts is the Score. (See Diagram p 12-9) The Score is the record of all that is done in the movie. Each box in the Score, or frame contains all important information about the object being used. This includes the objects location as well as it's position in relation to other objects on the screen.

The second item used in Director is the Cast. (See Diagram p. 12-9). This contains all objects and sounds that are used in the production. All members of the Cast are numbered. (For example A11, A24, B12 etc.). Each Cast member has a different number. These numbers are used in the score to identify the Cast member being used. Each Cast member used is represented in a separate frame of the score.

BASIC STEPS IN CREATING A MULTI-MEDIA PRODUCTION.


Choose paint from window menu.
Create graphics or import from another source.
Import sound from other source
Place cast members in the cast
Choose stage from the window menu.
Place items in proper position on screen.
Repeat until all cast is created and placed.
Add sound and transitions to score
Transfer to video

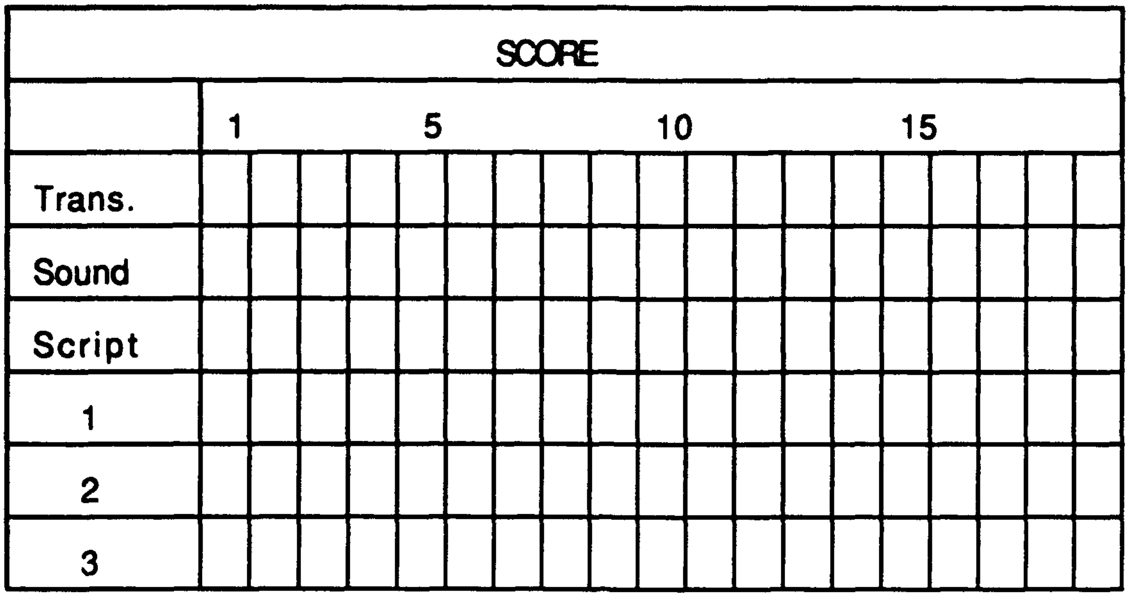

SCORE
1
5
10
15
Trans.
Sound
Script
1
2
3

Figure 1: Sample score chart

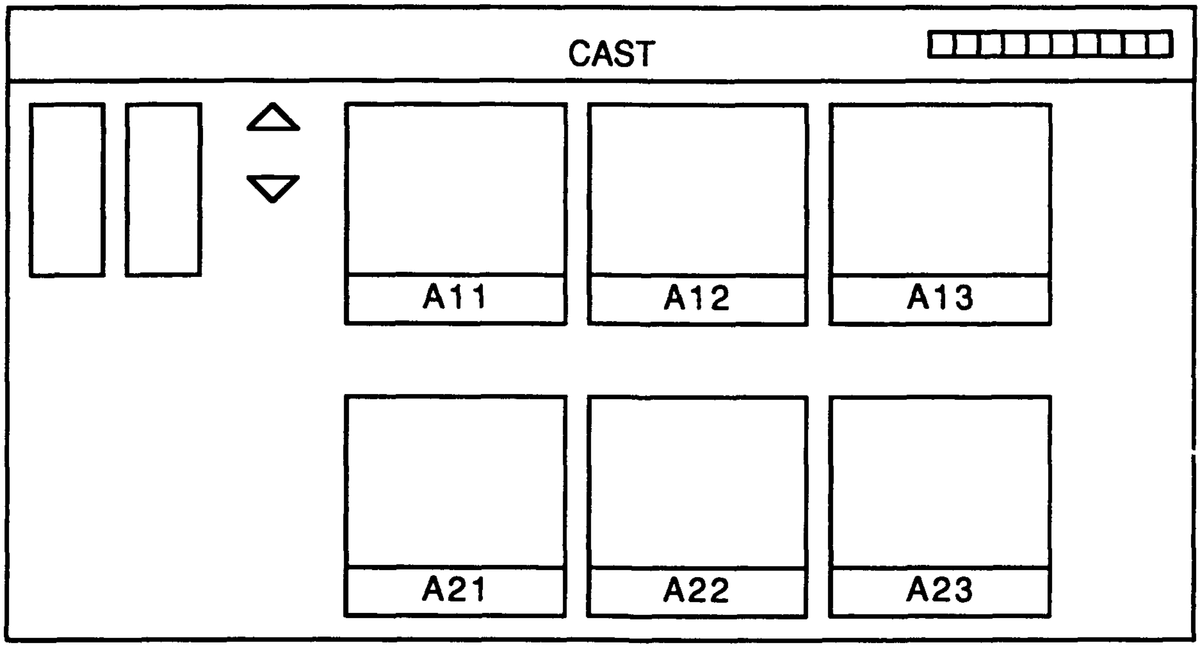

CAST
A11
A12
A13
A21
A22
A23

Figure 2: Sample cast chart

The Cast members are created using the paint option. This is found under the window menu. Cast members do not have to be created using the Director. They can be imported from other sources using the import option from the file menu. After the Cast members are imported, they can be modified. Colors can be changed. Objects can be added or erased. The object can even be enlarged or shrunk. This is also done using the paint option of the Director. The Director does not have an option to allow the sound Cast members to be modified.

Another item that can be used by Director to make the project more interesting are transitions. These allow one item on the screen to fade out, and one item to fade in. Transitions have their own row in the Score chart. To add a transition, first double-click in the transition frame above the item one wishes to fade in. Then select the proper transition, and then click on OK. The rate at which the objects will fade in and out can also be changed. This is done when choosing the transition.

An important part of any multi-media presentation is animation. Animation is using many slightly different pictures in rapid sequence to give the illusion of motion. To animate graphics using the Director does not require the user to place the cast member in each individual position in it's path. The object need only be placed in it's starting position and ending position, both on the screen and in the score. Then the user can choose the in-between option from the score menu. The objects path will automatically be filled in. When it is played back the object will move across the screen. This can only be done when the object moves in a straight line. The object can move in any direction and at any angle across the screen. Objects that show motion, such as a person with a moving hand, must be drawn in every position shown.

Also used in a multi-media project is sound. Sounds, like, transitions have their own row in the Score chart. These cannot be created using the Director or the MediaMaker. They must be imported from other sources. The procedure for importing sounds is the same as importing graphics. The import option must be chosen from the file menu.

Once the project is ready to be put together, it is time to use the MediaMaker. The MediaMaker is needed because of the memory limitations of the Director. This takes all of the short segments from the Director and pieces them together. The MediaMaker is used basically like an editor. One can place smaller segments in their proper order.

Once the project is pieced together using the MediaMaker, the sounds must be added to the presentation again. The MediaMaker does not recognize the Director's sound effects. Sounds made for the MediaMaker must be used. The advantages to this are the MediaMaker sounds are longer, and easier to add to the project.

To put together the project using the MediaMaker, one must first put together a collection of all the small segments to be used in the presentation. This is done by first choosing the file menu, then choosing New Collection from the menu. Now one is ready to create their sequence. To begin piecing together the collection, first choose the elements menu, and then choose the type of element one wants, such as graphic, sound, animation, etc.

Once the type of item to be placed into the collection is decided, it is time to import the object. The item is imported in the same way as graphics and sound are imported on the Director. All items to be used in the movie must be placed into a collection, even the sounds.

After the collection is completed the movie is ready to be put together. To do this, first choose New Sequence from the file menu. The computer will then show a box that looks something like a time-line. This is where the small parts of the movie and the sounds are placed in their proper order.

To assemble the movie, first choose the picon (picture icon) that is to go first. Then, drag the picon to the desired location in the sequence. The picon will then shrink, or enlarge to fit the amount of time needed on the time-line. After placing the first one, simply place all other picons in the desired order following after the first one.

Sound is available at the bottom of the time-line. The procedure for placing the sound is the same as the one for placing the animation, except for the rows are different.

After placing everything in it's proper order, save the project using the save command under file. Then press the play arrow on the sequence box, and the production will play. To stop the movie from playing, press the mouse button.

RESULTS:

I felt that once I started to get used to the program it became easy to use. Short-cuts found along the way made it much easier, and less time consuming. The most important short-cut was the use of the in-between command. I found that objects did not have to be moved to every point in their path, just the beginning and end points. Then, by dragging the mouse in the score, and choosing in-between from the score menu, the object was automatically animated.

The movie itself came out quite well. The quality was much better than expected. I did not think, at the beginning, that a high quality production could be made on a computer, with such ease.

CONCLUSIONS:

A multi-media architecture as described in this report is extremely valuable for creating a multi-media project. The tools and equipment that were available for the experiment worked extremely well. The software was easy to use, and very effective. Both the Director and the MediaMaker preformed much better than I had expected. The recording to video from computer was also much easier than I expected. What I thought would take an entire day, took only about two hours, and a few trials.

I feel that using multi-media software is well worth the time needed to create it. The use of multi-media can greatly reduce the time needed to teach many types of texts.

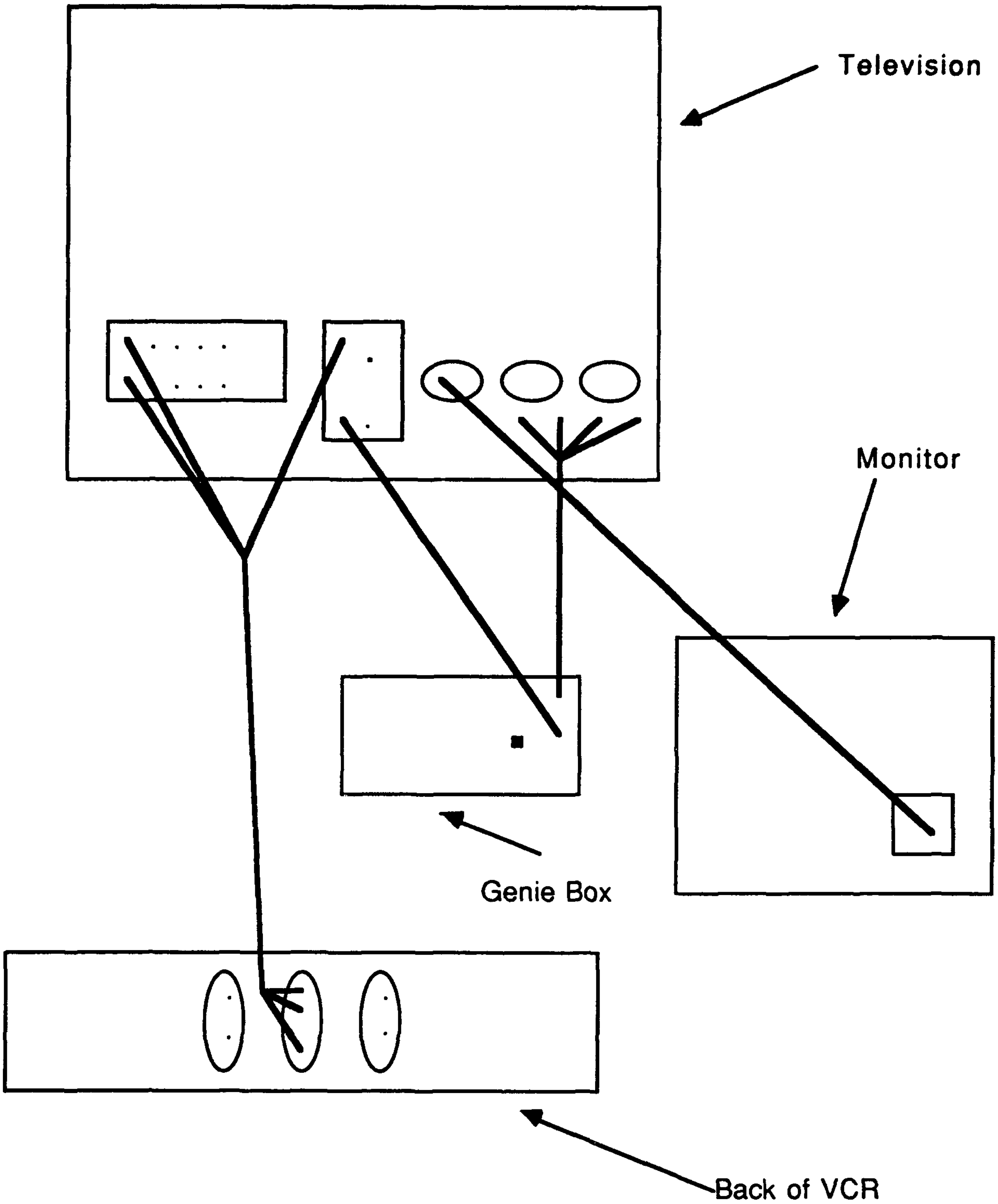
For instance as part of this research, an experiment was developed by a summer colleague (Ray Liuzzi, "Is Multi-Media the Answer?"). The experiment tested how well the training video worked. It demonstrated the great success of multi-media as a training vehicle. The actual multi-media software is available and easy to learn for a novice.

Many different kinds of data were computed in my experimental environment. (See Diagram p.12-4). I used it to create a production that is quite useful for a number of applications.

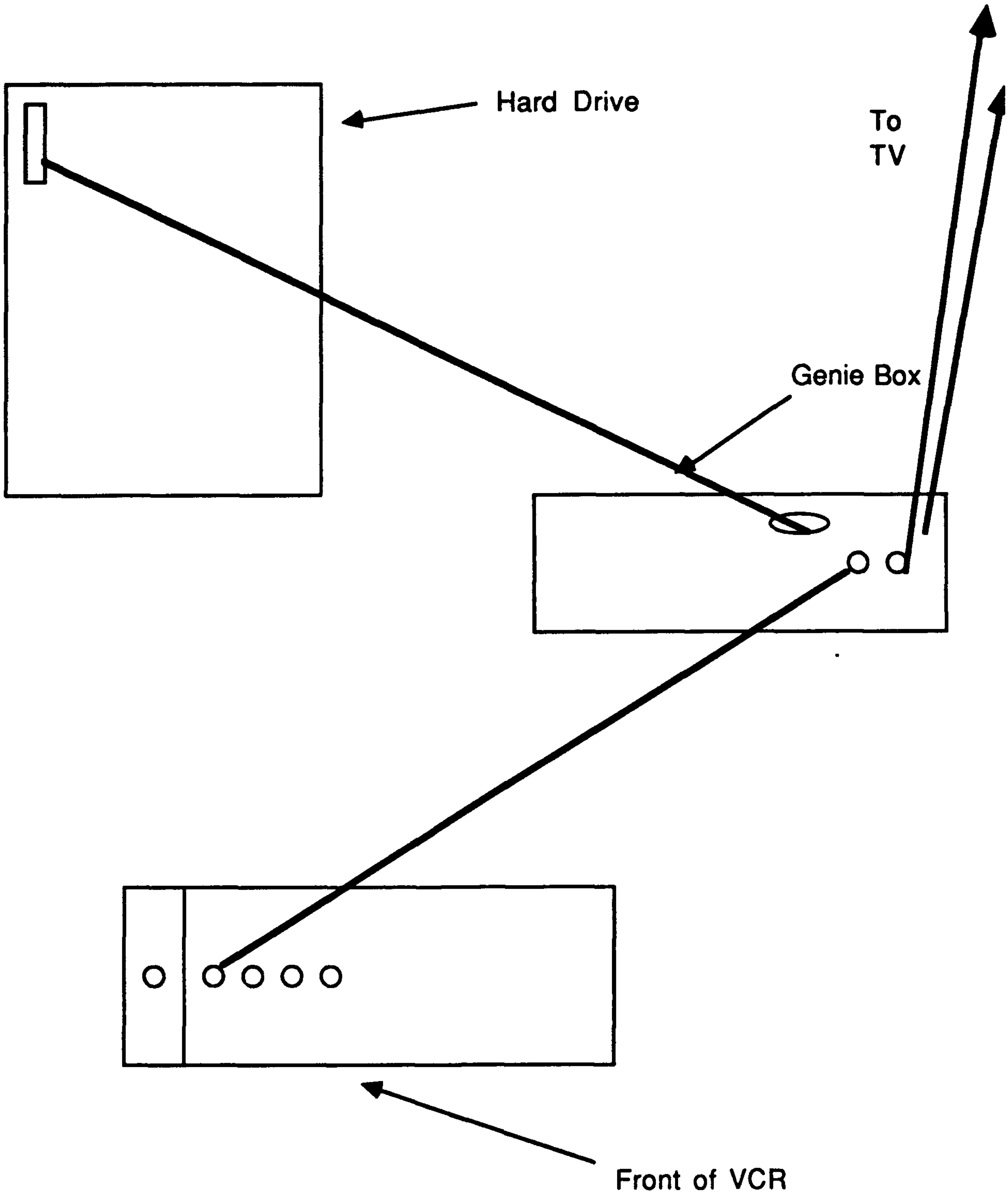
Many different types of media were not available for use at the time, but these can be used in a multi-media production. These included the compact disc player. This could have been used to add longer and higher quality sounds to the production. Also availability of actual video clips, transferred to computer from a video tape would enhance the overall production. Without this capability, images would have to be scanned into the computer using a scanner. Scanned images take up more memory than the Director program could handle.

Based on this information, the results of the experiment, and my own personal experience, I would have to say that multi-media is more than it is hyped-up to be. The tools, hardware, software, and overall architecture are are available and ready to be used. The It is a technology that will be useful in the next decade. It is up to the creative minds to take advantage.

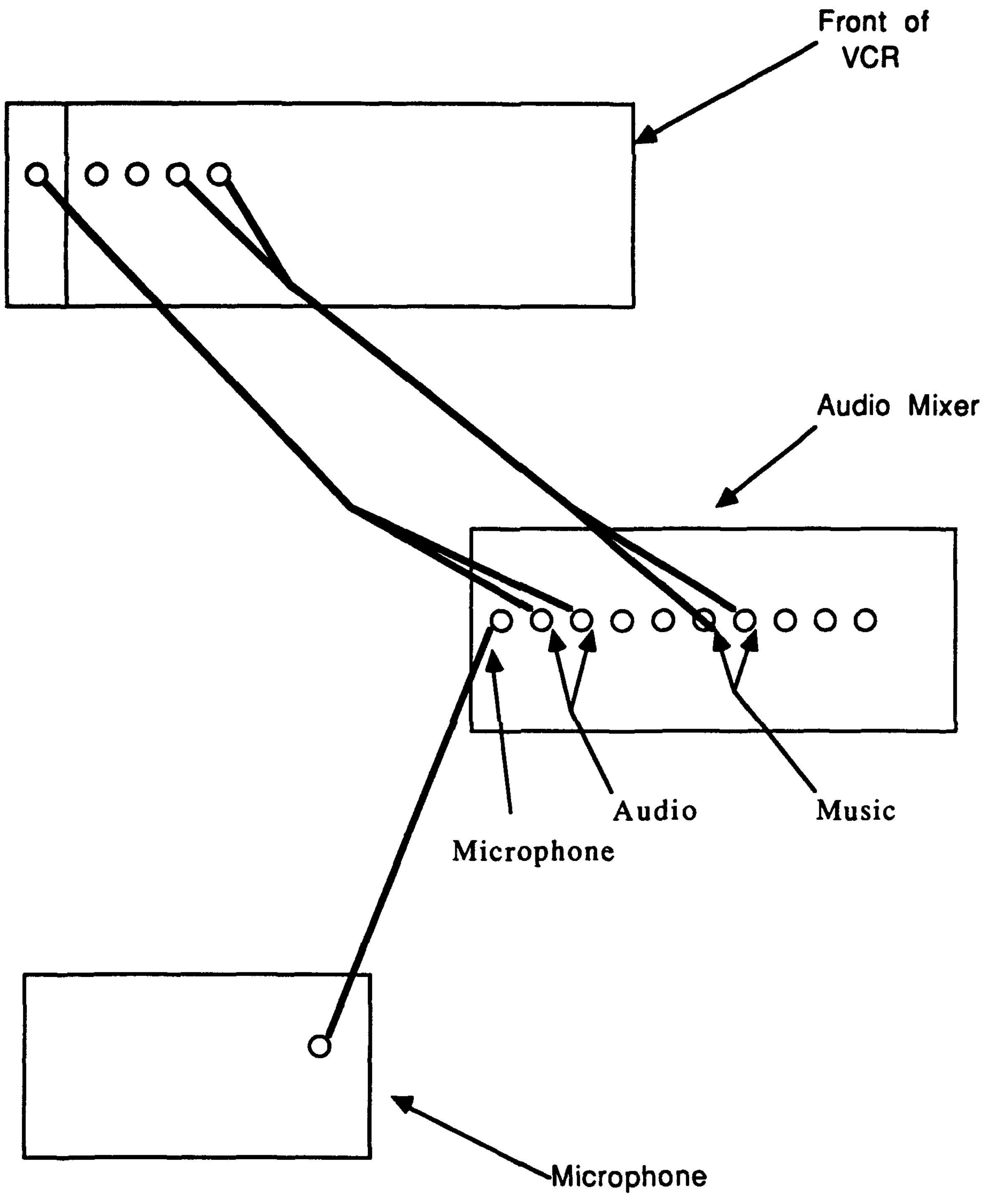
Wiring


Television
Monitor
Genie Box
Back of VCR

Wiring2


Hard Drive
To TV
Genie Box
Front of VCR

Wiring 3


Front of VCR
Audio Mixer
Audio
Music
Microphone
Microphone

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STUDY OF PARALLEL DISTRIBUTED PROCESSING

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Final Report For:
Summer Research Program
Rome Laboratory

Sponsored By:
Air Force Office of Scientific Research
Bolling Air Force Base, Washington, D.C.

August 1992

A STUDY OF PARALLEL DISTRIBUTED PROCESSING

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Abstract

Parallel distributed processing (neural networks) was the topic that was studied and demonstrated. To understand this program some basic knowledge of the brain is required. An artificial neural network is a massively parallel array of simple computational units or neurons that model some of the functionality of the human nervous system and attempts to capture some of its computational strengths. Neural networks learn on their own to make judgements the way human beings do. In other words it's like trying to create a computer to mimic the way the brain reacts to certain stimuli and how it actually thinks. The following report will discuss the differences between neural networks and digital computers, what distinguishes the neural network program from any other, what we've learned from the human brain, network structures, and the future of the neural network program.

A STUDY OF PARALLEL DISTRIBUTED PROCESSING

Anne E. Pletl

INTRODUCTION

The topic of this report shall be explained further. This program was designed to address the needs of government and industry as well as finance. The objective is to successfully apply neural nets to real problems. The approach is to understand the theory of neural networks including most popular architectures and learning rules, study applications and examples of neural networks, and learn the mechanics of applying NeuralWare Software to real problems. Neural networks can switch from one task to another easily because it's not programmed, it's trained. These programs learn on their own to make judgements the way human beings do. It's like trying to create a computer to mimic the way the brain reacts to certain stimuli and how it actually thinks. The content of this report further explains the parallel distributed processing unit (i.e, neural network) and the work that is being done with it.

THE BRAIN

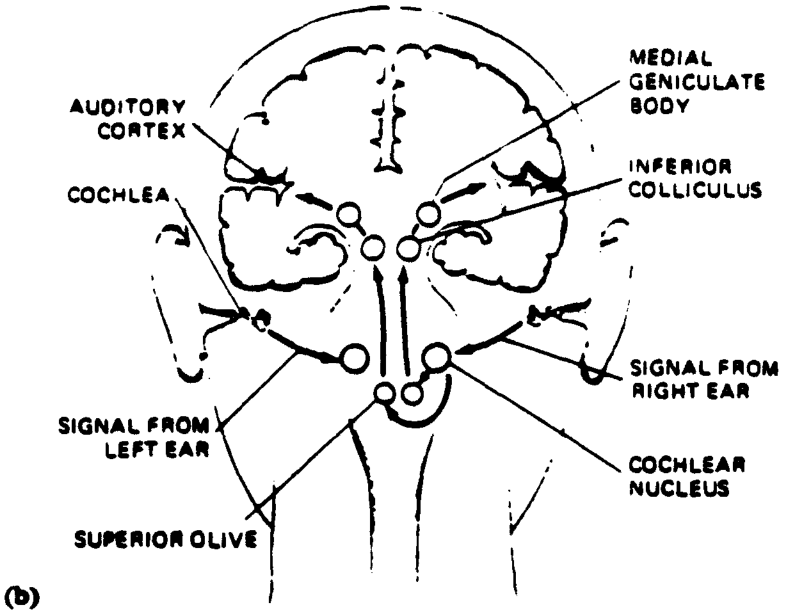
In order to recognize and understand how the neural networks program works you must first have some basic knowledge of the brain(see Figure 1).

To give you an idea of how complex the human brain is would be to tell you that the number of possible assemblies of the groups of neurons, which make up the brain, is greater than the number of atomic particles that make up the known universe (see Figures 2 and 3). [Ref 1] The connections between neurons are themselves used to store information.

The size of the actual brain is what differentiates between the thinking and development capacity of humans and animals (see Figure 4). In the past three million years of evolution, an explosion in brain size has taken place.

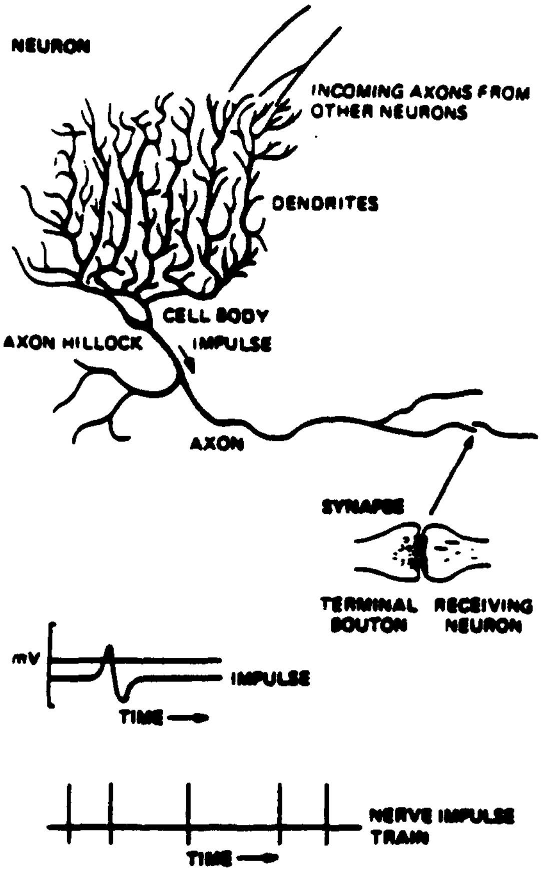
The mind is made up of several parts but the one we are primarily concerned with is the cortex. This part of the brain

Figure 1


AUDITORY CORTEX
MEDIAL GENICULATE BODY
INFERIOR COLLICULUS
COCHLEA
SIGNAL FROM RIGHT EAR
SIGNAL FROM LEFT EAR
COCHLEAR NUCLEUS
SUPERIOR OLIVE
(b)

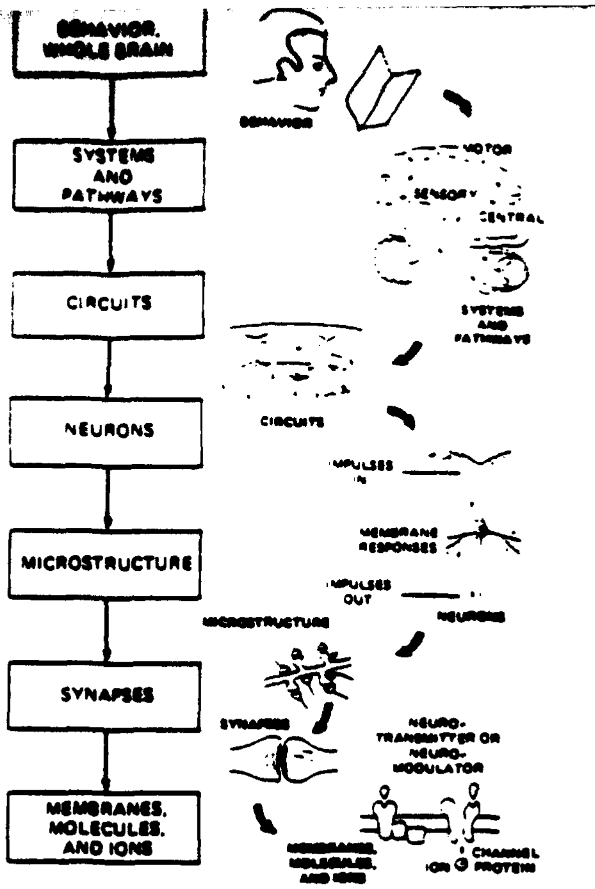
(b) Basic pathways of the auditory system, from the ear to the auditory cortex.

Figure 2


NEURON
INCOMING AXONS FROM OTHER NEURONS
DENDRITES
CELL BODY
AXON HILLOCK
IMPULSE
AXON
SYNAPSE
TERMINAL BOUTON
RECEIVING NEURON
mV
IMPULSE
TIME
NERVE IMPULSE TRAIN
TIME

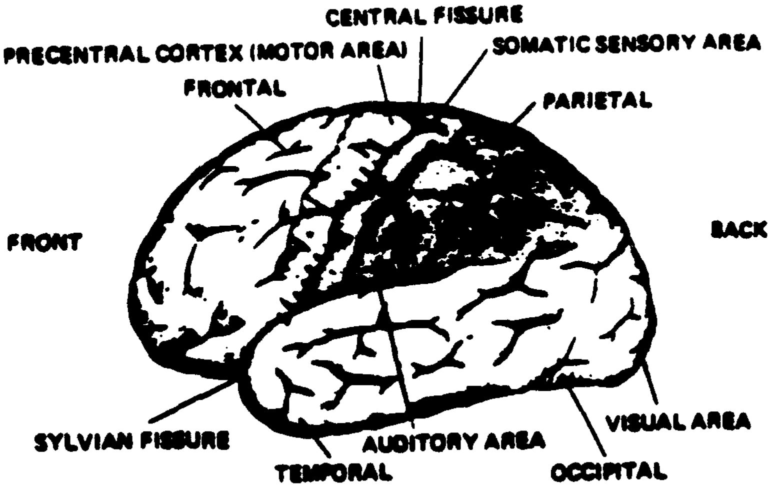
Recording a nerve impulse train with a microelectrode p
near an axon. A trace of the nerve impulse waveform is shown, as it would a
on an oscilloscope if recorded from the microelectrode. A nerve impulse t
shown at bottom.

gure 3


BEHAVIOR, WHOLE BRAIN
SYSTEMS AND PATHWAYS
CIRCUITS
NEURONS
MICROSTRUCTURE
SYNAPSES
MEMBRANES, MOLECULES, AND IONS
BEHAVIOR
MOTOR
SENSORY
CENTRAL
SYSTEMS AND PATHWAYS
CIRCUITS
IMPULSES IN
MEMBRANE RESPONSES
IMPULSES OUT
NEURONS
MICROSTRUCTURE
SYNAPSES
NEURO-TRANSMITTER OR NEURO-MODULATOR
MEMBRANES, MOLECULES, AND IONS
CHANNEL PROTEIN
ION

Levels of organization in biological nervous systems.

Figure 4


CENTRAL FISSURE
PRECENTRAL CORTEX (MOTOR AREA)
SOMATIC SENSORY AREA
FRONTAL
PARIETAL
FRONT
BACK
SYLVIAN FISSURE
AUDITORY AREA
VISUAL AREA
TEMPORAL
OCCIPITAL

Side view of the human brain, showing the convoluted surface of the cerebral cortex.

controls speaking, understanding speech, analyzing visual information, organizing motor activities, and other aspects of intelligent behavior. If the cortex were to be damaged in any way a person's ability to speak correctly and understand speech would be destroyed.[Ref 2]

Over the past two decades, biologists, neurophysiologist, computer scientists, and others have investigated the brain's structure and what that means for its functions. Over the past five years, computer scientists have become attentive to the work of these biologists and neural physiologists hoping to pick up clues that can be transferred from living gray matter to inanimate material.

Neural networks rely on distributed storage. This spacial location of the neural response in the brain has some importance. It seems to be course specialization of areas in the brain based on sensory stimulation or types of thinking. The signals in the mind seem to be a mixture of digital and analog which means capacity of complex computation may not rely on high degree of accuracy.

The research in this field is aimed at obtaining a better understanding of the functions of the human brain. The results may prove useful in the development of computer associative memories. It is important to realize however, that there is no claim that the proposals for neural computers function in any manner similar to the human brain. Artificial neural networks are said to be biologically inspired, not biologically correct.

NETWORK STRUCTURES

Neural Networks can be used as an associative memory which works on the same concepts as the neuron system of the brain works. It stores data in a kind of symbolic form and it contains almost an infinite combination of patterns if theoretically available. Associative memory outputs the signal(s) most closely associated or resembling the input signal based on some criteria of association.

There is also a mechanism called the crossbar switch which had already been present in the first computers and can be implemented by neural networks.(see Figures 5 and 6) It was found in the middle-1700s that the crossbar switch was useful in defining the basic network structure containing adaptive crossbars both at input as well as for feedback. If more complex systems have to be defined, an arbitrary new organization can be implemented by interconnecting modules of this type, whereby many parallel lines are needed for an "interconnect" between a pair of modules.

HOPFIELD MODEL

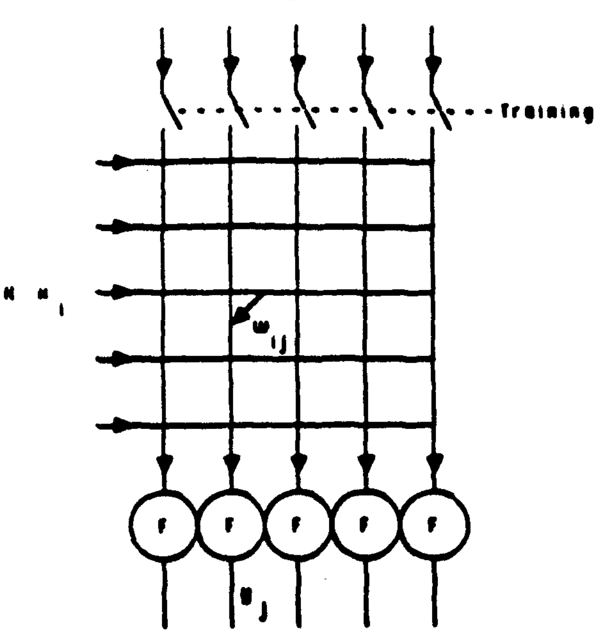
John Hopfield of California Institute of Technology formulated a relatively simple model for these associative memory neural networks in which neuron operation is modeled as a threshold operation and information is stored in the interconnections represented mathematically by a matrix of values corresponding to the interconnection strengths. His research was based on studies of neural networks in such creatures as garden slugs. These studies suggested that the brain can call up responses from any place in response to a given stimulus.

Prior to Hopfield's model the most prominent of the artificial neural network techniques was the linear associative or correlation matrix memory by Teuvo Kohonen.

COMPARISONS

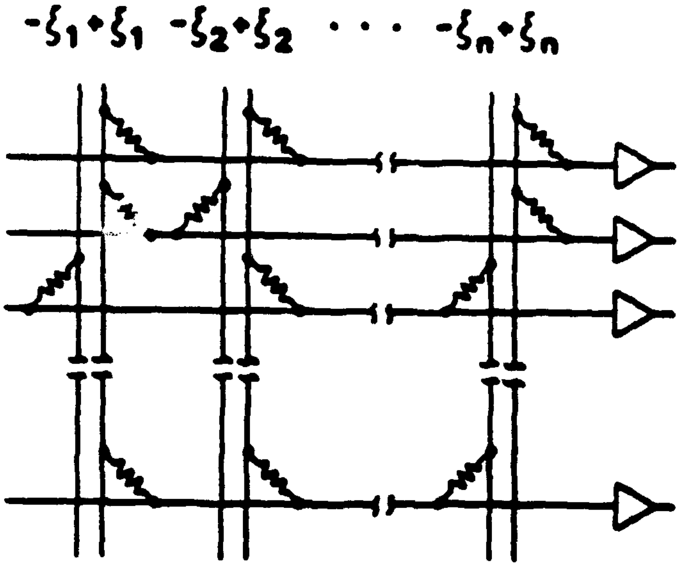
Neural Networks are quite different from the conventional digital computers. Digital computers process digital data that is written in 1's and 0's for mathematical precision whereas neural networks process analog signals that fluctuate continuously, providing a range from say, black through all shades of gray to white. The Conventional system makes yes/no decisions, using mathematical and logical functions but in the parallel distributed processing system, it makes weighted decisions on the basis of fuzzy, incomplete, and contradictory data. Analog computers handle data in rigidly structured sequences so that operations are always under control and results are predictable, with the advanced technology available to us, neural networks can independently formulate methods of processing data, often with surprising results.

Figure 5


Y
Training
X x_i
w_{ij}
F
F
F
F
F
y_j

Crossbar associative network.

Figure 6


$-\xi_1 + \xi_1$
$-\xi_2 + \xi_2$
$\cdots$
$-\xi_n + \xi_n$

The crossbar switch is the basic structure in neural networks. (2.11.8)

CONCLUSION

There are many benefits to using the neural network system. Its devices can store large numbers of complex patterns. These include speech templates, visual scenes, robot movements, spatiotemporal behavior, and social behavior. These devices can also classify new patterns to stored patterns at a speed independent of the number of patterns stored. They then immediately map input patterns to nearest stored patterns (if too many patterns are stored, classification accuracy degrades).

Even with the new technological advances that are available, neural computers only have 16,000 processing units and cannot match functions of even a worm's brain, which is about a thousand neurons linked together. Compared to conventional computers however, they are more powerful and can process information in analog form.

I feel that the parallel distributed processing system is the new wave of the future for certain applications. This concept however, will take some getting used to but the more we learn, the better the situation becomes. People are hesitant to use this program over their rival program, expert systems, because they cannot see how the computer is functioning. In expert systems you can see certain rule bases in the "if then" statement form whereas in the neural networks you can only see the program working. Once the knowledge of this system is more developed I feel we can begin to hear more about this advanced technological discovery.

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2.) An Introduction to Neural Network Architectures, Dayhoff, Judith E., (c) 1990 VanNostrand Reinhcld, New York

3.) Parallel Distributed Processing, Rumelhart, David E. & McClelland, James L. Vol. 1 & 2 (c) 1986 MIT, Mass.

4.) "An Introduction to Computing with Neural Nets", Lippmann, Richard P. IEEC ASSP Magazine April 1987.

5.) "Computers That Think Like People", O'Reilly, Brian Fortune Vol. 119 February 27, 1989

6.) "Back Propagation", Jones, William P. & Hoskins, Josiah BYTE Vol. 12 No. 11 October 1987

The Research of Different Samples Using the Scanning Electron Microscope

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Final Report for:
AFOSR Summer Research Program
Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, Washington, D.C.

August 1992

The Research of Different Samples Using the Scanning Electron Microscope

Anthony M. Richards
Student at Bedford High School

Abstract

A material was studied under high magnification to find out what materials it was made of. To observe the sample, it was placed in an electron scanning microscope. With a magnification of between 10x and 300,000x, the microscope could see what the naked eye or light couldn't. The sample could be seen through a TV screen, which is part of the microscope. After being focused, a picture was taken of the image on the TV screen. This was done with a Polaroid camera hooked up to the microscope. A computer program was now used to identify the elements in the sample in the form of peaks, and at what percent they were in.

INTRODUCTION

When the light microscope was invented, it opened up a whole new world for scientists. With this, they could see things that were too small to see with the naked eye. But after a while, there came the need for a better microscope. This was the electron microscope, because electrons have a much shorter wavelength than light. The electron microscope had a magnification of over 100,000 times, much more than the light microscope. There were also many more things you could do with an electron microscope. The ability to photograph the sample at a high magnification was a great help to the scientific world. There are two types of electron microscopes, the scanning electron microscope and the transmission electron microscope. For this report, I am using the scanning electron microscope.

EQUIPMENT

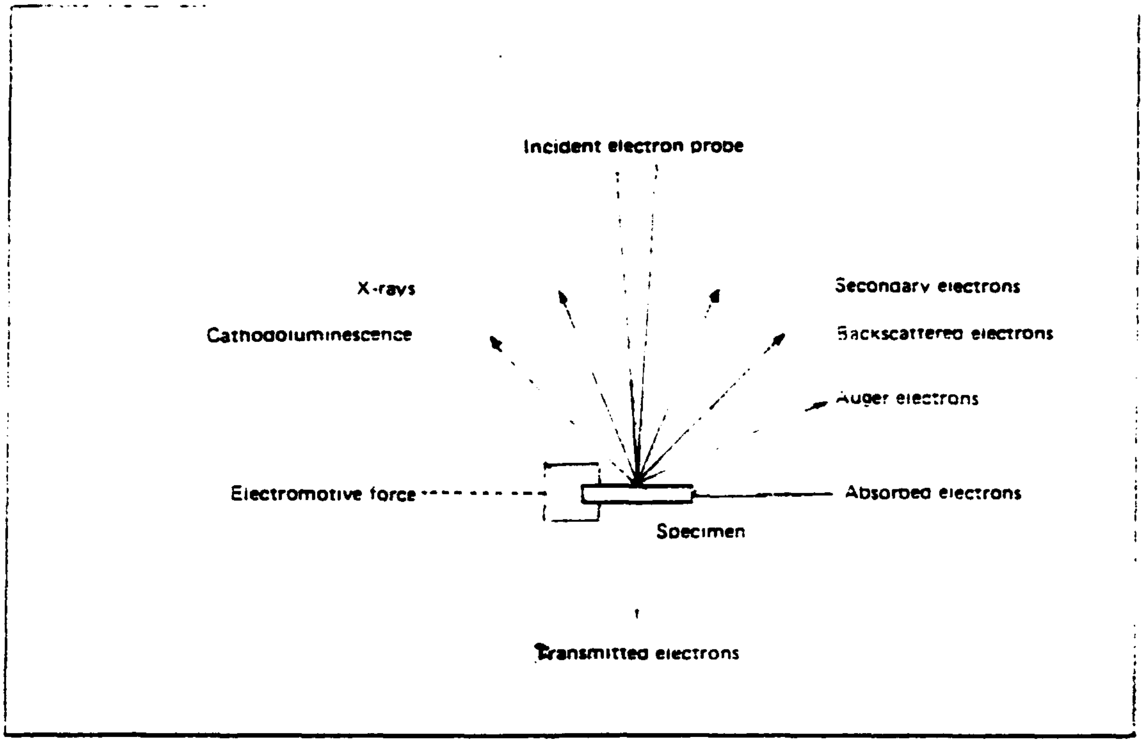
Microscope

The very first piece of equipment you have is the scanning electron microscope (SEM). Very simply, it is made up of two major parts, the electron gun and the condenser.[1] The electron gun is the source of the electrons, and the condenser regulates the intensity of the beam and directs it onto the sample. When the electrons hit the sample, they bounce off into different directions. The microscope is capable of reading different electrons like the backscattered, auger, and secondary electrons. There is a secondary electron detector in the microscope that converts electrons to photons, which are displayed on the TV screen. The

---

[1] Wischnitzer, Saul Introduction to Electron Microscopy. Pergamon Press, New York, 1962. pg. 31.

SEM has a polaroid camera hooked up to it for taking photographs. The electron gun is inside a large tube, and connected to that is a control panel. This has the screen to view the sample, the camera, and many buttons. These buttons are used to change the image of the sample. Most of the buttons don't even move the sample at all. To move the sample, four knobs are placed near the specimen chamber. One moves the sample side to side, one moves it up and down, and the other two knobs tilt the sample. After the SEM itself comes the sample.


Incident electron probe
X-rays
Secondary electrons
Cathodoluminescence
Backscattered electrons
Auger electrons
Electromotive force
Absorbed electrons
Specimen
Transmitted electrons

Sample

The sample is the item you are looking at under the microscope. If it is an organic substance, it must be coated first in a conductive element. The sample is usually coated in gold because it is the easiest to work with. The reason it is coated is because an organic material cannot conduct electrons, so the electrons pile up on the sample and makes it glow. When the sample is coated, the element that the sample is coated with can conduct the electrons. If the sample is inorganic, then it is not coated. The sample is now placed on the next piece of equipment, the stand. Because of different size samples, there are different size stands to fit the sample. The stand has a hole going all the way through it. A screw is placed in this hole, and can be raised or lowered by a screwdriver. The sample sits on the screw, and it is moved up or down until it is level with the hole. On the side of the stand is smaller hole that only goes about half way through it. This is where the rod screws in.

Rod

The rod is a long stick with a screw at one end, and a handle on the other. The screw is used to attach the stand and the rod. Between the screw and the handle is a circular window of thick, leaded plastic. Once the stand is attached to the rod, the rod is placed up against a circular chamber. One end of the chamber is connected to the specimen chamber with a door separating the two, and the other end is open to the outside. The window on the rod covers up the hole of the chamber. All the air is then released from the smaller chamber, and the door is then opened. The rod is pushed into the specimen chamber, and the stand is placed in the chamber. The rod is unscrewed, and is pulled back into the circular chamber. The door is closed, and the vacuum is released from the smaller chamber.

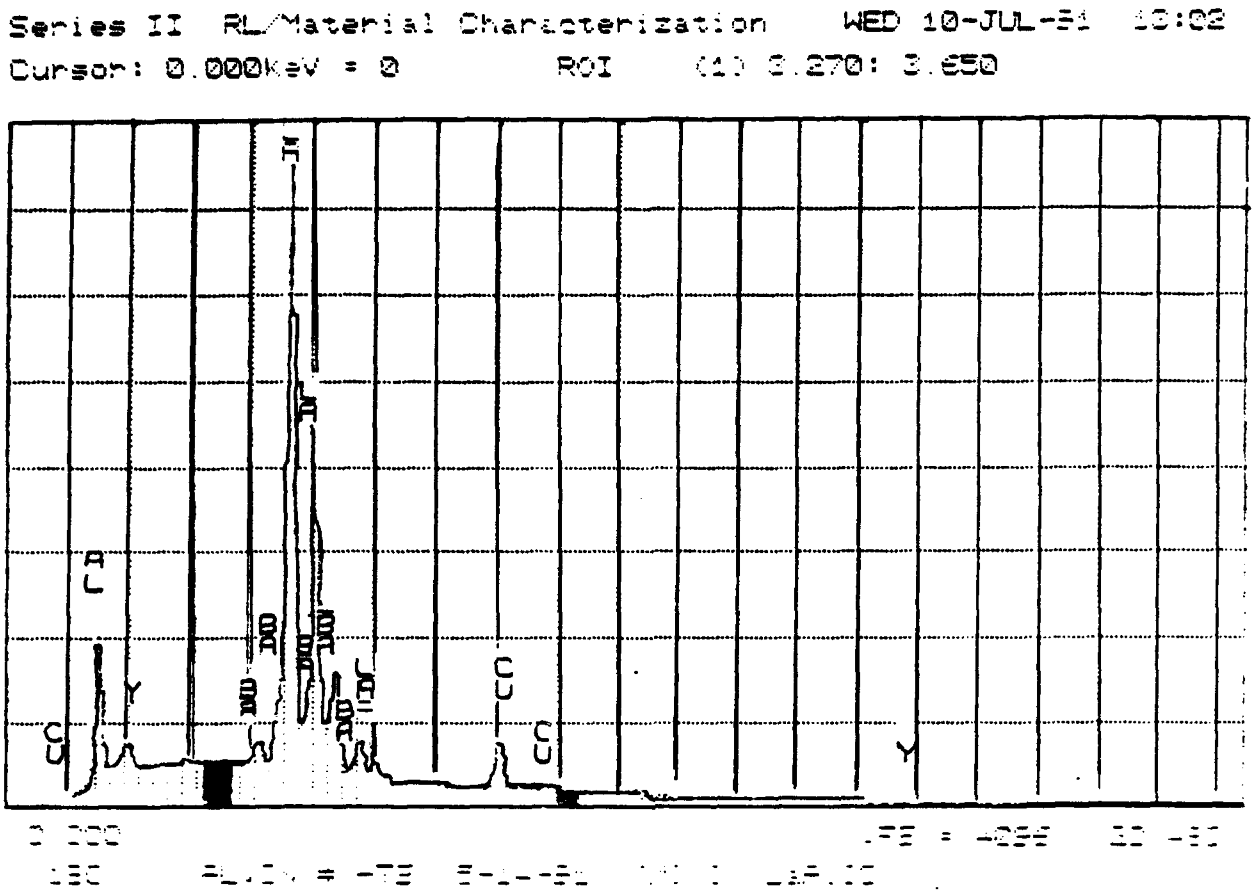
Computer

A common use of the microscope is to identify the different substances that made up a sample. This was done with the help of a computer. A program was made for the computer that allows the computer to identify what elements are in the sample.

Program

I said earlier that the scanning electron microscope reads the secondary electrons, but this program reads the X-rays because it uses a different type of detector. The program can be set for how long it looks at and identifies the sample. The longer it is set for, the better the readings. The normal time is 180 seconds. But this does not mean that in three minutes it will be over. The amount of time it takes to look at the sample is longer than the amount of time it takes to display the elements. The time left over is called dead time, and it is displayed in percentage. You can adjust the amount of dead time using the probe current on the panel of the SEM. A good amount of dead time is 20-25%. If you lower the dead time, it looks at the sample faster and not as accurate. The elements of the sample are displayed on the computer screen in peaks that represent the X-ray counts.

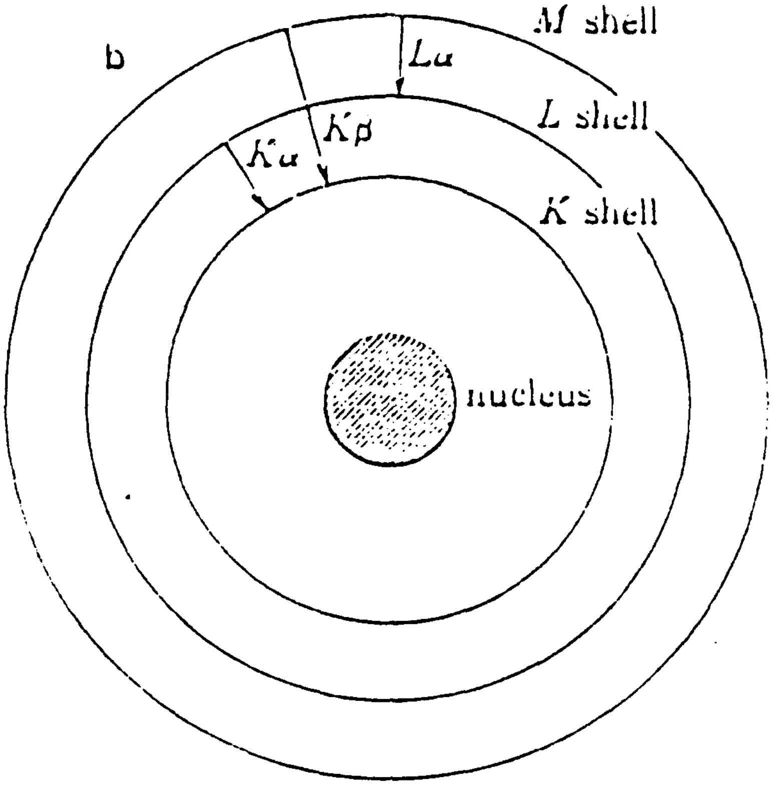
In the peaks, there are two bars. When the computer prints out the results, it doesn't look at the area in these bars. These bars reduce the noise level from the elements.



Results of Program

After the set time is up for the program, each of the peaks are identified. After this, the elements must be put back into the computer on a chart. On the left hand side is where the element is put. Then a letter must be placed beside it. The letter will either be a K, an L, or an M. These stand for the outer rings of an atom.

b



Each element will have one of these, but it depends on the sample for which one it is. After that there is a column that allows you to have EDS (Energy Dispersive Spectroscopy) in or out. For example. Say you were looking at something that was placed on aluminum. The computer would read the aluminum along with the other elements. But if you have EDS out for aluminum, it won't count it in the final result.

After all the elements have been put into the computer, it will print out the results. One of the first things it prints out is the Chi sqd. The lower the number of the Chi sqd, the more accurate the results. 0-4 is acceptable, but any more is not very good. If the number is high, that means that you did not put all the elements of the sample into computer. If this happens, then there is another element that had a small peak.

```
SQ: READ SPECTRUM BOTH-HALVES FILE=221 DRIVE=4

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

ALVIN # HTS  5-14-91   (M) ON LaAlO3
Standardless Analysis
  20.0 KV    40.0 Degrees
```

(should approach 1.0 to indicate a "good" fit)

Chi-squared value

```
Refit _SIK  _CAK  _MGK   _K K   _S K
Chi-sqd = 1.52
```

K-Ratio calculated from net counts (normalized so that K-Ratio sum = 1.0

Net Counts determined from Least-squares fit

```
Element       Rel. K-ratio                  Net Counts
 Y -L      0.01677 +/- 0.00112
 Ba-L      0.06241 +/- 0.00395        4225 +/-    294
 [illegible]  0.05708 +/- 0.00395     9057 +/-    560
 Cu-L      0.00477 +/- 0.00243        6185 +/-    177
 [illegible]  0.00063 +/- 0.00042      374 +/-     33
 [illegible]  0.00000 +/- 0.00041      203 +/-    122
 [illegible]  0.00000 +/- 0.00000        0 +/-      0
 [illegible]  0.00000 +/- 0.00000        0 +/-      0
 [illegible]  0.00000 +/- 0.00000        0 +/-      0
 [illegible]  0.04125 +/- 0.00000        0 +/-      0
 [illegible]  0.00000 +/- 0.00042    11415 +/-    124
 [illegible]  0.00102 +/- 0.00000        0 +/-      0
 [illegible]  0.00251 +/- 0.00037  [illegible] +/- 182
 [illegible]  0.75137 +/- 0.00175      534 +/-    375
                                   [illegible] +/- [illegible]
ZAF Correction 20.00 [illegible]    40.00 deg
[illegible] Iterations = [illegible]
```

UNCERTAINTY in Counts

Accelerating Voltage

Takeoff Angle

```
Element  K-ratio
 Y -L     0.092      Z      A       F
 Ba-L     0.349    0.993  1.632   0.998    Atom%       Wt%
 Cu-K     0.479    1.098  1.011   0.939    14.20      14.93
                   0.933  1.048   0.999    23.61      38.34
                                           62.19      46.73
                                          Total =    100.00%
```

Intensity Ratio calculated from net counts

Atomic number correction

Absorbance correction

Fluorescence correction

Atomic, weight percent

WEIGHT PERCENT IN EXCITATION VOLUME

COPY AVAILABLE TO DTIC DOES NOT PERMIT FULLY LEGIBLE REPRODUCTION

there is another element that had a small peak.

Further down the page will be the net counts of each element put into the computer. This is the amount of each element, with a plus or minus number beside it. Below that is the Atomic Weight percent and Weight percent in excitation volume. The one to look at is the Atomic %, which is more accurate than the Weight%.

CONCLUSION

The scanning electron microscope has been a major tool in helping scientists learn about the microscopic world. With the aid of the computer, the microscope has become an even greater tool in helping scientists discover things they never knew before. And it will continue to help us as long as we live.

Besides the Scanning Electron Microscope and a computer, I was also involved with crystal growing and electronics in other areas. Another activity I was in was using a camera that shows high and low temperatures. The camera was pointed at an area, and then it would read the temperature difference. A picture was taken, and then transferred to a computer where different people worked on enhancing the image. During my eight weeks here, I was exposed to many new things and I really liked it.

LASER DIODE ARRAY TESTING

Eugene C. Salerno

Final Report For:
Summer High School Apprenticeship Program
Rome Laboratory
Griffiss Air Force Base, New York 13441-5700

Sponsored by:
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Bolling Air Force Base, Washington, D.C.

June 29 through August 14, 1992

LASER DIODE ARRAY TESTING

Eugene C. Salerno

Abstract

The purpose of the work was to be able to control the temperature and bias current of a laser diode array and then make measurements of its output power, far field pattern, and wavelength. This would be controlled by the LabView software package installed on a Macintosh IIfx.

Introduction

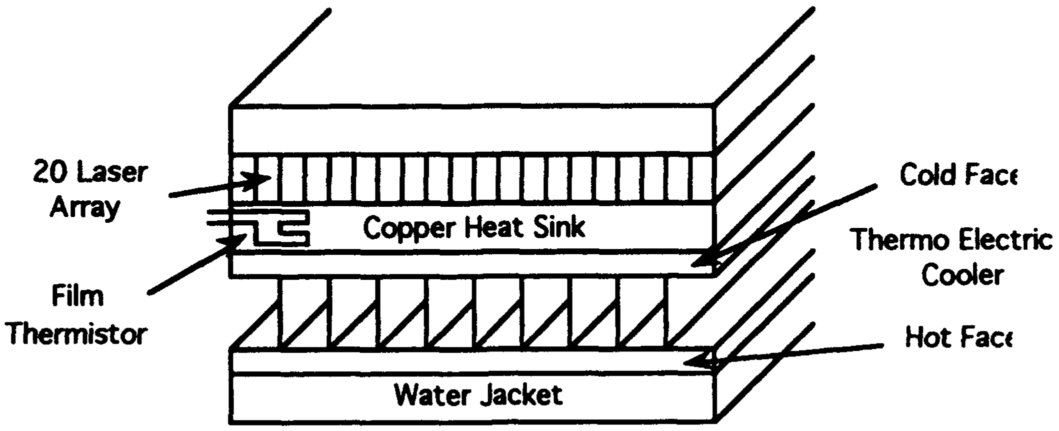
The purpose of this work was to control the temperature and bias current of a TRW ROW laser, number 1210-4 A3T. Measurements were made of its output power, far field pattern, and wavelength. These measurements were controlled by the LabView software installed on a Macintosh IIfx.

LabView is an icon driven programming language that can be used to control laboratory equipment. The software is used to create virtual instruments. These are graphical representations of actual instruments in the lab. Changing a value on the computer screen will effect a change at the actual instrument. These changes can be preprogrammed. When linked together, they perform a sequence of operations that would otherwise be very time consuming.

Laser Temperature Control

In order to measure the laser's temperature, a thermistor and operational amplifier will be used in an active bridge circuit. The change in resistance of the thermistor will cause a proportionate change in the output voltage of the op-amp. This change in voltage will be read by the Macintosh and related to a change in temperature. The change in temperature will determine how much current will be sent to the thermoelectric cooler at the laser. If the temperature rises above the set value, more current will be sent to the cooler. If the temperature falls below the set value, no current will be sent to the cooler, thus allowing the laser to warm up.

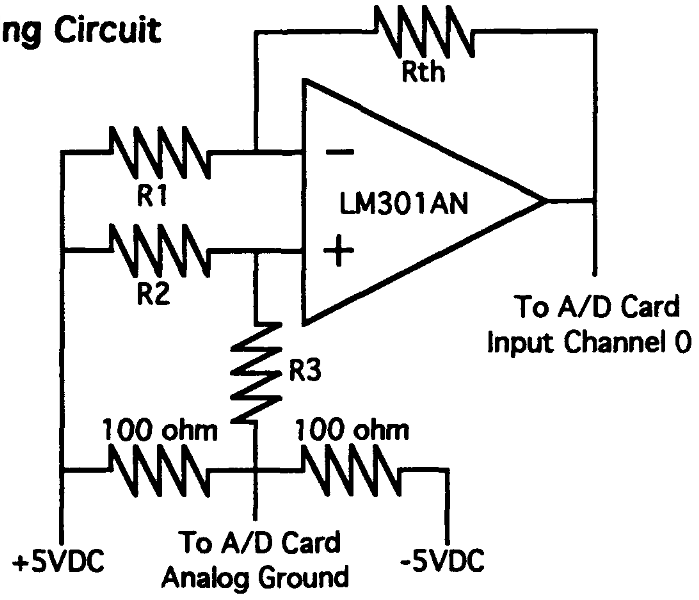
TRW ROW Array Laser Setup


20 Laser Array
Film Thermistor
Copper Heat Sink
Water Jacket
Cold Face
Thermo Electric Cooler
Hot Face

The diagram above shows the arrangement of the laser, the temperature sensing device, and the temperature control devices. The water jacket is used to draw away any excess heat created by the thermoelectric cooler. The water inside the water jacket is cooled by a NESLAB RTE-110 refrigeration system.

An operational amplifier will be used to limit internal heating of the thermistor. The following diagram shows the sensing circuit with the thermistor and operational amplifier LM 301AN.

Sensing Circuit


Rth
R1
R2
R3
LM301AN
−
+
To A/D Card Input Channel 0
100 ohm
100 ohm
+5VDC
To A/D Card Analog Ground
-5VDC

With this circuit we relate the change in the resistance of the thermistor to an output voltage

$$Vout = -Vin * (Rth - R)/R$$

where Rth is the actual resistance of the thermistor at the present temperature, and R is the nominal resistance at a specific temperature. Vin is the voltage applied to the circuit.

In order to determine the value of R, the following equation relates resistance to temperature.

$$R = Ra * \exp(Beta/T)$$

In this equation the resistance (R) of the thermistor is exponentially related to the absolute temperature in Kelvins (T) and a thermistor specific constant Ra, which can be derived from R(0), T(0), and Beta. From the manufacturer's specifications for the thermistor being used, R(0) = 100.0 Kohm, T(0) = 298.0 K, Beta = 3988 K. Solving for Ra we get

$$Ra = R(0)/\exp(Beta/T(0))$$
$$Ra = 100 \text{ Kohm}/\exp(3988 \text{ K}/298.0 \text{ K})$$
$$Ra = 0.1542 \text{ Kohm}$$

Now that we have Ra, we can find the nominal value for R that is best suited for the temperature range that the testing will cover. As the laser will be operated at temperatures from 13 to 23 degrees Celsius, 18 degrees Celsius (291 K) will be used in the equation. Solving for R we get

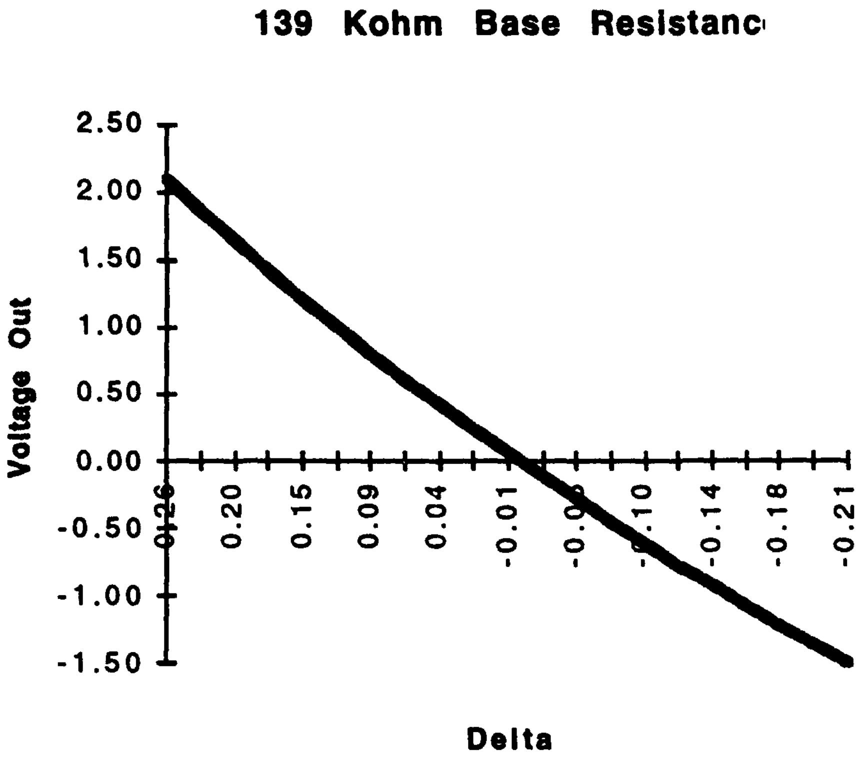
$$R = Ra * \exp(Beta/T)$$
$$R = 0.1542 \text{ Kohm} * \exp(3988 \text{ K}/291.0 \text{ K})$$
$$R = 138 \text{ Kohm}$$

This resistance value will be used for resistors R1, R2, and R3, but since we do not have a 138 Kohm resistor, 139 Kohm will be used.

The following chart is based on the equation Vout = Delta * (-Vin), where Delta = (Rth - R)/R. R is a constant 139 Kohm while Rth is calculated using the equation Rth = Ra * exp(Beta/T). Therefore

$$\text{Delta} = (\text{Ra} * \exp(\text{Beta}/\text{T})) - \text{R})/\text{R}$$

for T from 13 to 18 degrees Celsius.



From this graph it can be seen that the change in output voltage with respect to delta is slightly nonlinear. But for our purposes the temperature measurement falls within acceptable limits throughout the test. The critical values for Delta are from 0.04 to 0.1. Through these points the graph is virtually linear.

One other test was conducted to check the consistency of the temperature reading as calculated from the thermistor and op-amp. After running the water cooler at four different temperatures (17.0, 17.5, 18.0, 18.5 C), it was found that the temperature as calculated by the thermistor reading was consistently greater than that of the water cooler setting.

The following data was collected:

Cooler Temp. C	17.0	17.5	18.0	18.5
Temp Reading C	17.5	18.0	18.5	19.0
Rth Kohm	141	138	135	132
V out DC	-0.068	0.033	0.133	.255
V according to Rth	-0.069	0.032	0.133	.252

The temperature difference of approximately 0.5 degrees Celsius is believed to be caused by the location of the thermistor and laser (they are not in direct contact with the water jacket). Therefore we are assuming they will never fully reach thermal equilibrium with the water, but that the thermistor is still giving us an acceptable measurement of the temperature at the laser diode.

The output voltage from the op-amp will be read by a National Instruments NB-MIO-16XL Analog to Digital converter. The A/D card was installed in the Macintosh. The ground of the sensing circuit is connected to the analog ground of the NB-MIO-16XL card. The output of the op-amp is connected to the analog input channel 0.

After the voltage reading is digitized by the A/D card it will be used to calculate the temperature. Solving for T we get

$$T = Beta/\ln(((Vout*R/(-Vin)\ )+\ R)/Ra)$$

This temperature will then be used to determine how much current the thermoelectric cooler will receive. The power supply for the thermoelectric cooler is a Hewlett Packard 6033A. This will be interfaced by LabView to either increase current to the cooler (if the temperature is too high) or send no current to the cooler (if the temperature is too low). Any excess heat generated will be drawn away by the water jacket surrounding the laser and thermoelectric cooler.

In this way, the temperature of the laser will be controlled. If the measured temperature is different than the set value it will be adjusted by the LabView program.

Laser Current Control

Similarly, the laser's power supply is a HP 6033A. Having IEEE-488 bus capability, the laser's current will also be directly controlled by the LabView program.

Optical Power Measurements

For measuring the output power of the laser, an UDT model 370 optometer with a 2500 integrating sphere will be used. The optometer will be continually taking measurements of the laser's output power and will periodically be asked for a reading.

LabView Program

The main purpose of the LabView program is to automate the measurements needed to be taken, thus greatly increasing the speed of taking them. This program performs five general tasks. It will control the power to the laser array, control the temperature of the array, access the optical power meter, store the data in a file, and plot the data.

Therefore, one portion of the program will control the amount of current given to the laser. This is done by first asking for a lower limit and an upper limit. The program will step from the lower limit to the upper by a value of 30 mA (as the resolution of the power supply used is 7.5 mA, a multiple of 7.5 had to be used). The lower and upper current limits cannot fall below or exceed 0 mA or 960 mA, respectively as not to destroy the laser.

The program must also control the temperature. The actual temperature of the laser is calculated by the process described earlier. When the program begins, the current to the cooler is adjusted until the temperature reaches the value set on the control panel. Then the laser will be powered up, thus warming up the laser and changing the temperature again. Therefore the current to the cooler must again be adjusted until the temperature is stable. This process continues for every step of current, ensuring that when the laser's power is finally measured, it will have been measured at the correct temperature.

Once the next laser current level has been set and the temperature has been stabilized, the program accesses the power meter. The power meter is also interfaced with an IEEE-488 bus. Before every run the meter is set for the correct calibration setting and then zeroed to account for the room lighting. The calibration setting is an internal set of values that are used to initialize the power meter for a specific type of detector such as the integrating sphere being used.

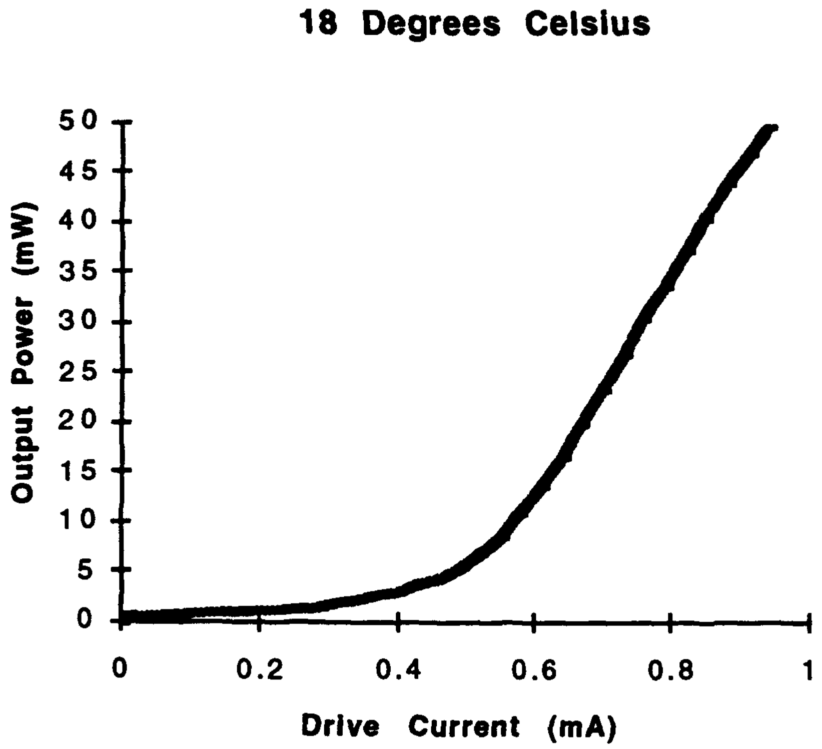
After the temperature has been stabilized, the meter sends a reading to the computer. The reading is stored in the computer, along with the value of drive current used by the laser, the voltage value, and the temperature. After every step of current and restabilization of the temperature, the latest values for these elements are taken and stored in an array.

As each new reading is taken, the power reading and the current reading are written to a text file specified by the user at the start of the run. The data in this file can be accessed outside of LabView for further processing.

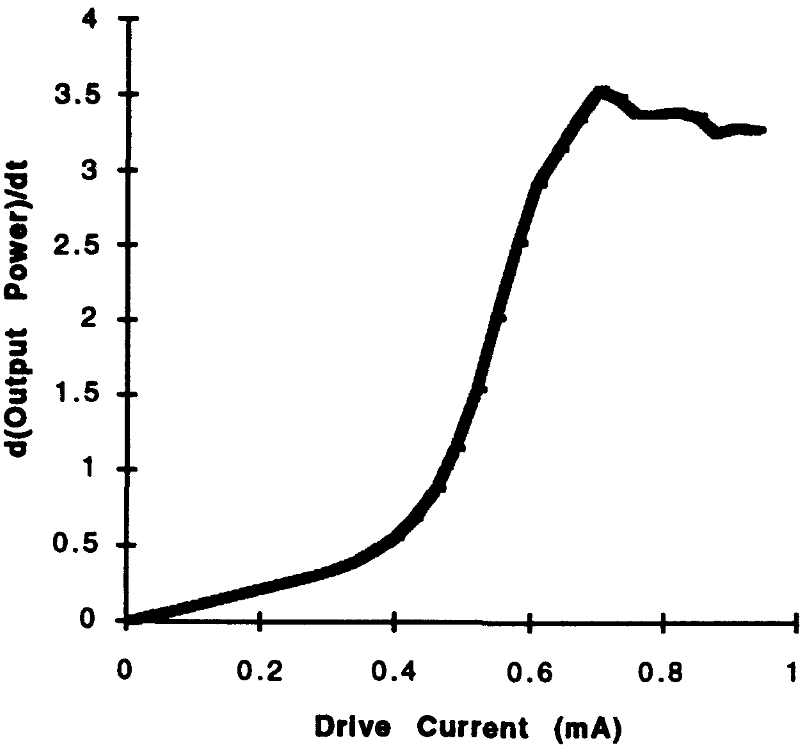
The final portion of the program will plot the data that has been stored in the array. There are a total of three plots. The first is the Drive Current to the laser vs the Power Output of the laser. For the next two graphs the array will be differentiated. The first is the Output Current of the laser vs d(Power)/dt and the second is Output Current vs d(d(Power))/dt^2. The program will terminate after plotting is complete, having removed all power to the laser.

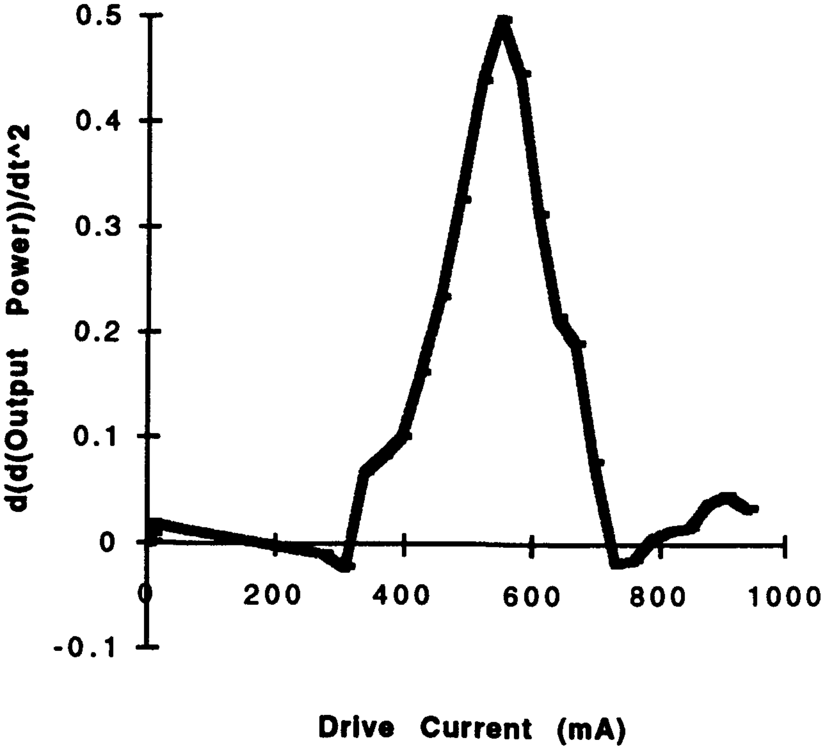
Test Data

One of the tests performed on the laser diode array was to determine its threshold current. The following data was collected at a temperature of 18 degrees Celsius. The power values where taken over the range of 0 to 930 mA by steps of 30 mA. First is a graph of the laser's optical power vs the current being used. The low power readings from about 0 to 500 mA are caused by non-stimulated, spontaneous radiation given off before lasing begins.



The second graph is the first derivative of the data. The final graph is the second derivative of the data. The peak on the final graph indicates at which level of current lasing began.


4
3.5
3
2.5
2
1.5
1
0.5
0
d(Output Power)/dt
0
0.2
0.4
0.6
0.8
1
Drive Current (mA)


0.5
0.4
0.3
0.2
0.1
0
-0.1
d(d(Output Power))/dt^2
0
200
400
600
800
1000
Drive Current (mA)

As the graphs indicate, lasing for this articular laser when at 18 degrees Celsius begins at about 550 mA of current.

Instrument Programming

As most of the equipment used in the testing will be controlled by programs in LabView, individual subnodes for each piece of equipment were made. A subnode in LabView is a "sub program" which can be called up within another program. This eliminates having to rewrite commonly used functions. The virtual instrument panels were created for four pieces of lab equipment, all having GPIB interface capability.

The first set of programs are for the HP 6033A power supply. The program "HP 6033A Setup" allows the user to set the fold setting for the power supply. It also sets the maximum voltage and current values that can be selected. This is useful in preventing the voltage or current from mistakenly being set too high by a programming error. As with all of the other programs, the address can be set to suit each piece of equipment.

The second program is "HP 6033A Write". This is simply used to select the voltage and current settings for the power supply.

The third program is "HP 6033A Read". This will display the current settings for foldback, maximum voltage, and maximum current. It will also show the actual voltage and current being drawn out of the power supply at the time of the read.

The second set of programs is for the Beamscan optical profiler. The first is "Beamscan Setup". This allows the user to select which aperture of the scanning head to be used. It can also be used to select the clip level. By running this virtual instrument, the autofind sequence is initiated. This function of the Beamscan will automatically locate the center of the light source and position it in the center of the display. It will also set the gain level for the reading as to scale the graph to the screen.

The second program is "Beamscan Read". This program first sets the resolution setting for that particular reading and the number of samples that will be averaged in to smooth the output. Then it outputs an array containing the intensity values for each point along the graph. The number of values depends on the resolution setting selected.

The third set of programs is for the United Detector Technologies optical power meter. The first program is "UDT 370 Optometer Setup". This allows the user to set the unit of measure, the wavelength to be measured, and the particular calibration setting to be used. It will also turn on the backlight of the display, zero the meter to account for room lighting, and trigger the meter to start taking readings.

The second program is "UDT 370 Optometer Read". This will simply return the current power reading and send it in the units selected in the setup program.

The fourth set of programs is for the Acton Research Corporation's monochromator. The first program is "Monochromator Grating". This simply selects the grating to be used and holds until the monochromator has finished changing the grating. If the grating selected is different than the grating already installed it will generally take about 45 seconds to complete the change.

The second program is entitled "Monochromator Scan". This will select the range which the monochromator will scan through and the rate at which it will do the scanning. It will also set the number of scans to be performed. When this program is run, the monochromator is told to start scanning as soon as the setting changes have been made. This is the default setting. A boolean value of false sent to the program will stop the monochromator from automatically scanning.

The third program is "Monochromator Read". This returns the number of the grating selected, the scanning rate, and the current wavelength being scanned.

Lab Setup

During my stay at Griffiss, the Laser Communications lab was being expanded. A room had recently been converted into a laboratory and required some organizing and setting up. Therefore, part of my time was spent moving some of the optics equipment into the lab and organizing it in the new workbenches. This meant centralizing all of the basic pieces of equipment to make them easier to locate when a new test is being set up.

ADVANCED RADAR CORRELATION ALGORITHMS

Andrew G. Sega

Final Report for:
Summer Research Program
Rome Laboratory/C3AA

Sponsored by:
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Bolling Air Force Base, Washington, D.C.

August 1992

ADVANCED RADAR CORRELATION ALGORITHMS

Andrew G. Sega
Rome Laboratory/C3AA

Abstract

The problems of large radar networks were studied. Specifically examined was the problem of clutter and how it can be minimized with the least loss of data. The algorithms presented have shown to be helpful in correlating scans together, and predicting where a scan object could possibly be at during a scan. The main solution was a toroid-shaped probability ring drawn around each scan, to simulate all of its possible movement between sweeps of the radar.

ADVANCED RADAR CORRELATION ALGORITHMS

Andrew G. Sega

Introduction

One of the necessary features of government is to keep track of the nation's skies. Today this is done using a network of interconnected radars to track anything that moves. Unfortunately, a large percentage of the data received is false. Birds, mountains, weather balloons, and the like all show up as detections on a radar scan, making extra information appear on the operator's display screen. These can all be classified as clutter, which we shall define as anything that creates a false report on the radar screen. This paper attempts to describe some methods for reducing clutter, and for filtering detections based on previous data.

Methodology

First, it is necessary to return to the basics. Take, for example, this hypothetical scenario. (This is illustrated in Figure 1.) On a map is located Radar A. Now, on the first sweep of Radar A, it picks up something. We shall call this Detection 1. On the next scan, it picks up something else nearby. This will be Detection 2. The question that arises is, "Are the two detections actually the same moving object?"

To answer this, we must define some terms. When a radar receives a detection, it is very limited in what it knows about that detection. Basically, all the radar can detect is the distance from itself to the target. However, you are also able to find out the direction that the radar was pointing at when it received the detection. Using a polar coordinate system, it is simple to find the location of the target.

Now we need the distance (in nautical miles) between the two scans. The best way to do this is by thinking of the problem in geometric terms. Take Radar A, Detection 1, and Detection 2, and draw an imaginary triangle between them. We can also find angle A by finding the difference between the two azimuths. One problem: the difference between the azimuths must be in the range of 0 to 360. Thus, just subtracting the numbers will not work. We must use a small conversion formula:

AZ1, AZ2 - the azimuths of the detections $\Delta AZ = |AZ2 - AZ1|$

If $(AZ2 - AZ1) \geq 180$ **then** $\Delta AZ = 360 - |AZ2 - AZ1|$

Finding the distance between the scans is done using the Law of Cosines. This states that in a triangle, the unknown side (in this case, the distance) is equal to the square root of the squares of the other sides plus two times the product of the sides times the cosine of the angle opposite the unknown side. (Whew!) In mathematical format, it looks like this:

$$c = \sqrt{a^2 + b^2 + 2(a)(b)(\cos c)} \qquad \text{(c = distance between the scans)}$$

This is fairly straightforward except for the cos c. In this case, the cosine of c is actually the cosine of the difference between the azimuths. Simply substitute the delta azimuth for the c in cos c, and you have it:

$$\text{distance} = \sqrt{a^2 + b^2 + 2(a)(b)(\cos \Delta AZ)}$$

Once we have the distance, we now know the speed at which the object was traveling at. This will allow us to proceed to the main problem of radar correlation, the problem of determining whether the object is real.

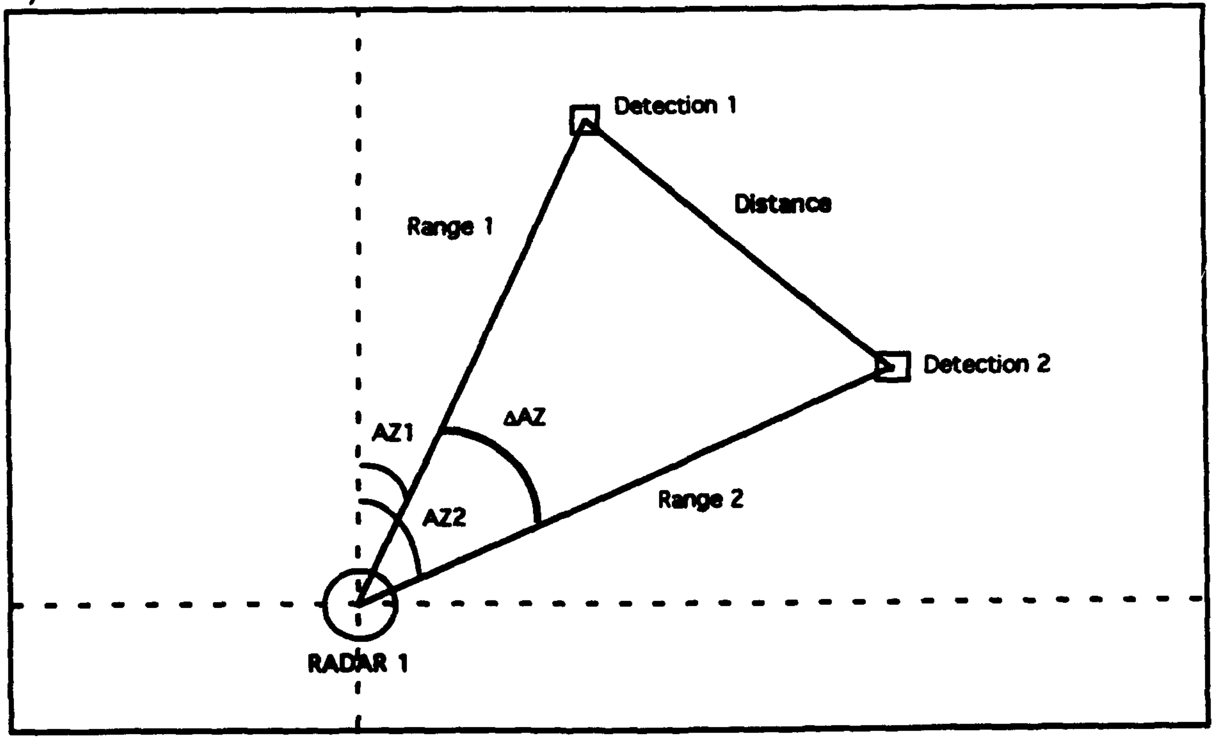

FIGURE 1

RESULTS

Now arises a question : "Could the aircraft have gotten from the first point to the second point in one scan?" Answering this is difficult, but possible. Let us imagine a plane in flight. The maximum speed at which the most advanced aircraft could fly at is called the MAXSPEED. Therefore, to find the maximum distance that the plane could feasibly fly in one scan, we use the following formula.

SCANRATE - the number of seconds it takes for the radar to turn 360 degrees.
MAXDIST - the maximum distance the plane could fly during one scan.

$$\text{MAXDIST} = \frac{(\text{SCANRATE})(\text{MAXSPEED})}{3600}$$

This formula works well in a few circumstances. However, it does not take into account all the possible paths of the target. Most likely, the target will change course during its flight. This will lower the maximum distance it could fly in one scan, due to the distance used by the turn. The problem may be represented this way:

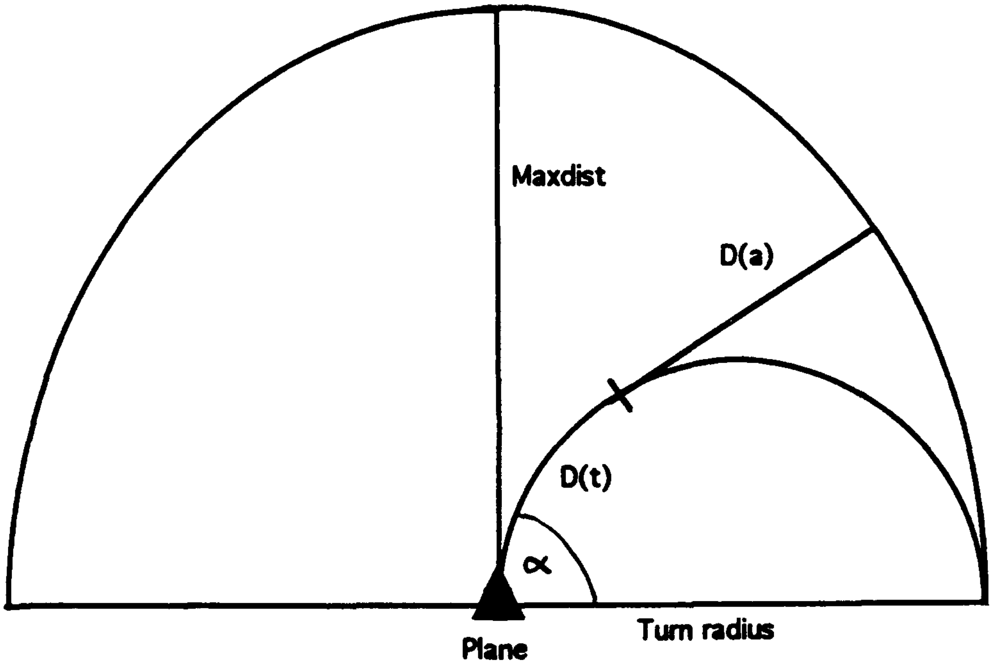

FIGURE 2

A plane has two choices during its flight. It can move straight ahead, or turn at an angle. To maximize the possible distance, a plane can only make a single turn. (See figure 2.). Making two or more turns would lower the maximum distance, so that does not have to be accounted for. The plane with no turn can fly Maxdist (see Methodology). When a turn is added the Maxdist becomes:

$$\mathbf{Maxdist} = \mathbf{Maxdist} - \left[\frac{\alpha}{2\pi}\right]t$$

t = turn radius in nautical miles (nmi)
α = angle of turn in degrees

(Note: This is based on a strictly 2-dimensional model, since 3-D radars are not yet completely integrated into the network.)

We must also take into account a minimum distance to eliminate birds and stationary objects. To find an equation of the complete possibility ring for the aircraft, we arrive at the formula:

$$\sum_{\alpha=0}^{\alpha=360} (\mathbf{Maxdist} - \mathbf{Mindist})$$

To simplify processing time, an approximation is used. By using (cos α + 3)/4 in place of the sum above, we create an elliptical ring with the aircraft at one foci, and the other foci pointing to the course heading. When we add a minimum distance filter, the ellipse becomes a 'donut' like figure, which represents the path fairly accurately. The complete equation:

$$\mathbf{Maxdist} = \left[\frac{(\mathrm{SCANRATE})(\mathrm{MAXSPEED})}{3600}\right]\left[\frac{\cos\alpha + 3}{4}\right]$$

Then simply check to see if **distance** < **Maxdist**. This will tell you if the scan could possibly be an aircraft.

IMPLEMENTATION

A correlator can be used in many ways, but it is more suitable for certain applications. One of these concerns the problem of multiple radars. When you have two or more radars with overlapping scan areas, you tend to recieve multiple detections of the same object. This is mainly due to radar unsynchronization. A correlator, like the one described above, will indirectly eliminate this problem. Illustrated below is a sample algorithm for a multiple radar processor/correlator.

1. Receive a detection from an incoming radar and pass it to the correlator.

2. Attempt to correlate the new detection with previous ones stored in an array.

3. If it does not match, declare it a new detection and add it to the table.

4. If it does match, then remove the corresponding detection from the table.

5. Send the new detection (if it still exists) to the display, and return to step 1.

It may be desirable to assign each detection a 'state' number, to keep track of how long it has been in storage. You could then revise the procedure to allow for an occasional miss without flushing the detection from the system.

RUNNING SOLID MODELS

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Final Report for:
Summer Research Program
Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Griffiss Air Force Base, Rome, N.Y.

August 1992

RUNNING SOLID MODELS

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Introduction

During this summer's tour our main goal was to establish, run,and check solid models. These models were supposed to be initiated on a DEC 5000/240 by way of magneto optical disc. Unfortunately, some problems quickly arose and we were not able to achieve the final goal.

Problems

Over the course of this tour many problems became evident early on. There was a mixture of technical as well as personal problems that ended up bringing any hopes of a project to a sudden halt.

The premier problem was the inability to get the models on the DEC Workstation up and running. The computer that I was initially meant to work on was given up for a more important use in a classified area that I did not have clearance to be in. There was a slight problem with the Workstation/optical disc interface on the new computer and data was not being accepted. The programs that I needed were long, extensive pieces of code stored on magneto-optical discs.

Another problem arose when my summer mentor was tied up with some important personal problems that demanded his immediate and full attention. Understandably these problems made it hard for him to spend much time to be available for my cause.

Project Alternatives

Luckily for me there were a few alternatives to follow. I took advantage of the situation by learning more about the running of a solid model and the environment that they were to have been run in.

In this case I read and learned about Network II.5, which is the environment that I would have been running the models in. I learned how to maneuver in it and what certain things mean.

I also read documentation on the subject of Ultrix commands, which are simply Unix commands on a DEC Workstation. I learned many new commands that can be used in this type of environment.

Towards the last couple of weeks of this tour I was able to give two fellow researchers help in preparing a project on Neural Networks. I helped them to code audio reproductions of voices into the data banks and have them be reproduced upon demand. By helping on this project I also learned a lot about Neural Networks and what makes them work.

Conclusion

In conclusion I feel that even though I was unable to produce a final project this summer I still learned a tremendous amount about a variety of things. This tour proved to be a learning experience where I was able to pick up many pieces of information that I will definitely be for my benefit in the near future.

NOISE MEASUREMENT OF INTERCONNECTING COAXIAL CABLE

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Hanscom A.F.B. Massachusetts

Final Report for:
RDL HSAP

August 1992

NOISE MEASUREMENT OF INTERCONNECTING COAXIAL CABLE

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Abstract

To measure the noise figure of the superconducting phased array antenna accurately, the noise figure of each component must be measured individually. In this paper we will describe the procedures for determining the noise figure of the coaxial cable connecting the antenna to the measuring device while encapsulated inside a cryostatic cooler.

NOISE MEASUREMENT OF INTERCONNECTING COAXIAL CABLE

Max Shapiro & William J. Walsh

INTRODUCTION

Maximum antenna system efficiency can be obtained by incorporating the use of superconducting microstrip lines as part of the array beam-forming network. In general, all metals reach zero resistivity at 0 degrees Kelvin, but since this temperature cannot be practically achieved, we can get virtually the same result by cooling special compounds such as Yttrium Barium Copper Oxide (YBCO) to about 70°K.

To achieve these temperatures, a special cooling chamber, known as a cryostat, must be used. The use of this chamber, however, makes the measurement of the antenna more difficult and complex as the antenna and measuring device are located in two separate ambiences. To bridge the gap between the antenna and measuring device, a coaxial cable is used as shown in Figure 1. Coaxial cables are typically lossy transmission lines and can, in part, be characterized by their attenuation. The attenuation present in the coaxial line

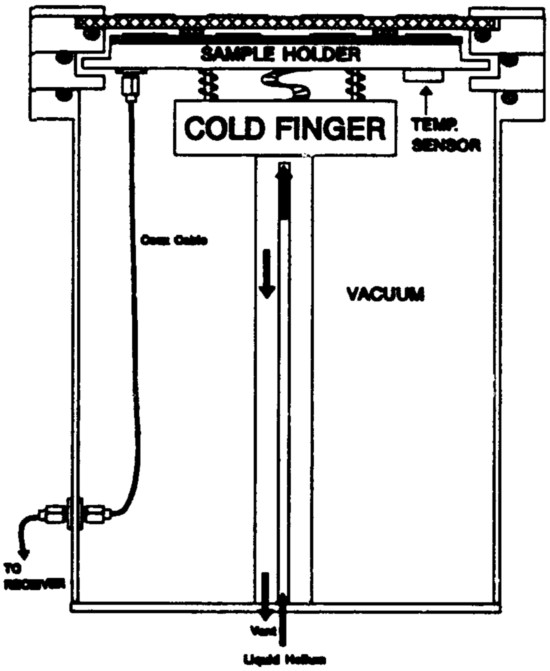

Figure 1 ARRAY MOUNTED INSIDE CRYOSTAT

gives rise to increased thermal activity within the wire, thereby introducing a proportional amount of noise. [1]

To differentiate the effect of the cable from the antenna measurement, the cable itself must be measured separately and its effects considered in the calculations. By measuring the loss introduced by the cable, we can calculate, using an established computational method, its noise figure. Noise figure is defined as: "A measure of the degradation in the signal to noise ratio between the input and output of the component." [2]

Discussion of Problem

The noise caused by the coaxial cable adds to that of the antenna. Because the antenna is at such cold temperatures and produces so little noise, even the slightest noise factor contribution from the cooled cable will severely affect the antenna system noise measurement. Once the noise figure of the coaxial cable is determined, since noise is additive, the antenna noise measurement can be achieved by subtracting the noise of the cable.

Apparatus

The apparatus consists of two chambers, as shown in Figure 1. The inner chamber allows liquid Helium to flow through it and as the helium changes to its gaseous state, it escapes out through a vent. In addition, this chamber is in contact with a cold finger which is cooled as the low temperature liquid passes through the chamber. The cold finger then cools the sample holder containing the antenna by thermal conduction, thus cooling the antenna. A temperature sensor is located on the sample holder to monitor the temperature at all times. The temperature is displayed on an external monitor.

To keep the antenna cold, the outer chamber is evacuated with a vacuum reaching almost zero microns of Mercury. The cable, normally attached to the antenna, is shorted and, for practical considerations, is kept in contact with the cold finger. This allows the cable to be cooled as if it had been connected to the cold antenna and reduces the risk of it coming in contact with the outer chamber wall.

Methodology

For our test, we disconnect the coaxial cable, enclosed in the cryostat, from the antenna and place a short at one end, as shown in Figure 2. Ideally, the short will reflect all RF energy back through the cable. At the other end, a network analyzer passes RF energy through the coaxial cable and reads the amount reflected back to the terminal. The analyzer measures the reflection coefficient

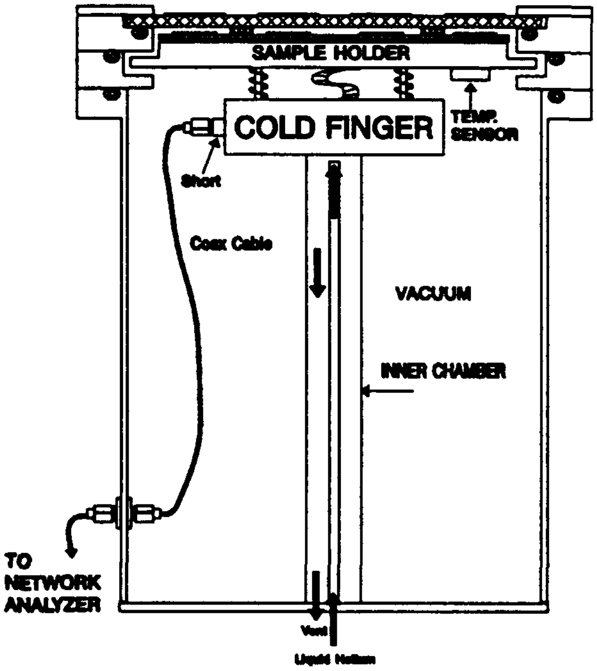
SAMPLE HOLDER
COLD FINGER
TEMP. SENSOR
Short
Coax Cable
VACUUM
INNER CHAMBER
TO NETWORK ANALYZER
Vent
Liquid Helium

Figure 2 CRYOSTAT REFLECTION MEASUREMENT TEST SETUP

(return signal divided by incident signal) and using this information, it calculates and displays the attenuation in the coaxial line. To avoid errors resulting from partial reflections introduced by the measurement system, we calibrate the system using specialized calibration instruments provided by the National Institute for Standards and Technology.

Next, the outer chamber is pumped to achieve a vacuum measuring nearly zero microns of Mercury. To achieve low Kelvin temperatures, liquid Helium is then circulated through the inner chamber. This chamber directly cools the cold finger which in turn, through thermal conduction, cools the coaxial cable. As the cable cools, its loss is monitored by the network analyzer, displayed on a screen, and plotted on a graph at selected temperatures.

With these methods, we are able to obtain an accurate measurement of the loss caused by the coaxial cable. Once the loss of the cable and the temperature are known, the noise figure is calculated using this formula.

$$F = 1 + (L - 1)\, T / 290^{\circ}K$$ [2]

F = noise figure L = loss T = temperature

Results

Loss of Coaxial Cable

Temp.	Measured Loss
293°K	2.0dB = 1.5849
70°K	1.5dB = 1.4125

Noise Figure

$$F_{293K} = 1 + (1.5849 - 1)\ 293^{\circ}K / 290^{\circ}K = 1.5910 = 2.0166\text{dB}$$

$$F_{70K} = 1 + (1.4125 - 1)\ 70^{\circ}K / 290^{\circ}K = 1.0997 = 0.4127\text{dB}$$

Conclusion

Through reflection measurement of the cooled coaxial cable, we have been able to calculate the noise contribution presented to the antenna system by this connection. With this information we are able to measure precisely the antenna efficiency. Also, the effect of temperature on the transmission property of the cable was quite revealing. For example, decreasing the temperature by about 220°K brought the coaxial cable noise figure down more than 1.5dB.

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2 Pozar, David M., Microwave Engineering. New York: Addison-Wesley Publishing Company, 1990.