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The United States Air Force High School Apprenticeship Program's (USAF- HSAP) purpose is to place outstanding high school students whose interests are in the areas of mathematics, engineering, and science to work in a laboratory environment. The students selected to participate in the program work in an Air Force Laboratory for a duration of 8 weeks during their summer vacation.

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RESEARCH & DEVELOPMENT LABORATORIES

5800 Uplander Way

Culver City, CA 90230-6608

Program Director, RDL
Gary Moore

Program Manager, AFOSR
Col. Hal Rhoades

Program Manager, RDL
Scott Licoscos

Program Administrator, RDL
Gwendolyn Smith

Program Administrator, RDL
Johnetta Thompson

Submitted to:

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Bolling Air Force Base

Washington, D.C.

December 1993

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HSAP Participant Data

Behm, Jessica
3301 Shroyer Rd.
Kettering Fairmont High School
Kettering, OH 45429-0000

Laboratory: WL/ML
Vol-Page No: 15-21

Berty, Sara
4524 Linden Ave.
Carroll High School
Dayton, OH 45432-0000

Laboratory: AL/OE
Vol-Page No: 12-31

Blanchard, William

Laboratory: WL/MN
Vol-Page No: 15-27

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Bond, Ryan
North Jackson St.
Tullahoma High School
Tullahoma, TN 37388-0000

Laboratory: AEDC/
Vol-Page No: 16- 1

Bowlby, Andrea
Mudge Way
Bedford High School
Bedford, MA 1730-0000

Laboratory: PL/GP
Vol-Page No: 13- 1

Brecht, Jason
5400 Chambersburg Road
Wayne High Achool
Huber Heights, OH 45424-0000

Laboratory: WL/FI
Vol-Page No: 15-12

Brown, David
12200 Lomas Blvd. NE
Manzano High School
Albuquerque, NM 87112-0000

Laboratory: PL/WS
Vol-Page No: 13-19

Cabral, Aaron
800 Odelia NE
Albuquerque High School
Albuquerque, NM 87102-0000

Laboratory: PL/SX
Vol-Page No: 13-13

Camero, Lisa
2515 Navajo St.
South San Antonio High School
San Antonio, TX 78224-0000

Laboratory: AL/AO
Vol-Page No: 12- 2

Campanile, Nicholas
2660 Dayton-Xenia Rd.
Beavercreek High School
Beavercreek, OH 45434-0000

Laboratory: WL/EL
Vol-Page No: 15- 7

HSAP Participant Data

Carranza, Jason
505 S. Ludlow St.
Chaminade-Julienne High School
Dayton, OH 45402-0000

Laboratory: WL/AA
Vol-Page No: 15- 1

Carroll, Shawn
1400 Jackson Keller St.
Robert E. Lee High School
San Antonio, TX 78213-0000

Laboratory: AL/CF
Vol-Page No: 12- 9

Casares, Carmen
1215 N. St. Mary's
Providence High School
San Antonio, TX 78215-0000

Laboratory: AL/AO
Vol-Page No: 12- 3

Cayton, Sabrina
5005 Stahl Rd.
James Madison High School
San Antonio, TX 78247-0000

Laboratory: AL/AO
Vol-Page No: 12- 4

Chuang, Eleanore
2660 Dayton-Xenia Rd.
Beavercreek High School
Beavercreek, OH 45434-0000

Laboratory: AL/CF
Vol-Page No: 12-10

Ciomperlik, Kara
7173 FM 1628
East Central High School
San Antonio, TX 78263-0000

Laboratory: AL/OE
Vol-Page No: 12-32

Cook, Theresa

Laboratory: WL/MN
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Cosgrove, Kathlyn
727 E. Hildebrand
Incarnate Word High School
San Antonio, TX 78284-0000

Laboratory: AL/CF
Vol-Page No: 12- 5

Dalley, Kevin
2660 Dayton-Xenia Rd.
Beavercreek High School
Beavercreek, OH 45434-0000

Laboratory: WL/AA
Vol-Page No: 15- 2

Danelo, David
25 Burwood St.
San Antonio Christian School
San Antonio, TX 78216-0000

Laboratory: AL/HR
Vol-Page No: 12-26

HSAP Participant Data

Davis, James
1000 School Ave.
Rutherford High School
Panama City, FL 32404-0000

Laboratory: AL/EQ
Vol-Page No: 12-20

DeBrosse, Nick
3301 Shroyer Rd.
Kettering Fairmont High School
Kettering, OH 45429-0000

Laboratory: WL/PO
Vol-Page No: 15-45

Decker, Michael
2601 Oneida St.
Sauquoit Valley Central School
Sauquoit, NY 13456-0000

Laboratory: RL/ER
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Deibler, Nancy

Laboratory: WL/MN
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Dodsworth, Christopher
4916 National Rd.
Northmont High School
Clayton, OH 45315-0000

Laboratory: WL/EL
Vol-Page No: 15- 8

Dominguez, Janette
114 E. Gerald Ave.
Harlandale High School
San Antonio, TX 78214-0000

Laboratory: AL/HR
Vol-Page No: 12-27

Ellena, Brandon
711 Anita Dr.
Tehachapi High School
Tehachapi, CA 93561-0000

Laboratory: PL/RK
Vol-Page No: 13- 9

Ethridge, Blake
7801 Wilshire Blvd.
La Cueva High School
Albuquerque, NM 87122-0000

Laboratory: PL/LI
Vol-Page No: 13- 6

Felderman, James
N. Jackson St.
Tullahoma High School
Tullahoma, TN 37388-0000

Laboratory: AEDC/
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Feucht, Danny
5833 Student St.
West Carrollton High School
West Carrollton, OH 45418-0000

Laboratory: WL/FI
Vol-Page No: 15-13

Finch, David
501 Niagara Ave.
Colonel White High School
Dayton, OH 45405-0000

Laboratory: AL/OE
Vol-Page No: 12-33

Focht, Jeremy
2660 Dayton-Xenia Rd.
Beavercreek High School
Beavercreek, OH 45434-0000

Laboratory: WL/ML
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Foley, Jennifer
2660 Dayton-Xenia Rd.
Beavercreek High School
Beavercreek, OH 45434-0000

Laboratory: WL/EL
Vol-Page No: 15- 9

Foth, Angela
501 Mosley Dr.
A. Crawford Mosley High School
Lynn Haven, FL 32444-0000

Laboratory: AL/EQ
Vol-Page No: 12-21

Fowler, Brendon
Chenango Ave.
Clinton Senior High School
Clinton, NY 13323-0000

Laboratory: RL/C3
Vol-Page No: 14- 2

Garcia, Stephanie
650 Ingram
Oliver Wendell Holmes
San Antonio, TX 78238-0000

Laboratory: AL/AO
Vol-Page No: 12- 6

Garcia, Alejandro
2515 Navajo St.
South San Antonio High School
San Antonio, TX 78224-0000

Laboratory: AL/CF
Vol-Page No: 12-11

Garcia, Andrea
6701 Fortuna Rd. NW
West Mesa High School
Albuquerque, NM 87121-0000

Laboratory: PL/SX
Vol-Page No: 13-14

Gavornik, Jeffrey
5110 Walzem Rd.
Roosevelt High School
San Antonio, TX 78239-0000

Laboratory: AL/CF
Vol-Page No: 12-12

Giles, Mark
1204 Harrison Ave.
Bay High School
Panama City, FL 32401-0000

Laboratory: AL/EQ
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HSAP Participant Data

Ginger, David
500 E. Franklin St.
Centerville High School
Centerville, OH 45459-0000

Laboratory: WL/ML
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Gonzalez, Christopher
1400 Jackson-Keller
Robert E. Lee High School
San Antonio, TX 78234-0000

Laboratory: AL/OE
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Gooden, Christie

Laboratory: WL/MN
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Grabowski, Holly
Shawsheen Rd.
Andover High School
Andover, MA 1810-0000

Laboratory: RL/ER
Vol-Page No: 14- 9

Gurecki, David
800 Cypress St.
Rome Catholic High School
Rome, NY 13440-0000

Laboratory: RL/C3
Vol-Page No: 14- 1

Hanna, Melissa
1312 Utica St.
Oriskany Central High School
Oriskany, NY 13424-0000

Laboratory: RL/IR
Vol-Page No: 14-13

Harrison, Deanna

Laboratory: WL/MN
Vol-Page No: 15-31

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Hartsock, David
3491 Upper Bellbrook Rd.
Bellbrook High School
Bellbrook, OH 45305-0000

Laboratory: WL/PO
Vol-Page No: 15-46

Hayduk, Eric
800 Cypress St.
Rome Catholic High School
Rome, NY 13440-0000

Laboratory: RL/OC
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Hemmer, Laura

Laboratory: WL/MN
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Hill, Thuan
North Jackson St.
Tullahoma High School
Tullahoma, TN 37388-0000

Laboratory: AEDC/
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Hodges, Melanie
5833 Student St.
West Carrollton High School
West Carrollton, OH 45418-0000

Laboratory: WL/PO
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Jost, Tiffany
Lincoln Rd.
Lincoln-Sudbury Regional High
Sudbury, MA 1776-0000

Laboratory: PL/GP
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Kitty, Alexandra
3900 W. Peterson
Our Lady of Good Counsel High
Chicago, IL 60659-3199

Laboratory: PL/RK
Vol-Page No: 13-10

Kozlowski, Peter
500 E. Franklin St.
Centerville High School
Centerville, OH 45459-0000

Laboratory: WL/ML
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Kulesa, Joel
940 David Rd.
Archbishop Alter High School
Kettering, OH 45429-0000

Laboratory: WL/EL
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Lormand, Bradley
PO Drawer CC
Rosamond High School
Rosamond, CA 93560-0000

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Maloof, Adam
251 Waltham St.
Lexington High School
Lexington, MA 2173-0000

Laboratory: RL/ER
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HSAP Participant Data

Marlow, Chris
925 Dinah Shore Blvd.
Franklin County High School
Winchester, TN 37398-0000

Laboratory: AEDC/
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Martin, Amy
3301 Shroyer Rd.
Kettering Fairmont High School
Kettering, OH 45429-0000

Laboratory: WL/FI
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Matthews, Suzanne
5323 Montgomery NE
Del Norte High School
Albuquerque, NM 87109-0000

Laboratory: PL/SX
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McEuen, Eric
800 Odelia Rd. NE
Albuquerque High School
Albuquerque, NM 87102-0000

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McGovern, Scott
3491 Upper Bellbrook Rd.
Bellbrook High School
Bellbrook, OH 45305-0000

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McPherson, Sandra
Jefferson & Grove St.
Bishop Brossart High School
Alexandria, KY 41001-0000

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Menge, Sean
Route 294
Adirondack High School
Boonnville, NY 13309-0000

Laboratory: RL/C3
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Merrill, Benjamin
3491 Upper Bellbrook Rd.
Bellbrook High School
Bellbrook, OH 45305-0000

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Middleton, Charles
4524 Linden Ave.
Carroll High School
Dayton, OH 45432-0000

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Miksch, Virginia
727 E. Hildebrand
Incarnate Word High School
San Antonio, TX 78284-0000

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727 E. Hildebrand
Incarnate Word High School
San Antonio, TX 78284-0000
Laboratory: AL/HR
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Morton, Gilbert
2001 McArthur Dr.
Coffee County Central High Sch
Manchester, TN 37355-0000
Laboratory: AEDC/
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Neitzel, Laura
N. St. Mary's
Providence High School
San Antonio, TX 78215-0000
Laboratory: AL/OE
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Nguyen, Quynhtrang
5833 Student St.
West Carrollton High School
West Carrollton, OH 45418-0000
Laboratory: AL/CF
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Nielsen, Eric
500 Turin Rd.
Rome Free Academy
Rome, NY 13440-0000
Laboratory: RL/C3
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Northcutt, Chris
925 Dinah Shore Blvd.
Franklin County High School
Winchester, TN 37398-0000
Laboratory: AEDC/
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Olson, Amanda
1000 School Ave.
Rutherford High School
Panama City, FL 32404-0000
Laboratory: AL/EQ
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Ondrusek, Kimberly
7173 FM 1628
East Central High School
San Antonio, TX 78263-0000
Laboratory: AL/HR
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Ortiz, Benjamin
6701 Fortuna Rd. NW
West Mesa High School
Albuquerque, NM 87105-0000
Laboratory: PL/LI
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Page, Melissa
501 Mosley Dr.
A. Crawford Mosley
Lynn Haven, FL 32444-5609

Laboratory: WL/FI
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Panara, Michael
500 Turin St.
Rome Free Academy
Rome, NY 13440-0000

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Pletl, Anne
Burrstone Rd.
Notre Dame
Utica, NY 13502-0000

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Prevost, Daniel
3301 Shroyer Rd.
Kettering Fairmont High School
Kettering, OH 45429-0000

Laboratory: WL/PO
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Price, Kristy
North Jackson St.
Tullahoma High School
Tullahoma, TN 37388-0000

Laboratory: AEDC/
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Protz, Christopher
501 Mosley Dr.
A. Crawford Mosley High School
Lynn Haven, FL 32444-5609

Laboratory: AL/EQ
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Rader, Thomas
1505 Candelaria NW
Valley High School
Albuquerque, NM 87107-0000

Laboratory: PL/WS
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Ray, Kristopher
401 Eagle Blvd.
Shelbyville Central High Schoo
Shelbyville, TN 37160-0000

Laboratory: AEDC/
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Reed, Tracy
711 Anita Dr.
Tehachapi High School
Tehachapi, CA 93561-0000

Laboratory: PL/RK
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Riddle, Cheryl
Highway 55
Moore County High School
Lynchburg, TN 37352-0000

Laboratory: AEDC/
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Rodriguez, Luis
5400 Chambersburg Rd.
Wayne High School
Huber Heights, OH 45424-0000

Laboratory: AL/CF
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Salinas, Carol
727 E. Hildebrand
Incarnate Word High School
San Antonio, TX 78212-0000

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7173 FM 1628
East Central High School
San Antonio, TX 78162-0000

Laboratory: AL/CF
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Schatz, William
500 Turin St.
Rome Free Academy
Rome, NY 13440-0000

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Schindler, David
Drawer 1300
Los Lunas High School
Los Lunas, NM 87031-0000

Laboratory: PL/LI
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Senus, Joe
500 Turin St.
Rome Free Academy
Rome, NY 13440-0000

Laboratory: RL/IR
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Servaites, Jonathan
500 E. Franklin St.
Centerville High School
Centerville, OH 45459-0000

Laboratory: WL/PO
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Shao, Min
869 Massachusetts Ave.
Arlington High School
Arlington, MA 2174-0000

Laboratory: PL/GP
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Simon, Ryan
701 E. Home Rd.
Springfield North High School
Springfield, OH 45503-0000

Laboratory: AL/OE
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Smith, Adam

Phillips Academy
Andover, MA 1810-0000

Laboratory: PL/GP
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Solscheid, Jill
500 E. Franklin St.
Centerville High School
Centerville, OH 45459-0000

Laboratory: AL/OE
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Spry, David
555 N. Hyatt St
Tippecanoe High School
Tipp City, OH 45371-0000

Laboratory: WL/PO
Vol-Page No: 15-50

Starr, Jennifer
221 E. Trotwood Blvd.
Trotwood Madison Sr. High Scho
Trotwood, OH 45426-0000

Laboratory: WL/AA
Vol-Page No: 15- 4

Strickland, Jefferey
501 Mosley Dr.
A. Crawford Mosley High School
Lynn Haven, FL 32444-0000

Laboratory: WL/FI
Vol-Page No: 15-19

Tecumseh, Tony
5323 Montgomery NE
Del Norte High School
Albuquerque, NM 87110-0000

Laboratory: PL/VT
Vol-Page No: 13-18

Terry, Nathan
75 Chenango Ave.
Clinton High School
Clinton, NY 13323-0000

Laboratory: RL/ER
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Thomson, Randy
Laboratory: WL/MN
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Triana, Zayda
727 E. HildeBrand
Incarnate Word High School
San Antonio, TX 78212-2598
Laboratory: AL/AO
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Trossbach, Christina
Laboratory: WL/MN
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Tseng, Miranda
3301 Shroyer Rd.
Kettering Fairmont High School
Kettering, OH 45429-0000
Laboratory: WL/FI
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Tutin, Darcie
Laboratory: WL/MN
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Vaill, Christopher
Route 31
Vernon-Verona-Sherrill Central
Verona, NY 13478-0000
Laboratory: RL/OC
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Ward, Jon
Laboratory: WL/MN
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Waterman, Sara
North Jackson St.
Tullahoma High School
Tullahoma, TN 37388-0000
Laboratory: AEDC/
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Weidner, Suzanne
7173 FM 1628
East Central High School
San Antonio, TX 78263-0000
Laboratory: AL/OE
Vol-Page No: 12-38

West, Johnny
2026 Stapleton Court
Belmont High School
Dayton, OH 45404-0000
Laboratory: WL/AA
Vol-Page No: 15- 5

HSAP Participant Data

Wick, Matthew
6400 Wyoming Blvd.
Albuquerque Academy
Albuquerque, NM 87109-0000

Laboratory: PL/WS
Vol-Page No: 13-21

Williams, Scott
3511 Dayton-Xenia Rd.
Beavercreek High School
Beavercreek, OH 45434-0000

Laboratory: WL/AA
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Wright, Rudy
6701 Fortuna Rd. NW
West Mesa High School
Albuquerque, NM 87121-0000

Laboratory: PL/SX
Vol-Page No: 13-16

Young, Matthew
5005 Stahl Rd.
James Madison High School
San Antonio, TX 78247-0000

Laboratory: AL/OE
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Zimmerman, Amy
4524 Linden Ave.
Carroll High School
Dayton, OH 45432-0000

Laboratory: AL/CF
Vol-Page No: 12-18

Alicia Araiza's report not available at time of publication.

Lisa Camero's report not available at time of publication

Computer "specialists" among us

Carmen Casares
Clinical Sciences Division
Decision Support Branch
MICAS Computer Systems

Providence High School
1215 N. St. Mary's
San Antonio, TX 78215

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August 1993

Computer "specialists"
among us

Carmen Casares
Clinical Sciences Division
Decision Support Branch
MICAS Computer Systems

ABSTRACT

This world has come to a period where almost everything has been automated. In a sense this can be good. With the proliferation of computers, it is almost impossible to know everything there is to know about them. There is too much to know and remember. In addition, there are too many types of systems, software, and computers.

At Brooks Air Force Base, computers are essential to the everyday work schedule of almost every person on staff. These people are helped by those who excel in computer science. As a team, the knowledge of all these computer "experts" is incredible. Their jobs include duties that range from putting personal computers together to managing databases and large mainframe systems. These people do even the simplest tasks such as restocking a printer with paper. Some of their work can be so involved that it can take weeks before something is wholly completed. Despite the fact that their jobs are often frustrating and demanding, they can be counted on to complete a task promptly and to the best of their ability.

Computer "specialists"
among us

Carmen Casares

INTRODUCTION

Computers have become a primary factor of almost all levels of existence. They are a convenience and luxury in the home. Among the work force, computers have come to play dominant and sometimes critical roles. Computers even contribute to the recreation of today's society.

There are people who allay "the computer fears" of others and make using a computer less frustrating. These people are a valuable asset to the work force. Many times, people are faced with learning to do their jobs with the aid of a computer. When using computers, there are bound to be times when the user will encounter difficulties. Although some of these problems may be simple, to a person with very little knowledge of computers, the problem may seem complicated.

DISCUSSION OF PROBLEM

The essential role of computers requires people to have the knowledge and skills to operate them. The complexity of some computers make it impossible for someone to know everything about them. At times, the obvious problem is the lack of knowledge regarding the machine that has indisputably taken a prominent role in this age.

METHODOLOGY

At times, a computer's intricacy can enable it to perform tasks that would be impossible by human attempt. Yet, this does not qualify it as "intelligent". Computers will do *exactly* what the user instructs it to do. Therefore, the user must supply the knowledge. As a result, many people are choosing to update their education or choosing a computer-related field as their area of expertise.

Within the Clinical Sciences Division at Brooks Air Force Base, almost everything is done with the aid of some data processing device. For one person to try to learn everything there is to know about every kind of computer, would probably be an impossible task. Therefore, people concentrate on specific areas of computer knowledge. These people are formally educated in their specific field.

(PC LAN MANAGER)

The initial configuration of a personal computer (PC) workstation is particularly important. The configuration process begins with purchasing the equipment. Manufacturers' technical specifications must be researched to determine if the hardware, software, and peripherals will function as a whole and meet the needs of the user. It is necessary for someone skilled in hardware and software integration to see to it that the essentials are properly installed before declared ready for use.

Memory may need to be added, along with other necessary items. These include items such as video cards, floptical disk drives, tape backups, scanners, and ethernet boards. Network cabling, floppy and hard disk drives are also installed. This person's job also

includes adding sound cards and connecting sound speakers if necessary. Sometimes in order for him to be able to put together a PC, cables may need to be ordered, or made if not available. Basic equipment such as a keyboard and mouse are also added.

Beside the hardware aspect, there is software that needs to be installed on the hard drive. The easy part is inserting disks when instructed by a message box, but it is much more complex. The hardware often needs software drivers to make it function. Making sure that one can output data onto paper, editing configurations, and making sure that one software application or driver does not conflict with another are only some of the things that require attention. Network operating software may be installed to allow the computers to share information such as data files, E-Mail, electronic scheduling, and mainframe data.

All of this is very time consuming and requires special knowledge and skills (and *tons* of patience). Many times the software or hardware does not perform as expected or advertised. Since a successful configuration (and the goal of a system integrator) is to hide all complexities from the end user, many hours, or even days can be spent with manufacturers' technical support. In addition to this time, extra hours from personal time may be necessary.

The person that is responsible for all this not only sees to this but also spends a lot of time dealing with the miscellaneous problems of users. Whether the problem is simple or complicated, he can be counted on to attend to it as soon as possible. Apparently, this person plays a vital role in the work progress and accomplishments of others.

(SYSTEM MANAGER)

The job description of the Multimodality Image Comparative Analysis System (MICAS) system manager is quite extensive. In short, he is responsible for the system management of VAXcluster of large mainframe computers, minicomputers, and microcomputers. This includes operations, maintenance, security and network data links for VAX system and clustered network nodes. The MICAS system manager also develops programs for system-wide use and supervises system operators and programmers who provide computer support and maintains administrative files. Finally, he is responsible for the completion of maintenance contracts for equipment and the repair of nonfunctional equipment.

(DATABASE ADMINISTRATOR)

In addition to the above mentioned, is the Data Base Administrator (DBA). The DBA deals with granting and securing the accesses granted to databases. He determines where data will be gathered from and where it will be put. Those dealing with large amounts of data (usually due to research) work directly with the database administrator. He aids in their research by determining the best information to use and where and how to store it. Finally, the DBA works with upper management to decide the future needs of the database(s).

RESULTS

It is obvious that not all the knowledge about computers is in hands of one person. There are many more areas that are concentrated on, other than the ones mentioned. These people work together to provide the best service possible. Without them, it would be very difficult to

accomplish a task on one's own.

CONCLUSION

I would like to emphasize that these computer experts are always very busy, but never too busy to help someone. They provide an essential service to the work being conducted here. No matter how small the problem is, someone is always willing to help. Sometimes it seems to me, that the work done by these people is taken for granted. It has become so routine to pick up the phone when we need something "fixed" that we forget how valuable they and their knowledge and skills are to us. Those that definitely deserve to be shown some appreciation are those who do whatever is necessary to help; even if it means putting in extra hours after everyone else has called it a day at 4:15.

EPIDEMIOLOGY AND ITS MANY ATTRIBUTES

Sabrina A. Cayton

Summer Research Apprentice

Aerospace Medicine

Brooks Air Force Base

2507 Kennedy Dr.

Brooks AFB, TX 78235

Final Report for:

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Sabrina A. Cayton
Summer Research Apprentice
Aerospace Medicine
Armstrong Laboratory

Abstract

Epidemiology's effect on scientific research and the field of medicine becomes obvious after learning of its many uses for the detection, prevention, and eradication of numerous human ailments. Through the use of its many descriptive and analytic studies, information can be collected and analyzed for answers to various scientific questions. Research of this kind requires the combined effort of a multitude of individuals that work toward a common goal. This feat involves the use of epidemiology's various studies, which lend themselves to the particular situation that surrounds the disease of interest. The accommodating nature of these studies is; however, slightly tainted by their susceptibility to bias, chance, and the like. The use of epidemiology has led to our vast knowledge of human disease, and it is epidemiology that will be responsible for the continuation of progress in this area.

EPIDEMIOLOGY AND ITS MANY ATTRIBUTES

Sabrina A. Cayton

Sir Richard Doll defined epidemiology as, "the simplest and most direct method of studying causes of disease in humans." What this definition fails to convey is its vast effect on numerous areas of science and medicine. It is epidemiology's carefully thought out studies and expertly analyzed results that have led to much of our present knowledge of medicine. This area of science involves everything from detecting the emergence of a disease to testing possible cures. Many important nuances encompass this aspect of research. Epidemiology is a science that involves a joint effort on the part of numerous individuals. It is the combined knowledge of various studies, at different points in time, that allow the researchers to progress toward their attainment of unknown information.

Epidemiology is generally divided into two different areas, one being descriptive studies and the other analytical. A researcher has the opportunity to choose from various types of studies that fall under one of the these two main topics. Descriptive studies are generally precursors to their analytical counterparts. They formulate the questions that are later answered by the

analytical studies. It is the descriptive studies that discover possible pathogens and emerging epidemics. Analytical studies test hypotheses concerning the effect of certain exposures on the occurrence of a particular disease or condition. It is the use of both types of research that enables a conclusion to be reached.

Descriptive studies involve the collection and examination of data that is used to formulate questions and to describe patterns of disease occurrence. Correlational studies document disease occurrence among an entire population. This particular approach can lead to incorrect assumptions because it considers a representation of the average not specific individuals. It also lacks the ability to control for confounding that occurs when another risk factor has an association with the particular exposure being considered. Case reports and case series are descriptive studies that consist of information that has been gathered from a patient or a group of patients that have a similar diagnosis. Formulation of a new hypothesis and subsequent analytical tests are normal results of these studies. In a cross-sectional survey, both the exposure and disease status of individuals in a well-defined population are determined at the same point in time. It provides information on the number with the disease and the risk of obtaining it at that point in time. It cannot determine whether the exposure was a result of, or

proceeded. the disease. Each of these methods have much to offer the medical research community by stimulating future research. It is the questions that are formed as a result of these studies that lead to additional investigations and tests.

Case-control studies are common in analytical epidemiology. In this type of research, subjects are selected because they do or do not have the particular disease or condition that is being studied. After the case and control groups have been selected, their histories are researched and compared to determine the effects of certain exposures. The 1980 study on Toxic Shock Syndrome is an example of this type of research. There were six studies set up to determine the exposure, or exposures, that lead to Toxic Shock Syndrome. Strict criteria were used to choose the cases from the individuals that had been diagnosed with the disease. The controls were similar in age and environment so that a better comparison could be made. The examination of the study results linked the use of tampons to the disease because it was a distinguishing characteristic of the cases. Case-control studies have some distinct advantages. They enable the researchers to identify a sufficient number of diseased and nondiseased individuals, as well as, identifying many different, but possibly causal, exposures. They reduce the complications associated with a long latency disease because it has

already developed when the study begins. Research of this type also has some disadvantages, mainly its susceptibility to bias. The collection of information concerning past exposures lends itself to both selection and observation bias. The individuals that actually participate may have a different exposure-disease relationship then the ones that were not chosen or did not want to become a part of the study. This occurrence is called selection bias and can occur in other types of studies as well. Observational bias deals with the subject's recounting of past exposures and the interviewer's methods of obtaining information. If the individual has had experience with the disease of interest, they are more likely to remember possible exposures, which is known as recall bias. The afore mentioned study involving Toxic Shock Syndrome had problems with recall bias; however, in that particular instance the results were so overwhelming that the effects of bias could not have possible changed the outcome. If the interviewer is aware of the person's disease status then he might approach the questioning in a different manner. In all studies the presence of bias is reduced to a minimum but fails to be eliminated completely. This is therefore taken into consideration when choosing a case-control study as one's means of research.

In a cohort study the researcher is working from exposure to disease instead of the disease to exposure

process that is associated with the case-control. The subjects in a cohort are selected and classified according to exposure status and then followed for disease development. This significantly decreases selection bias and allows the collection of more accurate information concerning the exposure status and time periods between the exposure and subsequent development of the condition. Rare exposures can be successfully examined with the use of this type of study. It also enables the researchers to examine various effects of a single exposure, as in the Nurses' Health Study. The study tested numerous possible effects of oral contraceptive use. It was a prospective cohort because the outcome had not occurred at the beginning of the study. Conversely, the outcome has already occurred when the retrospective cohort begins. Whether the condition has developed or not, a cohort always moves from exposure to outcome. This method of research does have weaknesses that are taken into consideration and subsequently reduced. The importance of follow-up causes problems because of loss of contact with certain subjects. The follow-up information is gathered at varying time increments so that changes or new developments can be documented. A significant loss in the number of responding participants can effect the statistical outcome and the accuracy of the conclusions that are drawn. In a prospective study of dietary calcium and other nutrients'

effect on kidney stones the response rate was kept high because they chose people that were part of the medical profession and therefore more likely to contribute to these studies. They also sent repeated questionnaires to the individuals that had not responded earlier. There are techniques to setting up and completing a study that will minimize inaccuracies due to lack of follow-up. Choosing the right study population and having effective ways of locating the participants limits the losses. Cohort studies enable the researcher to use exposure information to determine an outcome.

Epidemiology also includes intervention studies, or clinical trials, as a means to acquire further knowledge of the causes of human diseases. A study of this kind provides the most accurate results but it is the most difficult to perform. The study must be sufficiently justified because it is the investigator who assigns the exposure status. There must be enough doubt about the exposure to allow withholding it from half the subjects and yet enough belief in it to allow distribution to the other half. Placebos are commonly used to prevent reporting of results that never occurred. It was realized that these were necessary when people that had not had treatment were reporting its effects. The use of placebos and randomization help prevent false results due to inaccuracies and bias. The clinical trial used to test the

Hepatitis A vaccine was a double-blind, placebo-controlled trial. Double-blind indicates the fact that both the person that examined the individuals and collected the data and the subject were unaware of their exposure status. If conducted correctly, these studies are the most beneficial because they offer the results that are most accurate.

The various types of studies that fall under the title of epidemiology can be used in numerous ways to combat human diseases. It is the combined effort of many researchers working towards a common goal that allows the science of epidemiology to continue in its positive direction. It is an area that perpetuates itself by discovering emerging diseases at the same time that it is uncovering possible answers to the many questions that it has developed. The many attributes of epidemiology are appreciated and used throughout the science and health fields.

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THE USE OF THE TRANSCUTANEOUS pO_2/pCO_2 MONITORING SYSTEM IN THE HYPERBARIC CHAMBER

Kathlyn E. Cosgrove
High School Apprentice

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Kathlyn E. Cosgrove

ABSTRACT

Hyperbaric oxygenation is used as a treatment for many different problems, such as acute traumatic ischemias and "bubble trouble." This experiment will be used to find out if the transcutaneous pO_2/pCO_2 monitoring system will help the effectiveness of the hyperbaric chamber. From previous studies it has been found that the transcutaneous pO_2/pCO_2 monitoring system dilates the size of the blood vessels. Under pressure, in the hyperbaric chamber, the size of the blood vessels decreases. If this monitoring system is used in the hyperbaric chamber then there is the possibility that the amount of time spent in the chamber can be decreased.

THE USE OF THE TRANSCUTANEOUS pO_2/pCO_2 MONITORING SYSTEM IN THE HYPERBARIC CHAMBER

Kathlyn E. Cosgrove

INTRODUCTION

Since first being invented, the transcutaneous pO_2/pCO_2 monitoring system has been used to determine many different problems. This system is important to the physicians working with the hyperbaric chambers. It reveals the inability of delivering oxygen to the tissue of the organism. It allows for continuous monitoring of oxygen and/or carbon dioxide. This monitoring system is used in many fields of medicine. Not only can it help to determine whether a skin flap transplantation has been successful or not, but it also helps physicians find the necessary level for amputation. The transcutaneous pO_2/pCO_2 system is used in the hyperbaric chambers because it is difficult to take blood samples in the chamber and almost impossible to perform blood gas analysis in the chamber. This monitoring system reduces the amount of punctures a patient must receive, thus making it a less stressful ordeal.

DISCUSSION OF PROBLEM

In the hyperbaric chamber patients are subjected to 100 percent oxygen under pressure. A standard dive is equal to the pressure experienced at forty-five feet beneath sea level. Many patients have poor circulation so they need 100 percent oxygen to heal. The dives last approximately two hours and thirty minutes. On a pattern of thirty minutes on one hundred percent oxygen then ten minutes breathing normal air. The patients are exposed to ninety minutes of one hundred percent oxygen. The confinement of the chamber is a problem for some of the patients. This is especially true for the claustrophobic patients. If the transcutaneous monitoring system could be used effectively then it could possibly mean that treatments could be made shorter. Then more patients could be taken on so that the beneficial effects of the hyperbaric chamber could be felt by more patients.

METHODOLOGY

Three electrodes are applied to the subject. These skin sensors are: an O_2 electrode, a CO_2 electrode, and a combined O_2-CO_2 electrode. These reveal the inability of delivering oxygen to the tissue of the patient. The electrode heats the skin making this usually tight membrane permeable to gas transport. The heat dilates blood vessels making the blood flow increase. Hyperbaric oxygen is the intermittent administration of one hundred percent oxygen at pressure greater than that at sea level. The chamber is pressurized with air to reach the correct depth. Once at the correct depth the patient breathes one hundred percent oxygen through a hood. Hyperbaric oxygen therapy is the primary treatment for decompression sickness, arterial gas embolism, and severe carbon monoxide poisoning. With all these problems it would be of great help if the treatments could be shortened with the use of the transcutaneous pO_2/pCO_2 monitoring system.

CONCLUSIONS

The testing of the transcutaneous pO_2/pCO_2 monitoring system is important for later, these test results may save time, money, energy, and even a patients life. At the time of this writing no subjective data can be supplied. Further testing will be done.

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A STUDY OF THE PHOTOELECTRIC EFFECT FOR POSSIBLE DETECTION OF BIOLOGICAL AEROSOL PARTICLES

Stephanie J. Garcia
High School Summer Apprentice
Vision Biophysics Lab
Clinical Sciences Division
Armstrong Laboratory
Brooks AFB, TX 78235-5000

Oliver Wendell Holmes High School
6500 Ingram Rd.
San Antonio, TX 78238

Dr. John Taboada
Mentor

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AFOSR Summer Research Program
Armstrong Laboratory

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Stephanie J. Garcia
High School Summer Apprentice
Vision Biophysics Lab
Clinical Sciences Division

ABSTRACT

The photoelectric effect was studied and two experiments were developed to demonstrate the effect. The photoelectric effect occurs when photons excite the valence electrons of a metal with enough energy to cause the electrons to escape the surface. The measured stopping potential is related to the substance's work function. The photoelectric effect seems to offer possibilities for the detection of biological aerosol particles for environmental health, medical, occupational, and defense reasons.

An RCA IP39 photocell illuminated with monochromatic visible light was studied initially. Data yielded a graph used to calculate Planck's constant, h. The other experiment involved a sample chamber illuminated with a (UV) deuterium lamp. Samples tested included non-metallics, metallics, salt, and an amino acid. Only metallic samples produced an observable effect. Further study of biological aerosol detection is required.

A STUDY OF THE PHOTOELECTRIC EFFECT FOR POSSIBLE DETECTION OF BIOLOGICAL AEROSOL PARTICLES

Stephanie J. Garcia

INTRODUCTION

The photoelectric effect is a process by which electrons may escape from a surface. It may occur when electromagnetic radiation is incident on a surface (usually metal) and photons supply electrons with energy equal to or exceeding the energy that binds that electron to the surface (2). Valence electrons are optically excited by absorbed photons to higher unbound energy levels. These electrons, known as photoelectrons, then diffuse randomly with a fraction reaching the surface with some energy loss due to electron scattering. The electron must then escape over the potential barrier at the surface if it is to be detected (3). A current is produced as monochromatic light shines on the cathode made of the sample material in the vacuum. This supplies energy to electrons that, when emitted from the surface as photoelectrons, travel toward the anode.

An applied reverse voltage and the frequency of light alter the photoelectric effect. Photoelectrons leave the cathode with varying kinetic energy and are repelled by the retarding electrostatic field of potential difference V. As the applied voltage is made larger, the photocurrent reaches a limiting value (1). A certain V can be applied that causes the photocurrent to drop to zero. This value of V is known as the stopping potential, Vs.

The threshold frequency is the frequency at which photoemission equals zero. This value must be exceeded for photoemission to occur. The threshold frequency depends on the work function of the various substances and is usually in the UV region.

Substances have characteristic work functions which determine the amount of energy needed for the excited electrons to escape the surface potential. Calculations can be made to determine the greatest wavelength at which photoemission can occur:

$$\text{Wavelength} = hc/\ kW,$$

where h is Planck's constant (J sec), c is the speed of light (m/sec), W is energy (work function, eV), and k is a conversion factor (eV to Joules). Thus, stopping voltage depends on frequency, and frequency depends on the work function.

DISCUSSION OF PROBLEM

This investigation ultimately concerns the study of the photoionization of biological substances. A method to detect biological particles in the air is vital for environmental health, medical, occupational, and/or defense reasons. Since biological molecules tend to ionize more readily than inorganic molecules, surface charges are a primary interest in the detection of these biological particles. Several existing detection methods do not distinguish between particles of biological or non-biological origin and tend to have other

inconvenient characteristics (9). R. Niessner and associates have experimented with the Photoelectric Aerosol Sensor (PAS) as well as with other methods for studies involving aerosols and polycyclic aromatic hydrocarbons (PAH) (4-8). Dr. John Tabaoda and Captain David R. Carpenter of the Armstrong Laboratory, Brooks Air Force Base have devised a method for detection and concentration measurement of biological aerosol particles in the air. Intense ultraviolet (UV) light (254 nm) from a mercury lamp, as well as other sources, provides ionizing photons that interact with electronic structures of the biological substances, probably the biological particle's outer surface. The particles are then passed through a detector in a sample air stream (9). Because of these initial studies, the use of the photoelectric effect to detect biological substances is being investigated in more detail (12-14). Due to time and resource restrictions, however, this initial project only demonstrated the basic principles of the photoelectric effect. The goal of detecting photoelectrons from biological particles is yet to be achieved, although the ground work is done.

METHODS AND MATERIALS

The physics of the photoelectric effect as well as related past experimental methods were studied (1-3, 10-11). Several set-ups were experimented with to observe the photoelectric effect, but only two produced favorable results. The first involved use of the RCA IP39

photocell placed in a light blocking tube with a small hole drilled for a fiber optic that transported light into the cell from the exit slit of a monochrometer (Jarrell Ash, serial 207661). A Xenon lamp (American Instrument Co.,INC. part no. 422-848) was focused with a lens at approximately 4.5 cm into the monochrometer at approximately 36 cm. The stopping potentials were determined for wavelengths between 385 nm and 620 nm. A Keithley Instruments model 148 Nanovoltmeter monitored voltage across a 500k Ohm resistor (Kidco RN25X 5763F). A Fluke model 415B high voltage power supply provided the stopping potential. The stopping potential versus the photon frequency was plotted.

A method to change samples simply and efficiently to study the photoelectric effect of various substances was investigated. Finally, an apparatus with a quartz window ported aluminum vacuum shroud in conjunction with a UV deuterium lamp was developed. The vacuum shroud (57 mm outer diameter, 35 mm inner diameter, 29 mm height) had a 10.4 mm opening at the top with a quartz window (~38 mm diameter, 5.7 mm thick) adhered to the opening with an ultraviolet curing glass adhesive (Duro Crystal Clear, Loctite Corporation). The base of the shroud sat on a plate (64.5 mm x 61 mm x 6.8 mm) with an O-ring to secure a vacuum. A Welch Duo-Seal Vacuum pump model 1402 was used to pump the system down. Incorporated on the base plate was an elevated brass disk on which samples were placed. A silver coated ring located above the disk approximately 7.8 mm in diameter served to collect the photoelectrons. A deuterium lamp from a spectrophotometer (Hitachi Perkin-Elmer 139 UV-

VIS Spectrophotometer) was then clamped approximately 8 cm above the vacuum chamber so that UV light could shine directly through the window. Previous experimentation with the entire spectrophotometer unit yielded no observable results. A voltmeter (Fluke 8050A Digital Multimeter) was connected directly to the electrodes of the vacuum chamber (positive on brass disk, negative on silver ring). This method yielded favorable results for the photoelectric effect of certain samples. Samples tested included zinc, lead, aluminum, salt, a paper towel, a green fluorescent notecard, Teflon tape, a penny, a nickel, and L-Lysine.

RESULTS

Experimentation with the IP39 photocell yielded enough data [Table I] to produce a stopping potential versus frequency graph [Fig.1]. The slope was used to determine Planck's constant, h [slope equals h/e, where e is the electron charge]. The graphing program displayed the equation of the fitted line:

$$Y = .186848x + -.553261.$$

The slope equaled 5.3519 x 10 (-15) Joule seconds per Hertz (Js/Hz) while the accepted value is 4.14 x 10 (-15) Js/Hz. The Y-intercept represents the work function divided by e (W/e). Calculation of h yielded a value of 8.56 x 10 (-34) Joule seconds (Js) compared to the accepted value of 6.63 x 10 (-34) Js, a relatively sound measurement considering the apparatus was simple and homemade. Errors that may have affected the readings included drift of the nanovoltmeter and small

Table I. Wavelength (L), frequency (f), and stopping potential (Vs) with the IP39

L (nm)	f x 10 (14) Hz	Vs (volts)
385	7.79	.90
405	7.41	.82
425	7.06	.76
450	6.67	.70
475	6.32	.63
500	6.00	.59
520	5.77	.55
540	5.56	.48
570	5.26	.40
600	5.00	.38
620	4.84	.35

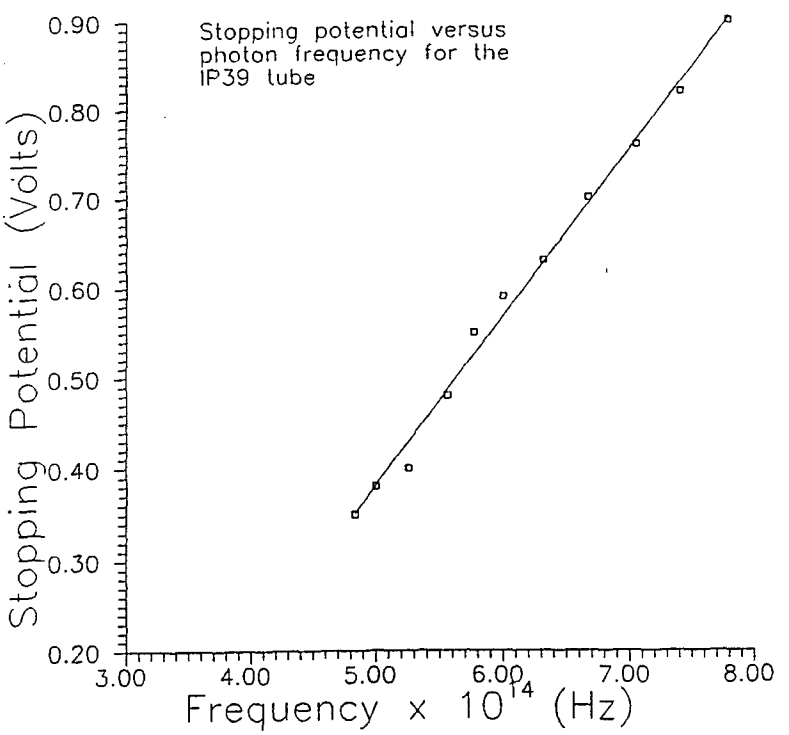

Figure 1. Data from the IP39 yielding Y = .186848x + -.553261 and slope = 5.3519 x 10 (-15) Js/Hz; h = 8.56 x 10 (-34) Js.

inaccuracies in the readings of the stopping potentials. It was thought that a digital voltmeter (Circuit Mate) might yield more accurate results since it would be easier to read; however, results were found to be less acceptable compared to results using the nanovoltmeter (i.e., Y = .13513x + -.199599; h = 1.184 x 10 (-33) Js).

Several trials finally led to successful observations of the photoelectric effect of various samples. Initially, the spectrophotometer unit was used to illuminate the substance with a controlled wavelength (~150 nm - 300 nm); no photoelectric effect was observable. The UV lamp was then brought directly above the chamber window and alternately removed so that with the light, voltage increased and without it, voltage decreased to a stable value. Thus, this indicated that the photoelectric effect can be observed with a simple, direct device. Samples around the lab were tested.

TABLE II. Monitored voltage (mV) using the Digital Multimeter to determine the photoelectric effect of various samples, unscraped (un) and scraped (s) when applicable.

Sample	UV off	UV on (un)	UV on (s)
Zinc	-.01	.95 - 1.00	1.87 -2.33
Lead	-.01	.18	.3
Aluminum	-.01	-.03 - -.0	.9
penny	-.01	0.00	3.15 - 3.4
nickel*	-.01	0.00	1.70 - 2.5
towel	-.01	-.01	N/A
notecard	-.01	-.01	N/A
tape	-.01	-.01	N/A
Salt (NaCl)	-.01	-.04 - -.01	N/A
L-Lysine	-.01	-.01	N/A

* coin, not element

In these experiments, if no photoelectric effect was observed, the voltmeter read -.01 mV. For the metallic materials (zinc, lead, aluminum, a penny, and a nickel), results were favorable [Table II]. The photoelectric effect was, however, much more observable when the surface was scraped clean just prior to testing. When the sample was placed in the chamber and illuminated, the voltage increased steadily until a peak was reached, then it decreased to a stable value. If allowed to oxidize, very little or no effect was displayed, possibly due to the insulating oxide film that caused a change in the work function of the material.

The distance of the silver coated ring also seemed to affect the intensity of the photoelectric effect. Depending on the thickness of the sample, the distance between the ring and the sample was approximately 2 mm. Other non-metallic materials (paper towel, fluorescent notecard, Teflon tape) were tested, but did not yield any observable effects.

Since the driving force of this experiment was to observe the photoelectric effect in biological substances (amino acids, proteins, or spores), a conducting metal, salt (NaCl), was tested to determine if granule materials would produce an observable effect. The salt was placed in an aluminum plate, wet, and left to dry. When the sample was tested, a small (~0.03 mV) change in the voltmeter reading occurred; however, the sample was then cleaned out and the aluminum plate was

retested, yielding a similar voltage change. Therefore, no photoelectric effect was observed, possibly because the work function of NaCl is a rather high 8.54 eV (5). As a final sample, L-Lysine was tested by placing a powdered form of the amino acid on the aluminum plate, scraped on both sides, and setting the sample in the vacuum chamber. As was expected from prior tests, no photoelectric effect was observed.

CONCLUSION

On the second apparatus used in this study, light shining on the metal samples energized sample electrons, causing them hit the anode, making it negative with respect to the cathode. When the anode potential reaches a limiting value, Vs, photoelectrons lack enough kinetic energy (energy from the photon minus the sample's work function) to escape the surface potential difference. Thus, under this condition, no more electrons reach the anode and the potential stabilizes to a measurable value, Vs. Mathematically, this occurs when:

$$e(Vs) = KE = hf - W,$$

where e is the electron charge, Vs is the stopping potential, KE is the kinetic energy, h is Planck's constant, f is the frequency, and W is the work function. This relation was qualitatively confirmed for various metal samples.

The photoelectric effect, due to the extremely small photocurrents to be monitored, the secondary anode emissions, and the sensitivity of the instruments used, is difficult to observe and monitor. The voltmeters, especially the 148 nanovoltmeter, registered abundant noise; motion of the observers sometimes caused the meter to drift. Also, the work functions of the samples (as observed with the sample chamber) as well as the frequency of light (as observed with the IP39) play a vital role in photoemission. The materials in the IP39 had a sufficiently low work function that remained constant in the vacuum phototube, so the photoelectric effect could be observed relatively consistently (taking into account the sensitive drift of the nanovoltmeter) in the visible light range (385 nm - 620 nm). The stopping potential was found to be related linearly to the frequency with slope equal to h/e, and y-intercept equal to W/e. The IP39 phototube produced favorable results, and it served to establish the basic principles of the photoelectric effect. The desired goal of testing different samples and eventually biological substances, however, led to the development of the removable chamber apparatus.

Based on the results of these experiments, only the metallic substances produced favorable results. It was found that metals scraped clean produced a more measurable photoelectric effect; sometimes, if the surface was not cleaned, no photoelectric effect was observed. Elementary Modern Physics (2) reports, "The photoelectric effect occurs when electromagnetic radiation shines on a clean metal surface and

electrons are released from the surface."

The non-metallic samples did not produce a photoelectric effect, possibly due to no conductivity, high work function, or low tendency to photoionize. Even though R.A. Millikan observed and collected data for the stopping potentials of pure sodium (1), sodium chloride (salt) did not yield an observable photoelectric effect; possibly, the chlorine in the compound suppresses the effect, or the apparatus or method lacks sufficient sensitivity. The latter could also explain the results of the L-Lysine experiment.

Several additional experiments are necessary to successfully develop a method for monitoring biological substances in the environment. Experimentation is underway using a laser in a modified version of Millikan's Oil Drop experiment to monitor particles in the air.

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THE PROTECTION OF FIGHTER PILOTS AGAINST GRAVITY

Zayda M. Triana
Incarnate Word High School

Final Report for:
AFOSR Summer Research Program
Armstrong Laboratory

Sponsored by:
Brooks Air Force Base
San Antonio, Texas

August 1993

THE PROTECTION OF FIGHTER PILOTS AGAINST GRAVITY

Zayda M. Triana
Incarnate Word High School

Essay

The acceleration of high-speed planes causes fighter pilots to experience a lurching similar to that which occurs when one turns sharply in a car: one's body sways to the side due to the tendency of an object in motion to remain in motion and follow a straight path. The "pull" of gravity which a pilot senses is a stronger force than someone would feel while standing at rest on the ground, and therefore the human body responds to it differently. Instead of the normal circulatory path through which the blood flows under 1 G, the blood begins to pool at the feet, causing the brain to be deprived of oxygen. Without enough oxygen to the brain, the fighter pilot's peripheral vision begins to blacken out, and before the pilot can compensate for the loss of sight, he loses consciousness, or "G-locks."

Experiments are thus being completed to investigate the physiological effects of high gravity on the various parts of the heart, such as the aorta, left ventricle, and right atrium. The subjects, usually baboons or rhesus monkeys, are placed on a centrifuge which can simulate anywhere from 2 to 9 G. After the

proper instrumentation is attached to the subject, data is recorded. These results are then processed through an analog to digital converter, and are conveyed into the computer uncalibrated, meaning "gains" and "offsets" must be applied so that the data will be accurate.

Familiarity with Matlab for Windows, an analytical program, is essential for the mathematical and conceptual aspects of the data analysis; strip charts, data tapes, laboratory procedure books, and data files are also used to acquire material which eventually leads to the numerous calibration factors and gives scientists usable information to help pilots survive through the harmful effects of gravity.

EFFECTS OF CHRONIC +Gz EXPOSURES ON RATS

Jason A. Barber

Final Report for:
Summer Research Program
Armstrong Laboratory

Sponsored by:
Research and
Development Laboratories

June - August 1993

EFFECTS OF CHRONIC +Gz EXPOSURES ON RATS

Jason A. Barber

ABSTRACT

A pilot study of the effects of chronic +Gz exposures on rats was conducted using a Small Animal Centrifuge (SAC). During the six weeks of the study, animals were exposed to either 0.5 +Gz or 22.5 +Gz in either single or multiple exposures. Control animals were not exposed to +Gz. Body weights, food intake and temperatures were recorded on a daily basis. Data collected showed a steady decline in body weights, an increase in body temperatures, and food intake remained at a constant consumption.

EFFECTS OF CHRONIC +Gz EXPOSURES ON RATS

Jason A. Barber

INTRODUCTION

Pilots who engage in air-combat maneuvers may reach high sustained +Gz levels several times during a flight. This type of exposure may also be repeated on a daily basis. With that in mind, the purpose of this experiment was to study the effects of chronic +Gz exposures over time using an animal model. It was unknown whether the Gz tolerance of animals could be increased or decreased by chronic +Gz exposures. It should be emphasized that this is a pilot study.

MATERIALS AND METHODS

ANIMALS

All animals used in this study were adult, male, Sprague-Dawley rats. The reason for using rats that are all the same is to minimize factors other that the experiment itself. Body temperature, food intake, body weights, and wound care were monitored on a daily basis as described.

TEMPERATURE

Body temperature was taken before and after acceleration exposures. This was done to assess the effect of +Gz stress on the Hypothalamo-Pituitary-Adrenal (H-P-A) axis and it allowed the possible detection of any infectious process that may be ongoing. The body temperatures were taken rectally with a small thermal probe which was lubricated with KY jelly.

Food Intake

The animal weight, size and padding of the restraint devices are a very important factors in determining the +Gz level at which the rats will undergo Gravitational Loss of Consciousness or GLOC.

Food intake was monitored daily to assist in pair-feeding. The rats were pair-fed, meaning that the food intake of the experimental animals was averaged and the same amount was given to the control animals. This way all of the animals received the same amount of food and the body weights of each group could be kept equal during the entire six weeks. Body weight recordings have shown this to be effective. Based on a previous study, the rodent model for +Gz exposure has an average +Gz tolerance endpoint (GLOC) of 22.5 +Gz. Our experimental animals were standardized based on the tolerance endpoint information, with referance to variability found in body weight. This led us to develop a criteria to reduce this variability

by normalizing the animals' body weight with restraint padding and slot position, mimicking an anti-G suit effect.

The padding effect was determined using the mean body weight of the chronic multiple +Gz group consequently, creating two subgroups: the GLOC group, which are generally below the mean body weight and the Non-GLOC group which are above the mean body weight. The lighter the animal, the sooner it will go into GLOC.

SMALL ANIMAL CENTRIFUGE

The Small Animal Centrifuge is five feet in diameter, five feet tall, and has a 21 inch head to axis radius. It has a 15 horsepower three-phase regenerative DC drive motor that is capable of producing an acceleration of 1 to 85 Gz at a rate of 20 G/sec. A Zenith 248 computer system with customized software controls the centrifuge and a stripchart recorder was used for data collection.

WOUND CARE

Wound care was provided on a daily basis. The most noticeable problem site was the nose where the nose restraint caused cutaneous ulcerations. These wounds were treated with hydrogen peroxide and a topical antibiotic.

INSTRUMENTATION

All animals received surgical EEG implants one week prior to the experiment. This was done in order to eliminate the surgical stress factor. This instrumentation allowed monitoring changes in the electrical potential of the brain. The rats were also instrumented for ECG to monitor changes in cardiac activity.

RESTRAINTS

All of the rats spun on the SAC were placed in restraints to maintain the proper Gz axis. The centrifuge was used to create the acceleration force of either 0.5 +Gz or 22.5 +Gz.

EXPERIMENTAL GROUPS

The animals were divided into five major groups: Control, Base Gz, Chronic Multiple, Chronic Single, and Acute Multiple groups.

The Control group consisted of seven rats. These rats were not placed in restraint devices and did not receive acceleration exposures. This group served as an unstressed group or the positive control.

The Base Gz group consisted of seven rats that were spun at 0.5 +Gz three times a day, five days a week for six weeks. This group served as a low multiple Gz-model group to compare with the control.

The Chronic Multiple group consisted of 13 animals which were divided into two subgroups, a GLOC group and a Non-GLOC group. Each group was spun at 22.5 +Gz three times a day, five days a week for six weeks. These two subgroups served as a high multiple Gz-model group to compare with the control.

The Chronic Single group consisted of seven animals that were also subdivided in to two groups, a GLOC group and a Non-GLOC group. The animals in these groups were spun at 22.5 +Gz one time a day, five days a week for six weeks. This group served as a high single Gz-model group compared to the control.

The Acute Multiple group consisted of 30 animals that received three exposures to 22.5 +Gz in one day and were sacrificed after the run and tissue samples were collected.

All acceleration exposures were of 30 seconds in duration. When animals received multiple exposures, they were given a 3 minute rest period between each exposure. This allowed the animals time to recover. In addition, all of the animals in the study were allowed to recover on the weekends.

It is important to keep in mind that all experimental animals were exposed to many types of stress: the stress of transportation to and from the place of

housing, the stress of being put in restraint devices, and most of all, the stress of being handled.

RESULTS

Food Intake

As you can see from graph 1 the cumulative food intake remained fairly constant through the six week experiment except during the interruption in pair-feeding during week five. The animal care person in charge during this time was not notified of the feeding method used.

Body Weights

The steady decline in body weights shown in graph 2 is likely to be the effects of the combined stress. The Control group was heavier throughout the six weeks due to the absence of stress other than the weighing of these animals. This graph indicates where the interuption of feeding occurred. From this point on, the Control group no longer served as a size match to correlate data from the other experimental groups.

Body Temperature

As shown in graph 3 the body temperature over the six week period tended to rise gradually. Body temperatures dropped dramatically at week five when the feeding schedule was interrupted. Once the animals were put back on their

regular feeding schedule, the body temperatures tended to level out at week six slightly lower than the level at week four.

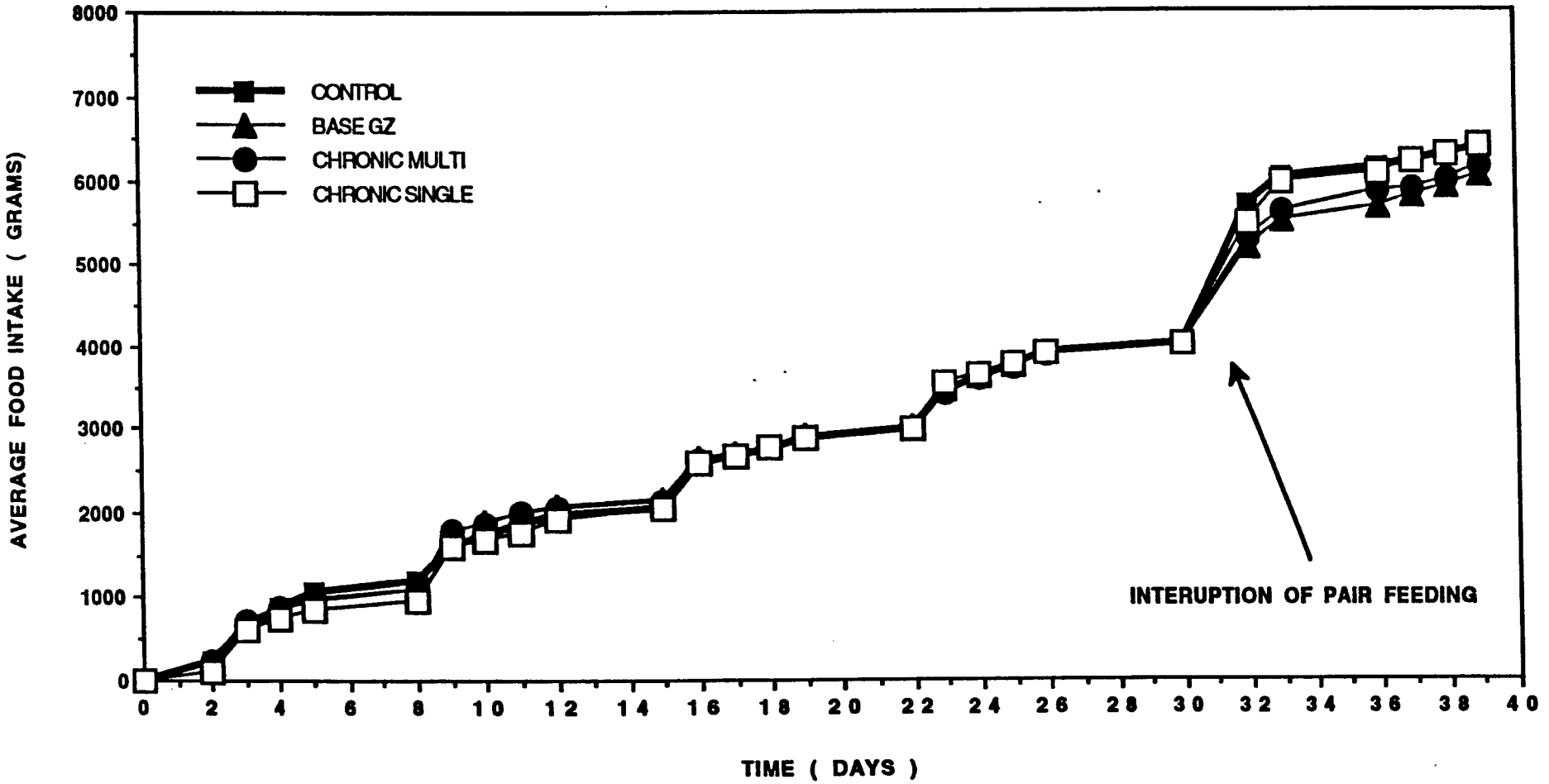
Conclusion

Over the six weeks of the experiment the baseline body temperatures tended to rise. This is probably a stress response due to handling or exposure to acceleration. This may be considered a negative adaptation to chronic +Gz exposure.

With the food intake remaining constant in the five experimental groups, the body weights of the animals in the base Gz, multi, and single groups tended to decrease over the six weeks while the control group, for the most part, remained fairly constant showing a dramatic increase in week six caused by the interrupted feeding. The animals showing a decrease in body weight over the six weeks indicated negative adaptation to stress of handling and chronic +Gz exposure.

CUMULATIVE FOOD INTAKE

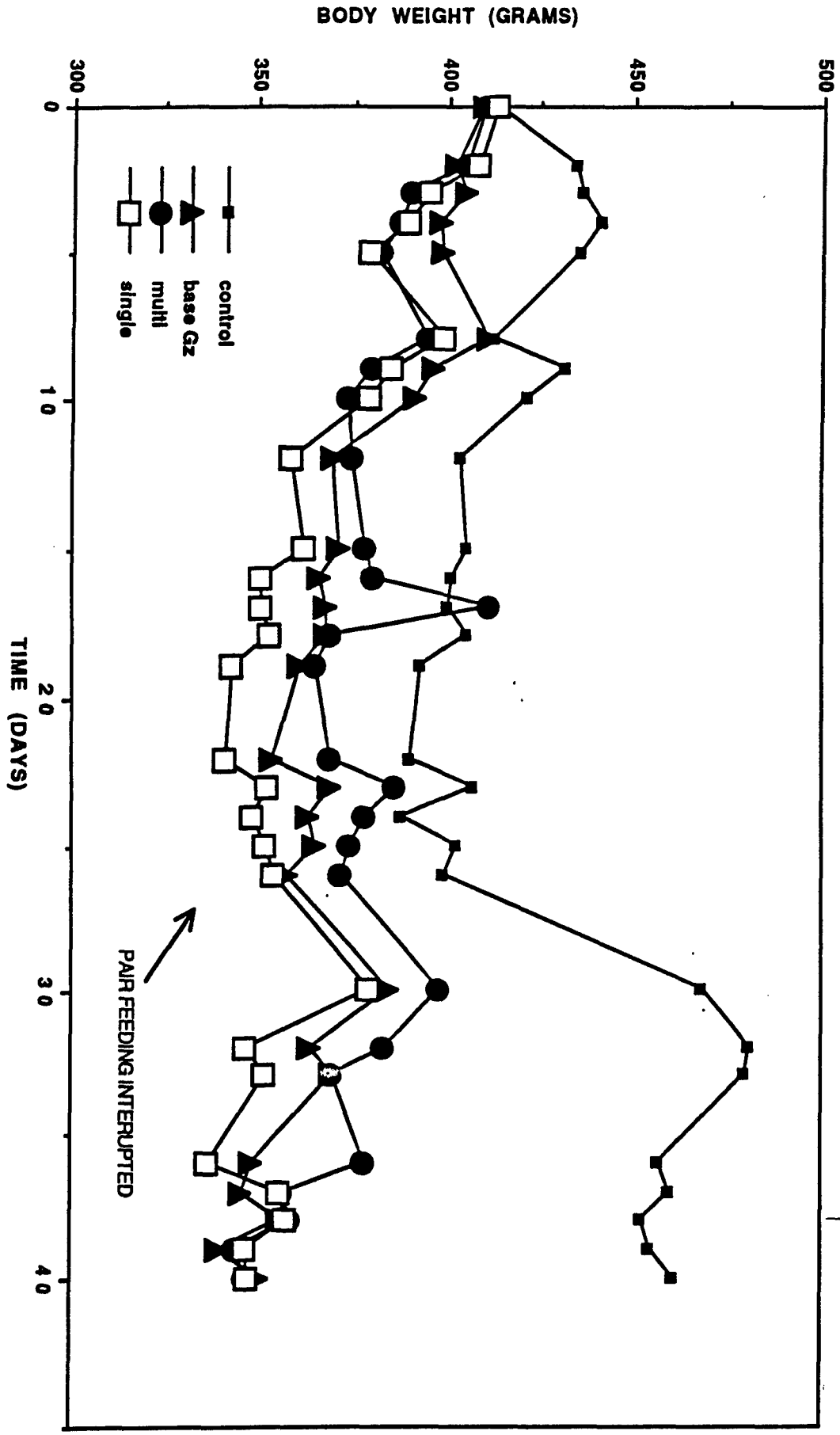
Graph 1



NOTES : * THE ABOVE GRAPH IS A REPRESENTATION OF THE AVERAGE CONSUMPTION OF SEVEN RATS PER GROUP

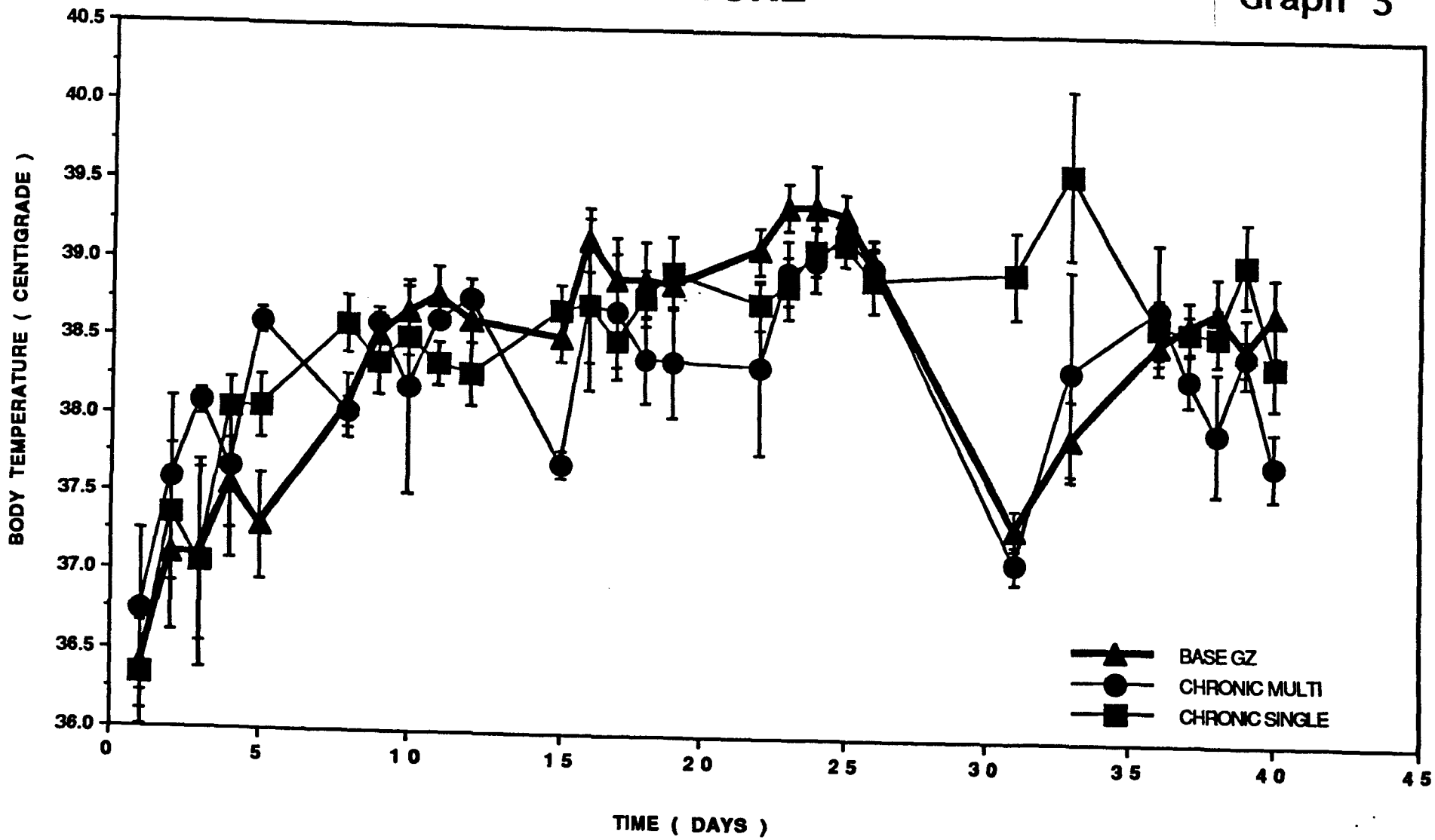
* NON STATISTICAL REPRESENTATION

* THE 3 EXPERIMENTAL GROUPS WERE FED AD LIBITUM DURING THE LAST TWO WEEKS


BODY WEIGHTS
Graph 2
BODY WEIGHT (GRAMS)
500
450
400
350
300
0
10
20
30
40
TIME (DAYS)
control
base Gz
multi
single
PAIR FEEDING INTERRUPTED

BASELINE BODY TEMPERATURE

Graph 3



Performance Testing of MSOGS

at Low Pressure

Shawn P. Carroll

Summer Research Apprentice

Department of Crew Technology Division

Robert E. Lee High School

1400 Jackson Keller

San Antonio, Tx. 78213

Final Report for:

AFOSR Summer Research Program

Armstrong Laboratory

Sponsored by:

Air Force Office of Scientific Research and

Research and Development Laboratories

Brooks Air Force Base, San Antonio, Tx.

August 1993

Performance Testing of Molecular Sieve Oxygen Generating System at Low Pressure

Shawn P. Carroll
Summer Research Apprentice
Systems Research Branch
Crew Technology Division
Armstrong Laboratory

Abstract

A performance study was conducted on two different high purity oxygen concentrating systems. The study was based on the goal of achieving a 99% or greater oxygen concentration at the most productive flow rate. The first system was constructed according to the design (U.S. Patent # 4,880,443) of a high purity molecular sieve oxygen concentrator. The second system resembled the first in all aspects except that a vacuum pump (Fig. 1) was installed via the exhaust valves. Theory indicated that the vacuum system, once pumped down to a low pressure, would outperform the standard system. Results of the study revealed that the vacuum system did in fact outperform the standard system, but only for half of the test parameters; the standard oxygen concentrator produced more desirable results for the remainder of the test parameters.

Performance Testing of Molecular Sieve Oxygen Generating System at Low Pressure

Shawn P. Carroll

Introduction

Approximately ten years ago, biomedical engineering barriers were surpassed with the invention and development of the Molecular Sieve Oxygen Generating System (MSOGS). This device is composed of four cylindrical-shaped beds each containing a molecular sieve (Diagram 1). Two of the beds contain zeolite molecular sieve (type 5amg 16x40 mesh 585g bed) in order to adsorb nitrogen, and the remaining two beds are comprised of carbon molecular sieve (10x40 mesh 394g bed) to adsorb the argon component of the inlet gas (Ref. 1). In it's operation, gas is pressurized in two beds while the other two are depressurized and purged of any remaining gases. The function is carried out in half-cycles thereby maintaining a continuous flow of product gas (Ref. 2). One minor drawback to the MSOG system concerns the limited amount of high purity oxygen that the system is able to produce, even at optimum conditions. Previously there had been speculation that a vacuum pump, when run at low pressure, could achieve a greater product flow at high purity levels (99.0% or higher) than the standard system; the theory had not been tested yet since its current operating conditions on jet planes (spec. 15-20 slpm at 93% level on standard one-seater) was sufficient. The purpose of this particular study was to determine whether or not an MSOG system, exhausted to a constant of 10 torr (approx. 2.098x10-1 or 94,000 feet altitude), could produce a product flow rate greater than .75 slpm (Ref. 3)

while maintaining an oxygen concentration percentage of 99.0, or higher, in the product gas.

Methodology

The procedure used to determine the performance of the systems involved operating both of them under a 3x4x1 test matrix. The test matrix encompassed three parameters which were held constant for both devices. Inlet pressure, product flow, and cycle time formed the input parameters and served as a control in order to acquire the data. Both apparatus were pressurized at 55 psia. PSA (pressure swing adsorption) cycle times input into the systems included 8, 12, and 16 seconds. Product flow consisted of .25, .50, .75, and 1 slpm. The non-vacuum system was exhausted to altitude pressure whereas the vacuum system was exhausted to an input of 10 torr (possible variation in measurement of exhaust pressure may have occurred). Each system was allowed 30 to 50 minutes for each data point in order to stabilize and record the best measurement of each point. Output evaluated as performance data included oxygen, argon, nitrogen concentration, and inlet flow. Each of these data were received by a Soltec DS-8400 strip chart recorder and relayed to paper as voltage readings taken from a Perkin Elmer 1100 Medical Gas Analyzer and a Tylan 0 to 150 slpm flow meter. The voltage readings were then interpreted into gas concentrations and flow data using voltage to percentage and voltage to slpm formulas.

Apparatus

The complete non-vacuum system consisted of a standard 99.% purity molecular sieve oxygen concentrator, a recording device, gas analyzer, tubing, flow meters, compressor, and cycle time program. Tubing throughout the device included 1/4 and 1/2 inch Norgren 210 psig max. nylon, 1/2 inch steel tubing, swagelok and pipe fittings. As seen on diagram 1, valves v2-v7 are all located on the device and are air-actuated valves fed by a Valcon 4 power supply and pumped by a Numatics Decco Solenoid max 150 psig. All remaining valves are manufactured by Whitey and include ball and needle valves. Two regulators were used to attenuate the flux of pressurized air from the compressor; both were Norgren R12-400 RGLA. The vacuum system included the same exact equipment as the non-vacuum system except that an industrial strength vacuum pump (approx. 500 cfm), located beneath the laboratory, was attached via piping to the exhaust end of the MSOG system.

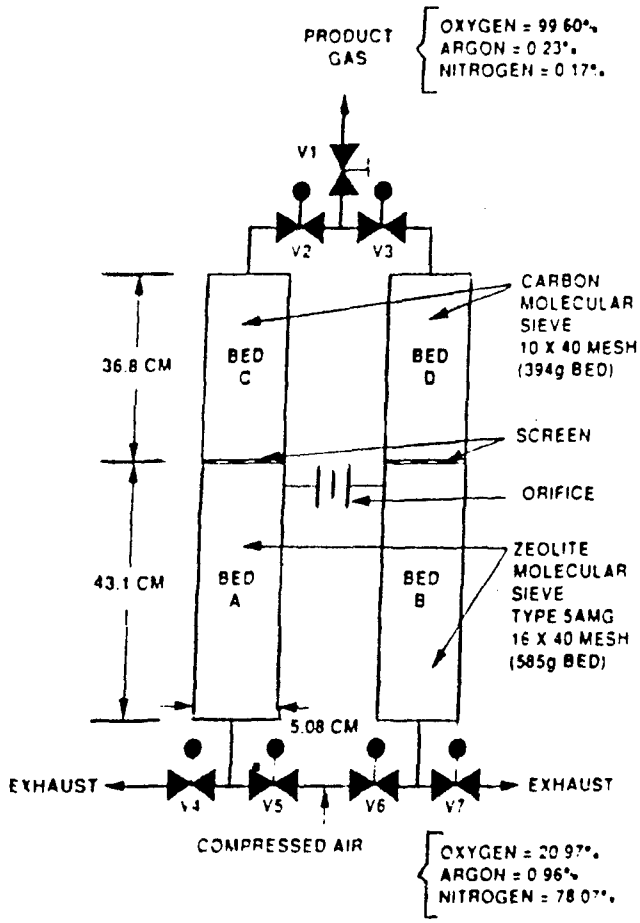
Results and Conclusions

Upon accumulation of all data points, an unexpected outcome was encountered. After comparison of the performance data, the results confirmed the theory that an MSOG system run at low pressure (10 torr) could produce 99.0% or higher purity product gas at a flow greater than .75 slpm. The vacuum system was able to reach the peak parameter of 1 slpm at a measured concentration of 99.1%, but only for the 8 second cycle time. A continued decrease in oxygen purity occurred after that point until at the 16 second parameter at 1 slpm it began to produce 82.5% concentration of oxygen. Alternately

the standard system outperformed the vacuum system in the 16 second cycle time, but was never able to achieve 99.0% purity product gas above .50 slpm at any cycle time.

In conclusion the MSOG vacuum system theory has been substantiated with proven data. Though the experiment was not as extensive as an in depth performance study usually requires, there does seem to be enough evidence that further and more thorough experiments along this line of work would be beneficial as well as cost effective in the future.

DIAGRAM 1



A Small-scale 99% Purity Molecular Sieve Oxygen Generator.

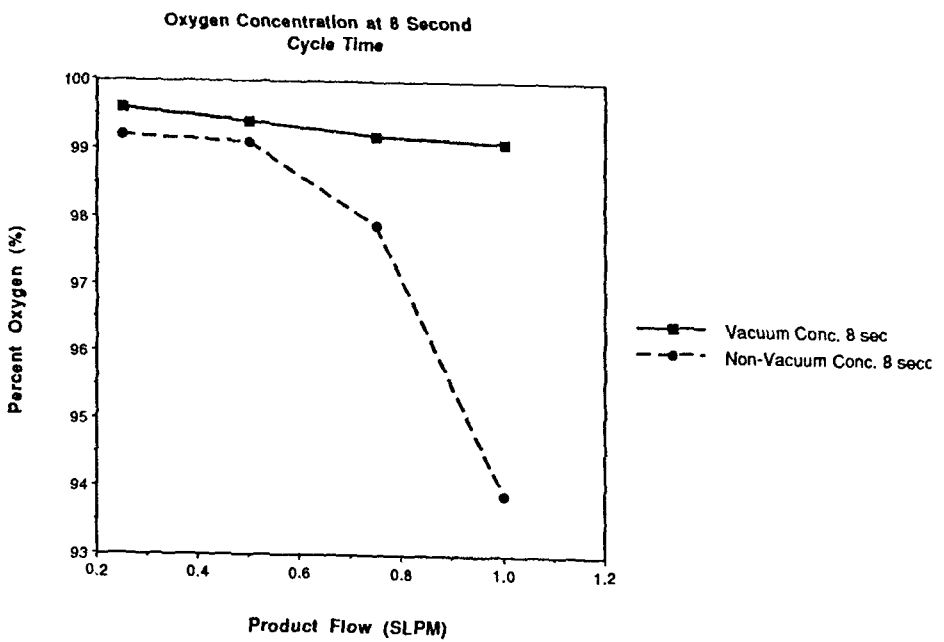

Oxygen Concentration at 8 Second
Cycle Time
Percent Oxygen (%)
100
99
98
97
96
95
94
93
0.2
0.4
0.6
0.8
1.0
1.2
Product Flow (SLPM)
Vacuum Conc. 8 sec
Non-Vacuum Conc. 8 secc

FIGURE 1

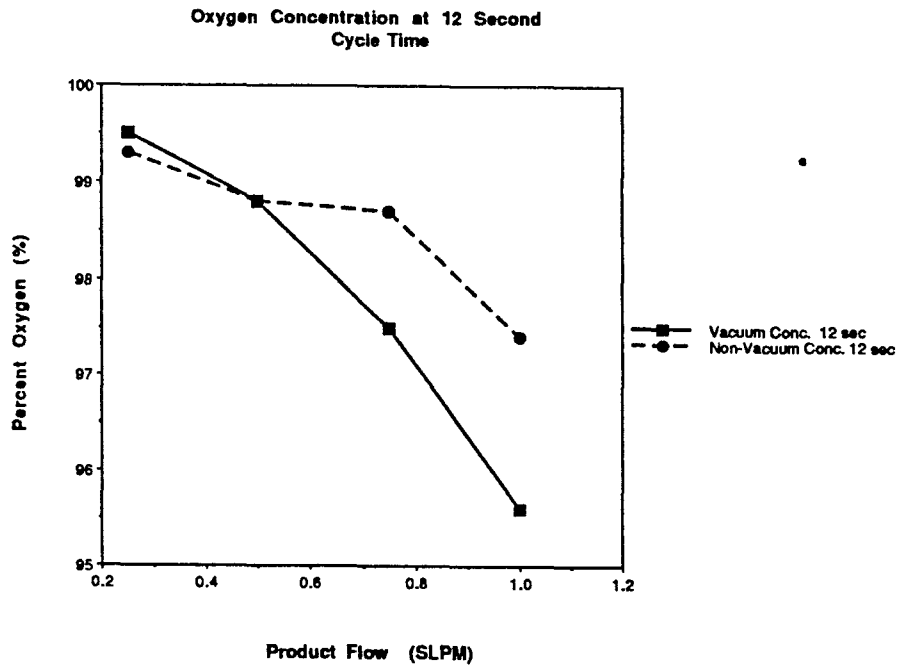

Oxygen Concentration at 12 Second Cycle Time
Percent Oxygen (%)
100
99
98
97
96
95
0.2
0.4
0.6
0.8
1.0
1.2
Product Flow (SLPM)
Vacuum Conc. 12 sec
Non-Vacuum Conc. 12 sec

FIGURE 2

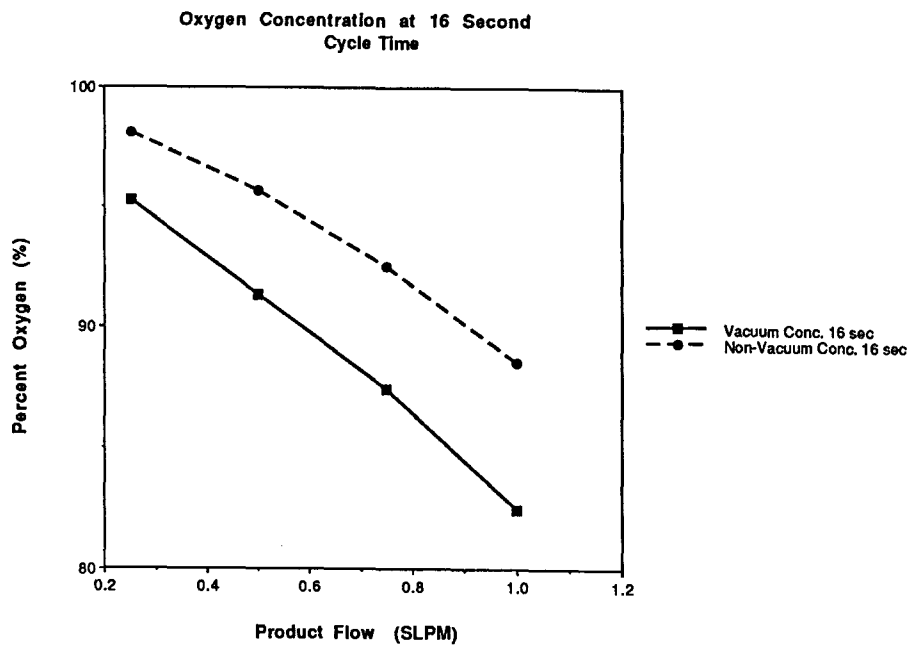
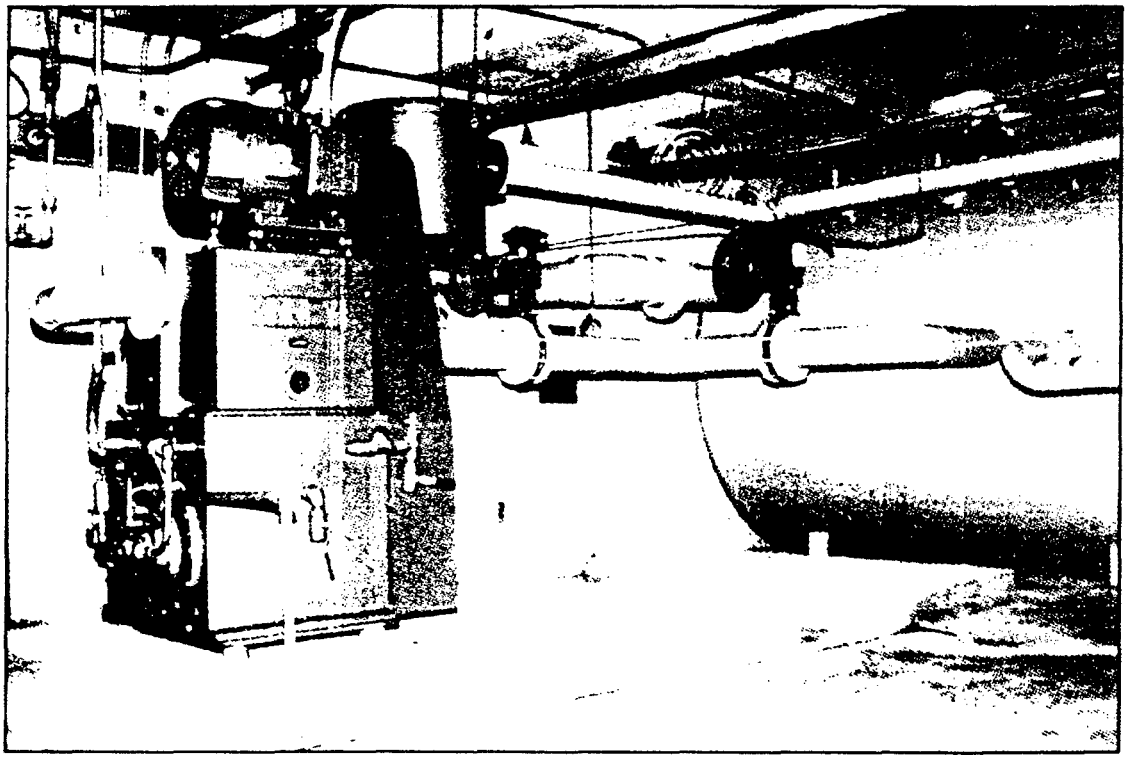

Oxygen Concentration at 16 Second
Cycle Time
Percent Oxygen (%)
100
90
80
0.2
0.4
0.6
0.8
1.0
1.2
Product Flow (SLPM)
Vacuum Conc. 16 sec
Non-Vacuum Conc. 16 sec

FIGURE 3

ONBOARD OXYGEN GENERATING SYSTEM (OBOGS) VACUUM SYSTEM



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COMPUTER AIDED SYSTEMS FOR HUMAN ENGINEERING

Eleanore Chuang

High School Apprentice

Beavercreek High School

2080 Dayton-Xenia Road

Beavercreek, Ohio 45434

Final Report for:

1993 Summer Research Program

Armstrong Laboratory

Human Engineering Division

Sponsored by:

Air Force Office of Scientific Research

Bolling Air Force Base, Washington, D.C.

August 13, 1993

ABSTRACT

As a high school summer apprentice in the Human Engineering Division of Armstrong Laboratory at Wright-Patterson Air Force Base, I worked in the DEfTech (Design Effectiveness Technology) Laboratory, testing software to be implemented in the CASHE (Computer Aided Systems Human Engineering) Version 1.0 program. In between software tests, I completed tasks which exposed me to graphics and program development and familiarized numerous hardware items, such as those involved in networking and memory augmentation. During the course of these eight weeks, I have learned a great deal about the importance of human factors engineering in product design. In addition, I have had the privilege of accessing some of the advanced software available for use on the Apple Macintosh family of computers.

INTRODUCTION

The CASHE (Computer Aided Systems Human Engineering) project currently in development by the Air Force Armstrong Laboratory, the Air Force Office of Scientific Research, NATO/AGARD, the Army Human Engineering Laboratory, the Naval Ocean Systems Center, the Federal Aviation Administration, and Search Technology, Inc., utilizes information from the *Engineering Data Compendium* and *MIL-STD-1472D* as the basis for its multi-media rendering of ergonomic data relevant to system design. The main objective of CASHE is to convert this information into an interactive software format to facilitate accessability, interpretability, and applicability through data visualization and prototyping in hopes of furnishing a more concise, more effective standard reference of human factors topics. Initially, the product was intended specifically to benefit government-employed system designers such as those laying out plans for aircraft crew systems; however, since the idea of CASHE was first introduced, interest from academic institutions and the private business community has mounted.

The CASHE system operates around concepts metaphorically related to the desktop of a system designer: the bookshelf, file management system, file viewer interface, and visualization tools. The "bookshelf" consists of volumes of reference material. The "file management system" provides easy access to any subject the user seeks through a table of contents, index, design checklists, author references, glossaries, and general access taxonomies. The "file viewer interface" accesses individual "entries" through key words and cross-referencing. Specialized "visualization tools" include the "Perception & Performance Prototyper" and the "Data Viewer." The "Perception & Performance Prototyper" allows the user to manipulate a number of variables related to the test bench topic and observe the effects of these conditions. The "Data Viewer" allows the user to view tables, figures, and text relevant to the topic.

At this time, programming code for five of the twelve test benches has been written. Completion of CASHE Version 1.0, for use on Macintosh II and upgraded Macintosh II computers, is now scheduled for December 1993.

DISCUSSION OF PROBLEM

Whenever any new product is in development, a prototype must be tested in order to ensure it meets design specifications and standards of quality control. No matter how skilled the programmers, simple mistakes in software code can occur, resulting in errors when the program is run. Therefore, a software tester from an objective standpoint comes in to evaluate the software and note anything unusual that appears during the run of the program and the circumstances under which the event is observed. Afterward, the programming team and the technical support group review the software tester's evaluation to determine which changes to the program are most crucial in keeping with the designer's original intent. A list of other more minor changes may be kept on file for reference when an updated version of CASHE is produced in the future.

METHODOLOGY

As the originator of the CASHE concept, Ken Boff, author of the *Handbook of Perception and Human Performance,* along with Janet Lincoln, his co-editor of the *Engineering Data Compendium,* developed the design plans for the current software approach. From there, experts in individual human factors topics created specification outlines for each Perception & Performance Prototyper test bench. Following these design plans and specifications, computer scientists in the DEfTech laboratory wrote software code utilizing the C programming language and developmental software such as Supercard and Hypercard. To expedite the production process, programming code was reused in different test benches where possible. After separate parts of a test bench were fitted together into a working model of the program, other computer scientists and human factors scientists wrote software tests according to original specifications. Finally the software tester, guided by the written tests, executed the program, describing all anomalous characteristics in the visual graphics, the text, and the operation of the program.

Before each test, information about the computer, its system software, and its hardware was recorded as a means of maintaining reliable, consistent results. All tests completed thus far were run on an Apple Macintosh IIfx computer, system software version 7.0.1, with an Apple 13" color monitor and an Apple extended model keyboard and mouse. Information about hard disk memory capacity, networking setup, printer setup, screensaver programs, virus protection software, system extensions, and system control panels were also recorded. For some tests, a hard drive for removable forty-four megabyte cartridges was needed because the program consumed more than the three megabyte memory capacity of a normal three and a half inch floppy disk.

RESULTS

Of the five test benches with programming code complete, two (Visual Acuity and Visual Optics) were fully tested and one (Flicker Sensitivity) was partly finished before testing on it was aborted because of impending changes in the test bench specifications. The testing of each test bench was divided into sections consisting of either the subtopic selection screen, the subtopic screen or screens, or the text screens. For all screens, the icons in the sidebar menu and the top menu bar were checked to see whether they were active or unactive as denoted by the specifications. For the subtopic selection screens, the headings and viewport were verified for correct text and graphic representation (images and radio buttons). The text screens labeled "Description," "Instructions," and "Technical Information" were proofread and edited.

In the Visual Acuity Test Bench, some screens contained numerous typographical errors. The graphic representation of a few visual targets was inconsistent through different subtopic screens. On the "Technical Information" text screens, mathematical equations drew some slight errors of a rather technical nature.

In the Visual Optics Test Bench, the graphic representations of image cells was incorrectly illustrated in the testing guide. A few minor mistakes in text were also found.

After tests for two subtopics of the Flicker Sensitivity Test Bench were finished, a number of human factors experts decided that the flicker phenomenon was not clearly demonstrated by the software model and that the program should be reconfigured before testing resumed. The observations made up until that point were dismissed for the time being.

Once testing for the test bench had concluded, a panel of software experts determined which problems found by testing were considered serious enough to demand immediate resolution and which were noncritical to the intended purpose of the software program. Those matters will be reserved for settlement in the next version of CASHE.

CONCLUSIONS

Through eight weeks of full-time employment in the DEfTech laboratory at Wright-Patterson Air Force Base, I have learned much about the amount of time and effort put into the production of one software program. Dozens of people thoughout the country have exerted thousands of man-hours to develop CASHE. I have also discovered how important human factors concepts are to designing innovative user-friendly products.

I have enjoyed the time I have spent here this summer and appreciate this chance to experience first-hand the work of computer programming scientists. The computer skills I have now acquired will enhance my future employment experiences.

ACKNOWLEDGEMENTS

First of all, I would like to thank Mr. Don Monk for giving me this opportunity to advance my computer skills while working in a real life environment. Next, I thank Tom Cona for finding extra projects for me to do when my workload grew scarce. Thanks to Keith Adams for teaching me how to use the graphics program Canvas 3.0 and taking me on tours around Armstrong Laboratory when I deperately needed a break from computer tunnel vision and eye strain. I want to thank Glenn Johnson and Roy Livingston for all their technical wizardry when my Macintosh computer refused interaction. Most of all, I would like to to thank Becky Donovan for being there to help me through all the rough spots in the project and answering all questions I had regarding this job.

In addition, special thanks go out to Ann Hartung, David Spangler, Don Kraft, Mary Alice, Jon Selvaraj, TSergeant Bob Stewart, Jeff Woods, Ken, and all the others who made the lab a friendly environment to work in.

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FACTORS ASSOCIATED WITH DECOMPRESSION SICKNESS

Alejandro Garcia

High School Apprenticeship Program

Sustained Operations Branch

South San Antonio High School

2515 Navajo

San Antonio, TX 78224

Final Report for:

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Preface

My work at Brooks Air Force Base was a very educational as well as a great challenging opportunity that I enjoyed. After only a week at the base it seemed as if I had been there for a year. The people there were very always willing to help. In an atmosphere such as this, it makes working that much easier for a student or anyone in general. Working there this summer gave me the opportunity to work with personnel from whom I learned a great deal. Couple the intellect of doctors and graduate students and you have a formula for ample helpful knowledge. My mentor, Dr. Bisson, was good at keeping me on task the majority of the time, yet he knew when a breather was needed and suggested a tour or a social event. He aided in what amounted to a challenging learning experience and an enjoyable stay. Working with Decompression Sickness gave me an understanding of the significance of the problem and its severity.

The task I performed also helped increase my computer knowledge and helped polish the rust off of some areas I hadn't worked in for awhile. I have not begun college but am certain this experience will help me. This is a program where a high school student can learn a great deal in little time. The experience was one in a few and I am proud to say I was a part of it.

FACTORS ASSOCIATED WITH DECOMPRESSION SICKNESS

Alejandro Garcia
High School Apprenticeship Program
Sustained Operations Branch
South San Antonio High School

Abstract

Decompression sickness (DCS) is a disease that remains mysterious - its long term consequences are not known. An anonymous survey was conducted and sent to active and retired High Flyer (U-2/TR-1) pilots. These surveys were compiled and responses entered into a database to investigate the severity, occurrence, duration, and affects of DCS symptoms. The results showed that DCS symptoms occurred inflight, with the duration of symptoms lasting on the average of an hour and a half. Furthermore the symptoms typically resolved during a flyer's descent to ground level but are not limited to this. The survey documents the self-reported incidence of DCS in this population. It was not able to document any long term effects or complications associated with exposures to DCS.

Introduction

Decompression sickness has long since affected the human realm. As aviators ascended to altitudes greater than 40,000 feet, they became susceptible to the bubbling disease associated with caissons and other deep sea divers. With twentieth century technology introducing aviators to low pressure environments, lingering and delayed effects remain an enigma to the medical investigators who are, diligently seeking new ways to cope with this sometimes mysterious disease.

Decompression Sickness(DCS) is a condition that originates from a sudden reduction in ambient pressures that causes inert gas bubbles to form and grow within body tissues and vascular spaces. These bubbles form from pressure gradients of dissolved gases maintained in solution in veins, arteries, lymphatic and tissue spaces, and atmospheric pressure.

DCS can occur following exposures to both hyper and hypobaric conditions such as in diving, caisson work, flight and space operations (Fryer 45). Pressurization of workers in air pressurized mine shafts showed that DCS could be experienced by depressurizations outside of the diving environment (Hill 34). Aviators experience DCS through depressurization by ascent to altitude. The physiological principals are the same as decompression from ascent after an underwater dive or compression and ascent in a compressed gas chamber.

DCS is popularly known as "bends" because it often occurs in the lower extremities of the body. The victim of DCS pain in the

lower extremities frequently assumes a stooped posture. Early observers aptly described these patients as appearing as if "bent" by the experience (De Hart 112).

Aviation was introduced to DCS when balloon and aircraft altitude records were set above 50,000 feet(15,240 m) in the 1930's (Fryer 67). Since then the risk of DCS in aviation has decreased by the use of pressurized cockpits; however, some aircraft continue to fly unpressurized at altitudes where the risk of DCS continues to be an unwelcome occupational hazard.

There are several physical factors that contribute to the formation of bubbles. Differential pressures between 100 and 1000 mmHg are required for bubbles to form (Holt 231). Bubble formation can also be affected by the presence of areas of negative hydrostatic pressured by muscle shear forces, rate of ascent, altitude attained, duration of exposure, and general environment. Miscellaneous physiologic factors that contribute include apprehension and race, age, sex, time of menstruation, obesity, exercise, previous injuries, physical fitness, hypoxia, diet and fluid intake, repeated exposure, or recent hyperbaric (Bisson & Pilmanis 92).

As for the symptomatic effects of DCS the symptoms can include pain in a joint or extremity, or neurologic, respiratory, skin, or circulatory effects can be seen. Neurological symptoms can be manifested by physical, sensory, visual, central sensory, motor, and, higher CNS functions (Bisson & Pilmanis). Chokes, cough, and dyspnea are respiratory complications associated with

the DCS symptoms and can be a prelude to particularly hazardous complications. In the skin, pruritus, rash, mottling, and edema are the most common symptoms (Bisson & Pilmanis). Signs and symptoms such as edema, syncope, and light-headedness pertain to the neuro-circulatory aspects of the illness (Bisson & Pilmanis). Recent autopsy evidence from the diving community suggests that long term neurological consequences of decompression sickness may be more severe than previously expected (Pilmanis 92).

Given the history of this disease, and recent interest within the medical community, numerous studies have and are currently underway to understand more exactly the physiology of how DCS originates and affects tissues. The long term effects of repeated occupational exposures in aircrew are unknown and there is no systematic monitoring. It was in this process that the majority of my work conducted at the Armstrong Laboratory, Brooks Air Force Base took form.

The military aspect of DCS is substantial since aviators are susceptible to reaching the altitudes in which DCS becomes a factor in the aviator's safety. Some aircraft designs and operational necessity routinely expose Air Force pilots to high occupational risks of experiencing DCS. This is particularly true in high altitude reconnaissance pilots flying the U-2/TR-1.

The U-2/TR-1 is an aircraft that routinely achieves altitudes above 80,000 feet. Cabin altitudes exceed 28,000 feet and mission durations up to eight hours are not unusual. Not surprisingly, a large number of U-2 pilots experience DCS as a

recurring occupational hazard. However, until recently the aeromedical response to reporting DCS was perceived as threatening to a pilot's career. This resulted in very few U-2/TR-1 pilots reporting their DCS symptoms and an incomplete accounting of the nature of the hazard and associated risks. In order to obtain a better accounting of the operational incidence of DCS in the high flyer community, an anonymous survey was designed and sent to 416 active and retired U-2/TR-1 pilots.

In order to avoid DCS, pilots prebreath 100 percent oxygen at ground level between 30 minutes to 120 minutes depending on the physical aspects and duration of a high fly mission. Prebreathing eliminates excess nitrogen from their tissues. Dissolved nitrogen in body tissues evolves across the pressure gradient created by rapid ascent to altitude where the partial pressure of nitrogen in the atmosphere is less than the partial pressure at ground level. (NOTE: The atmosphere is 80 percent nitrogen and normal atmospheric pressure is 760mmHg. The partial pressure of nitrogen is therefore 608mmHg. At 25,000 feet, atmospheric pressure is 282 mmHg resulting in a nitrogen partial pressure of 226 mmHg. This difference in partial pressures creates a gradient encouraging nitrogen to evolve from tissues and equilibrate with the atmospheric concentration of nitrogen. The process is identical to carbon dioxide bubbling out of a soda bottle when it is first opened.)

Other coping strategies to minimize the risk of evolved gas

symptoms include minimizing or eliminating exercise before a flight, and maintaining a high protein, low bulk diet. Some leave alcohol out of their daily routine to help in the process of minimizing risk of DCS.

Pilots who experience decompression sickness at altitude are at least partially treated by descent to ground level and continued breathing of 100 percent oxygen for the remainder of flight. Symptoms usually are fully resolved with descent, but it is not clear whether this represents adequate treatment in view of the general consensus that the definitive treatment for decompression sickness is hyperbaric therapy (Fryer 11).

Methodology

The data for this study was obtained by mailing an anonymous survey to 416 of the 503 pilots known to have flown the U-2 or TR-1. The 87 remaining pilots were deceased in some cases or their addresses were unknown.

The Blackbird reunion committee was influential in the process of obtaining a good starting address list of high altitude flyers. Approximately 362 surveys were sent out in December 1992. A follow-up mailing in February/March 1993, was used to contact new or updated addresses and to re-contact those who had not responded to the first mailing.

The survey was divided into three parts which were Section I: Demographics/General health habits; Section II: Specific Symptom Review/Report of Illness; Section III:DCS History. The DCS and

demographic questions were written by Drs Bisson and Pilmanis. The health habits and symptom survey questions were designed by Drs. Bisson and Ainscough at Armstrong Laboratory, Sustained Operations Branch.

Of 416 surveys sent out, 267 were returned for a response rate of 64%. An additional 36 crewmembers were identified as deceased increasing the response rate to 73 percent of potential responders. The 16 page survey comprehensively addressed DCS and other health related symptoms. Pilots could return the survey anonymously, although only 16% chose to remain anonymous. The survey was largely conducted in response to discussions at a workshop on Decompression Sickness in aviation that was held at Brooks AFB in Oct 1990 that reemphasized the need for a more complete accounting of DCS in the high flyer community. Changes in the aeromedical response to DCS increased likelihood for obtaining cooperation. The survey was made anonymous to overcome lingering distrust in some members and concerns about how the data might be used. Grounding, waivers and other adverse actions associated with reporting DCS is now rarely necessary as part of the aeromedical response to most episodes of DCS that resolve before landing. Present policies allow a pilot who reports on episode of pain-only DCS to return to flying with no requirement for grounding or extensive aeromedical evaluations.

A preliminary survey limited to 40 active duty pilots re ceived good support and cooperation. The results of this preliminary survey resulted in adding questions on somatic, genetic and

teratogenic effects that might be occupationally related to exposures to cosmic radiation or the long term health consequences of repeated episodes of DCS. Questions on tobacco and alcohol use associated with increased risk for a number of diseases were also added. Checklist questions asked for responses to the presence or absence of common signs and symptoms of many diseases. Specific items commonly associated with health risks from radiation exposure were embedded in comprehensive symptom lists or various diseases. Multiple questions about other health matters were included to avoid bias as well as to detect any unexpected health problems in this cohort.

The high response rate to the survey along with number of DCS cases reported in the survey suggest that it represents a creditable accounting of the frequency and risk of DCS events in this occupation. Anonymity and retired status modulate most reasons for under or over reporting. Of those reporting symptoms of DCS, 74% reported fewer than ten episodes. Recall of a small number of significant events suggests that these self-reports are probably reliable. A respondent hoping for compensation could exaggerate information, but the patterns of answers suggest few respondents exaggerated symptoms. It appears more likely that high flyers continue to under report or minimize their symptoms.

Results/Discussion

Analyzing the data to deduce correlations showed many similarities and variations on the extent of high flyers encounters

with Decompression Sickness and the severity of the episodes.

Figure 1: Pilot Ratings of the Health Importance of Decompression Sickness

Importance of DCS	Frequency	Percent
Serious Health Hazard	84	38.9
Health Hazard	62	28.7
Some Importance as Health Hazard	47	21.8
Slight Importance as a Health Hazard	13	6.0
No Importance as a Health Hazard	10	4.6
TOTAL	216	100

To begin with 67.6% of the 267 answered surveys, said that Decompression Sickness was an important or serious health hazard. (Fig 1).

This is spurred by the fact that high flyers as well as the public in general do not fully recognize the long term implications of DCS. One hundred and fifty (64.7%) of 232 pilots experienced limb pain or pain in the joints during flights exceeding cabin altitudes of FL 180. For the 150 experiencing probable pain only DCS, 96 (64%) responded that they experienced this pain on rare occasions, 43 (29%) answered that pain affected them occasionally, and 8 (5%) had frequent experience of pain in

joints. It is important to add that these episodes represent self-diagnosed DCS and some episodes may have been due to other (non-DCS related) causes. The 150 pilots reported a total of 1,520 cases of limb pain. The percentage experiencing limb pain is slightly higher than a previous survey by Pilmanis and Bisson, where 42.5% admitted to probable pain related DCS. If the 35 non-respondents to this part of the survey are included, 56% admit to probable symptoms of DCS manifested by pain. The surveys suggest similar reporting criteria for bends pain were used by both active duty and retired pilots reporting pain associated with exceeding FL 180.

In contrast to the limb pain experienced during exposure to cabin altitudes above FL 180 only 42 flyers said they experienced onset of limb pain after descent. The 42 reports amounted to 125 cases of probable DCS. Most cases resolved before reaching the ground and onset after flight was comparatively rare.

Another possible symptom of DCS is inappropriate fatigue. This can be excessive fatigue not associated with recent physically fatiguing activities, e.g., running, post-work fatigue, lack of rest, little sleep, etc,. Thirty-nine of 230 pilots responded saying they suffered from this symptom. These cases may or may not represent DCS. A total of 424 cases of inappropriate fatigue were reported inflight (69 cases) and postflight (355 cases). At least some of these cases probably reflect undiagnosed DCS within the central nervous system.

The altitude of 18,000 feet or one-half an atmosphere is

considered to be the altitude at which evolved gas becomes a possible factor causing DCS (Fryer 73). At altitudes above 36,000 feet the frequency of DCS increases dramatically depending on the duration of exposure causing complications of the DCS nature in pilots. When pain persists at these altitudes a descent is in order for pilots to rid themselves of the DCS symptoms. The data suggest that descent alone caused symptoms to resolve in 62% (74 of 120 surveys).

Another common symptom often associated with flying is headache. Causes of headaches in high flyers include dehydration, noise, pressure suit equipment and other environmental stimuli in addition to DCS. It is likely that most reports of headaches are not DCS however, CNS symptoms of DCS can be manifested by HA and are of special concern. Headaches were reported by 68 of 231 pilots responding to this question. Almost 46% of those experiencing headaches said that they occurred occasionally to frequently while flying.

The results showed that 16% of those who answered the survey reported using prescribed or over-the-counter (OTC) drugs before flight. Medications can affect the onset of DCS or other complications in flight. The majority of this reported drug use reflected OTC analgesics or sleep aids. Restoril is prescribed to enhance sleep before U-2/TR-1 missions that take off at unusual times or that include particularly stressful flight profiles.

Good hydration is thought to minimize risk of DCS. Good hydration was defined as drinking more than one quart of fluids

every 2 to 4 hours while flying. Of the 224 surveys answered 63.4% felt that they kept themselves well hydrated during a flight. 36.6% assessed that they did not keep well hydrated. This is a probable factor in the cause of headaches during a mission. Further analysis should reveal whether dehydration contributed to pilots reporting more frequent episode of DCS.

Nine percent (23 of 267) reported descending early, or terminating a mission altogether due to Decompression Sickness. The number of missions aborted is small, yet represent the severity to which these symptoms can adversely affect a pilot during a mission. The fact that even one mission had to be terminated is a militarily significant factor that needs to be addressed in terms, whether DCS is an acceptable risk in high altitude operations.

The onset of a typical DCS experience is worth noting. Of the 117 responses, over 90% indicated that DCS develops gradually. A few (6.8%) experienced the onset of DCS as a sudden occurrence with less than 3% citing another onset pattern.

One of the question helped detail the severity of DCS cases. The Worst episode of Bends on a scale of 0-10 is shown. Mild Pain was the norm for the worst episode although it is worth noting that 26 flyers reported having very intense to excruciating pain (6-10 on the scale) out of 108 reports. (See figure A-2) The average worst pain generally followed the same course with the majority of cases occurring in the 2-5 range area of the scale. We conclude that pain was generally fairly mild case.

Figure A-2

PAIN WORST EPISODE	Freq	Percent
1 VERY MILD PAIN	5	4.6%
2 MILD PAIN	24	22.2%
3 SOMEWHAT PAINFUL	18	16.7%
4 DIFFICULT	17	15.7%
5 MODERATE PAIN	17	15.7%
6 VERY INTENSE	10	9.3%
7 SEVERE PAIN	6	5.6%
8 NEARLY UNBEARABLE	6	5.6%
9 EXCRUCIATING	5	4.6%
Total	108	100.0%

Figure A-3

PAIN AVERAGE	Freq	Percent
1 VERY MILD PAIN	9	8.9%
2 MILD PAIN	39	38.6%
3 SOMEWHAT PAINFUL	24	23.8%
4 DIFFICULT	7	6.9%
5 MODERATE PAIN	11	10.9%
6 VERY INTENSE	7	6.9%
7 SEVERE PAIN	4	4.0%
Total	101	100.0%

The follow up to those problems was to find out the average severity of pain on the same type scale. On the average an episode of pain was mild or only somewhat painful, about 71% of the time. Basically this stated that the average episode(s) of pain were of the mild variety and subsequently were tolerable.

The survey also asked about the duration of DCS symptoms. This is an important issue because it provides an understanding of how long a mission can be distracted by DCS symptoms. A surprising finding was that in 39 of the 95 reported cases, DCS symptoms continued for two and three hours. Numbers before hand had already supported pain typically resolved during flight or on

descent. Theoretically, it makes sense that DCS symptoms may gradually resolve in flight as nitrogen partial pressure gradients equilibrate. However, the progression of pain only bends to neurologic or other CNS mediated DCS is too great to ignore. Even the shortest duration of DCS symptoms averaged of about 48 minutes per episode. When it came to a total average duration of episodes, the data suggest that pilots might expect an episode to last over 60 minutes before resolving.

As mentioned, most episodes of DCS resolved before or during descent, but it is important to note that 18 cases persisted at ground level and lasted 1-4 hours after landing.

Upon further analysis of the survey results, the question of what happens to pain after a DCS episode lasting longer than 10 minutes, was characterized. The majority showed that DCS usually had gradual onset to stabilized (constant) plateau. Seventy-four of 97 records described the type of course or onset.

The caliber of pain was described as variable by 25 of 31 reports. Variable onset pain resolved either inflight or on descent, which is in line with the rest of the data reported thus far.

In reviewing the data collected and the statistics generated from the database several factor come to mind. Namely that high flyers had a tendency to experience an onset of DCS inflight and it was typically resolved on descent.

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THE EFFECTS OF CHRONIC +Gz EXPOSURES ON RATS

Jeffrey Gavornik

Final report for Summer Research Program

Armstrong Laboratory

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Bolling Air Force Base, Washington D.C.

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Abstract

We studied the effects of chronic multiple and single exposures to high +Gz in rats using a small centrifuge in order to determine the effects of GLOC on the various body systems. Over a six week period we daily measured food intake, body weight and temperature of the experimental and control animals. Using surgical implants we also collected EEG and ECG signals from the animals prior to, during, and after the centrifuge run. At the end of the experiment various organs were removed and weighed and blood samples were collected to be analyzed. All data is preliminary but the trend appears to point towards a positive adaptation in the rats to chronic G exposures.

Introduction

It is widely known that acceleration can cause loss of consciousness in both humans and animals and the upper limits of resistance to acceleration is known for most creatures. But with new faster and more agile fighters being developed by the Air Force there is an ever increasing need for understanding as to the effects of gravitational loss of consciousness (GLOC) on the body and its many systems and organs. Of particular interest are the effects of chronic and multiple exposures to Gz and GLOC.

Previous studies have been done on the effects of sustained low +Gz (1) in the domestic fowl. A study on high Gz in rabbits (2) was conducted, but it focused on the cardiovascular long term effects, and a study on the adaptation of guinea pigs and rats to -Gz was also done (3). We wished to determine the adaptation, positive or negative, to chronic high +Gz exposures in rats.

Methods and Materials

One week prior to the first centrifugation surgery was performed on all male Sprague-Dawley rats in order to minimize the effects of stress from surgery as a reasoning for the effects which we would observe. EEG (electroencephalograph) electrodes were attached to the skull of each animal to allow for recording of the electrical potential in the brain. Baseline body weights were taken and the animals were sized matched and divided into five groups: 1. Control- no restraints or acceleration exposures (n=7), 2. Base Gz- 0.5 +Gz

exposure x 3 per day x 5 days per week x six weeks (n=7), 3. Chronic multiple- 22.5 +Gz exposure x 3 per day x 5 days per week x six weeks (n=13), 4. Chronic single- 22.5 +Gz exposure x 1 per day x 5 days per week x six weeks (n=7), 5. Acute Multiple- 22.5 +Gz exposure x 3 (n=30). Base Gz served as a low G control and Acute Multiple as a sized matched high G control.

Food intake was measured on a daily basis and the animals were pair fed on the basis of the average amount of food consumed by the chronic multiple group. Body weight was also collected daily, as was body temperature (excluding the control group).

Centrifugation was done on a small animal centrifuge with a diameter of 5' and an acceleration rate of 20 Gz per second. The control of the centrifuge was all done by computer. The animals were restrained in plexiglass tubes and held in place using a padded bite bar which screwed against their nose. Pads and metal plates were placed at the posterior and provided support for the body. Instrumentation alternated between EEG and ECG (electrocardiograph) every other day. EEG, ECG, and acceleration were recorded on a strip chart and acquired for analysis by a Macintosh FX II computer.

One Acute Multiple animal was spun every day and then sacrificed. Blood samples were taken as well as brain and adrenals. At the conclusion of the experiment all animals were sacrificed and adrenal, blood, brain, kidney, liver, heart, and bone samples were collected.

Results

A trend became readily apparent when adrenal weights were viewed (fig 1). Even before the weights were normalized (mg/Kg Body Weight) the order of weight from least to greatest went from control and Acute Multi to the non GLOC experimental groups with Base Gz and finally the GLOC experimental groups. It appeared that there was a significant difference in weight between the control and Acute Multiple groups and all of the chronically stressed groups (no statistics have been done at this point).

This same pattern remained the same throughout all of the organ weights. Water content of the liver was determined using a small biopsy. The scale was very compressed and showed a slightly higher water content in the Base Gz group (fig 2).

The pattern was reversed in the hematocrit (% cells in the blood stream), with the Acute Multiple and control groups having the highest concentration of blood cells, almost 10% higher then the chronic groups (fig 3).

By analysizing the strip charts approximate time until GLOC and recovery time from GLOC could be determined. Using this data we plotted a chart of both time to GLOC and recovery time for the Chronic Multiple and Single groups (fig 4). The amount of time to GLOC increased quickly during the first week in both groups from approximately 11 seconds until it leveled at about 27 seconds. Recovery time showed no apparent pattern.

Discussion

The weights of the various organs can be explained in large part due to

stress. The effects of the physical stress involved with handling, restraints, instrumentation, and centrifugation can account for the increased adrenal weight as well as the kidney and liver. There are several possible explanations for the fact that the Base Gz group was always very close to the chronic multi and single groups in which GLOC was observed. The first is that the handling stress is much greater than the acceleration stress and that the small difference is actually not significant. The second has to do with the plateau effect seen in all living systems. Organs can only grow to a certain maximum size, at which point they will not grow regardless of the amount of stimulation they receive. It is possible that the stress of handling brought the organs up to this plateau point and that no matter how much additional stress is involved in high Gz exposures, the organ weights would be approximately the same. The fact that in some instances the chronic single weights were heavier than the chronic multiple weights could show positive adaptation in the chronic multiple group due to the multiple runs. This might suggest that adaptation occurs more rapidly when multiple exposures are used instead of single exposures.

The body weight difference (until the interruption of pair feeding) is a result of the stress factor. The body, when subjected to stress, reallocates its energy to adapt to that stress which results in a decrease in body weight. The pair feeding kept the food intake the same so differing amounts of food eaten can be ruled out for the reasoning behind the discrepancies.

The best indication of positive adaptation came from the graphs of the time to GLOC. The trend clearly showed that the amount of time necessary to induce GLOC increased the more times the animal was exposed to acceleration, until a

plateau point is reached. This is positive adaptation because it is desirable to maintain consciousness for as long as possible. This adaptation may or may not be possible for a pilot. However it is possible that this adaptation is artificial. As the rats increase in size they fit tighter and tighter into their plexi glass restraints and the cages act as a G-suit by restricting the blood flow much as the air bladders used in human G-suits do. It is also possible that the adaptation is a learned response, or possibly an accidental one related to the straining of muscles, conscious or otherwise, which also serves to increase blood flow. It is my opinion that whatever the reason is, it is not a conscious response, due to observations of the rats. The animals which did not loose consciousness tended to fight harder than the GLOC animals when they were placed in their restraints which suggests that they (non GLOC animals) remember this experience from a previous time. This makes me feel that the GLOC animals do not remember what is going on and as such they should not remember that tensing would make any difference. Extrapolation upon this also makes me feel that adaptation is not due to tensing, since if the rats did not naturally tense during their first runs, and if they do not remember previous runs, then they should not naturally tense more as time goes on.

Conclusions

Positive adaptation is clearly possible to high Gz through chronic exposures. Multiple exposures appear to cause faster adaptation also, although more work will have to be done to determine the best combination of exposures

to maximize adaptation with minimal time required.

Acknowledgement- This project would not have been possible without Dr. Paul Werchan, Roger Echon or Jason Barber who is also a high school apprentice program student.

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ADRENAL WEIGHT: (WITH GLOC GROUPS)

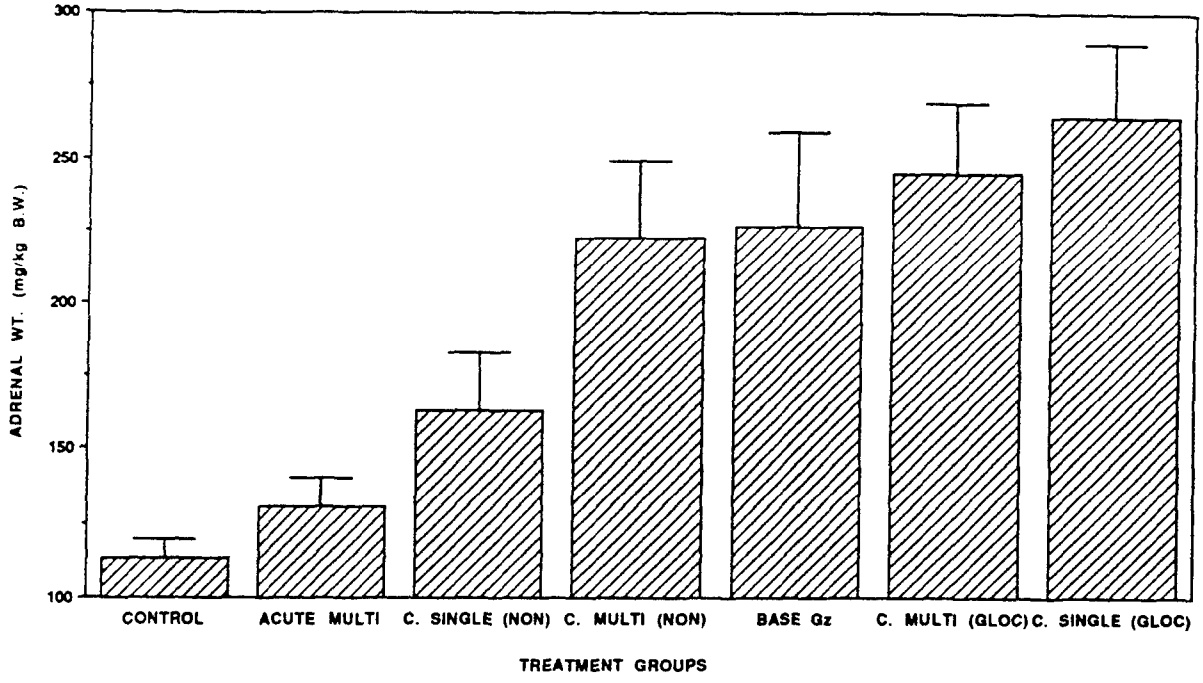


Fig 1

LIVER WEIGHT (WITH GLOC GROUPS)

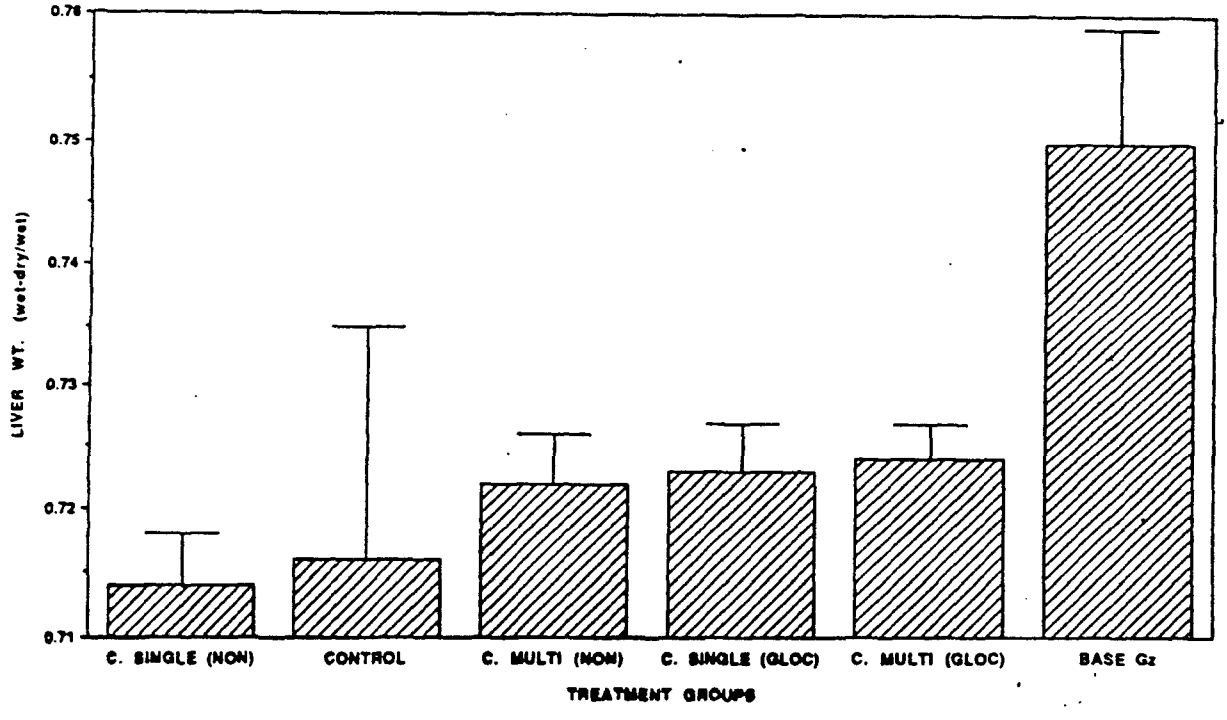


Fig 2

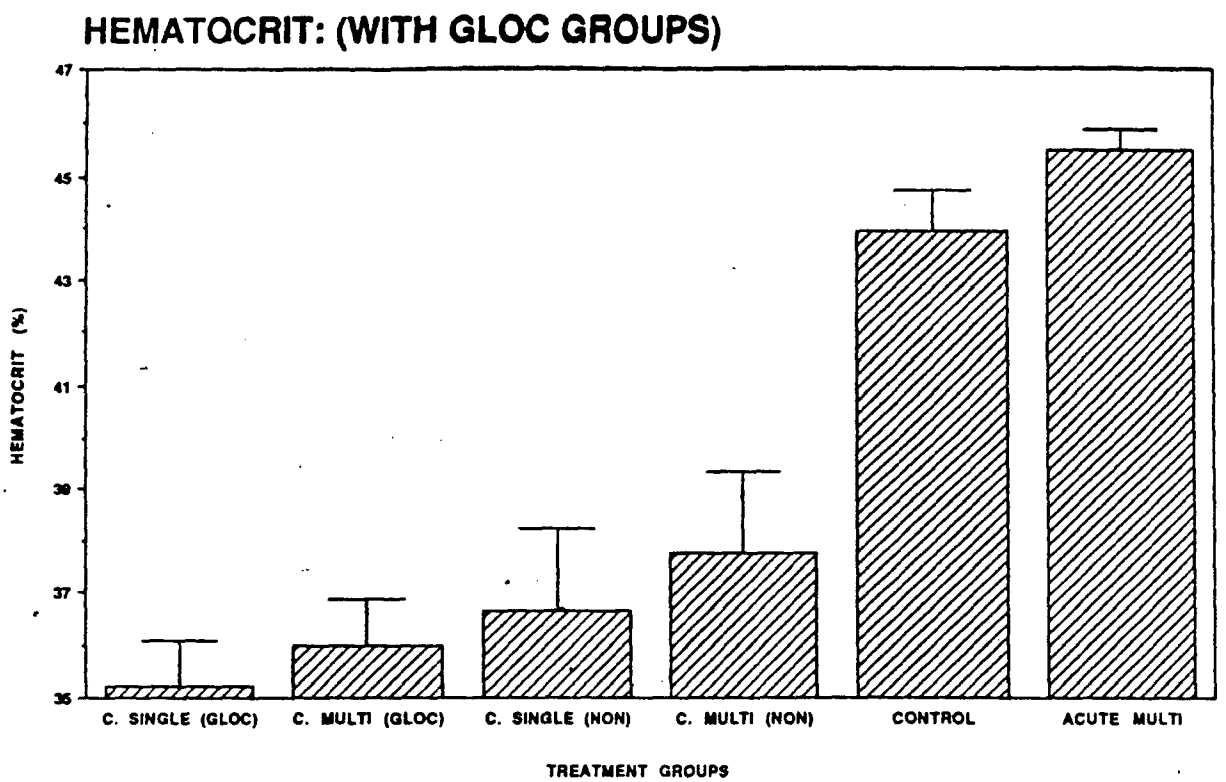
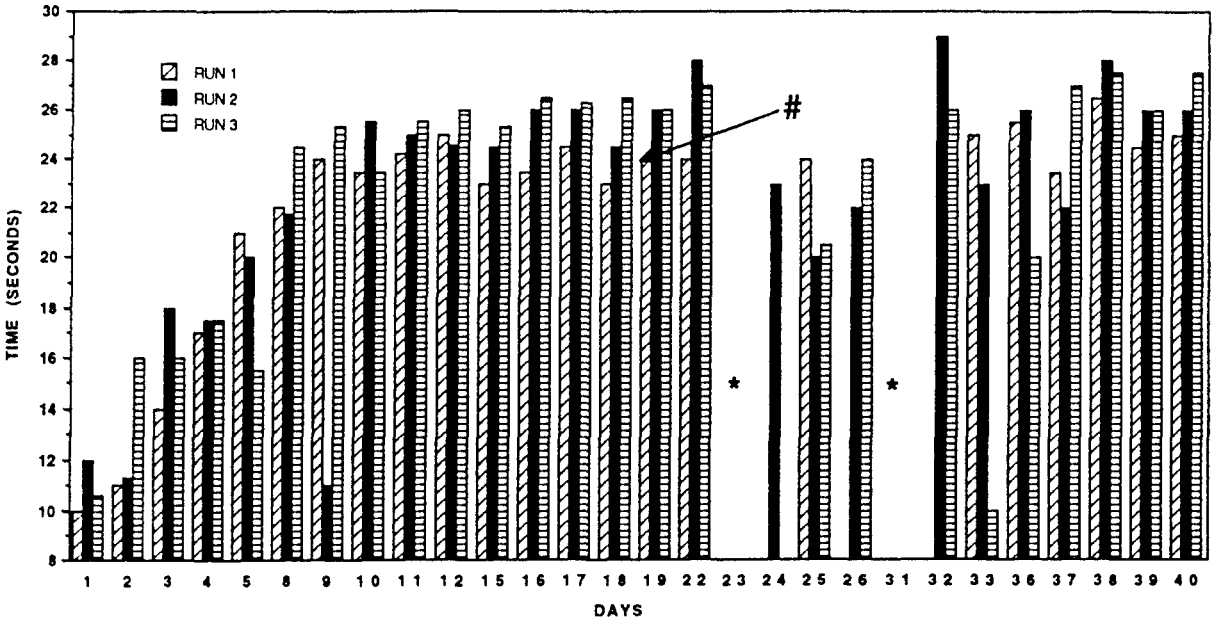

HEMATOCRIT: (WITH GLOC GROUPS)
HEMATOCRIT (%)
47
45
43
41
39
37
35
C. SINGLE (GLOC)
C. MULTI (GLOC)
C. SINGLE (NON)
C. MULTI (NON)
CONTROL
ACUTE MULTI
TREATMENT GROUPS

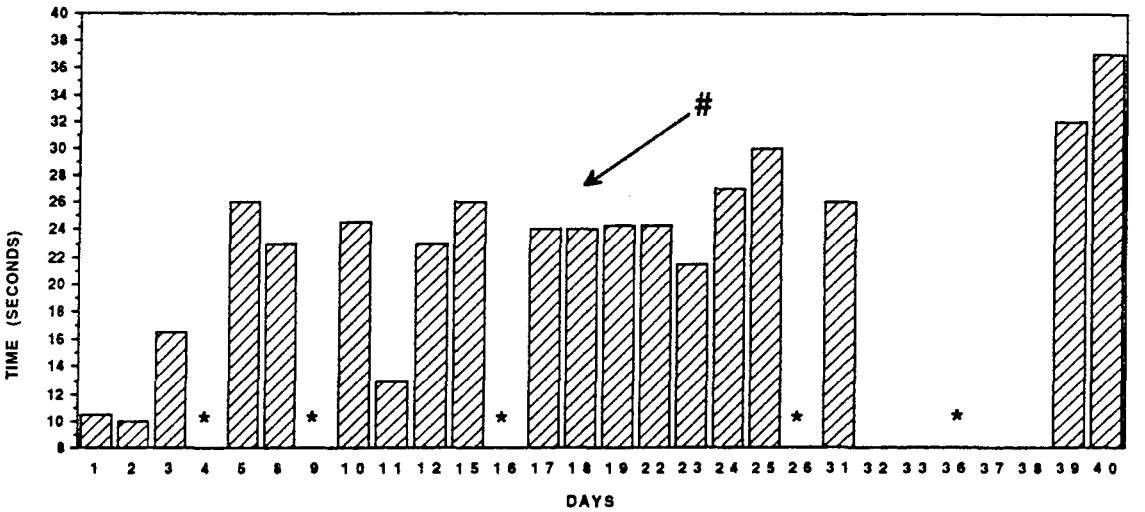
Fig 3

TIME TO GLOC (CHRONIC MULTIPLE)



LEGEND: * NO GLOC OBSERVED
# REDUCTION OF EEG INSTRUMENTATION
N = 1 TO 4

TIME TO GLOC (CHRONIC SINGLE)



LEGEND: * NO GLOC OBSERVED
# REDUCTION OF EEG INSTRUMENTATION
N = 1 TO 4

Fig 4

A Comparison of Feature Conjunction Tasks Between Color/Orientation and Size/Orientation Mediums in Two Dimensional Space.

Virginia Amalia Miksch

Student

Incarnate Word High School

Mentor

Fred Previc, Ph.D.

Final Report for

AFOSR Summer Research Program

Armstrong Laboratory

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A Comparison of Feature Conjunction Tasks

Virginia Miksch

A feature conjunction task was developed in two dimensional space on a Silicon Graphics 3130 IRIS computer system. The task tested the advantages and disadvantages of a feature conjunction task using either size/orientation or color/orientation. Six employees at Armstrong Laboratory volunteered to serve as subjects for study. An upper right field advantage was shown using the color/orientation medium, but the size/orientation medium showed the overall upper field advantage.

INTRODUCTION

Imagine you are shown a photograph of a bookcase containing various colored books, and you are asked to locate and identify the blue book in the picture. Chances are if the blue book was located in the upper half of the photo you would identify it quicker than if it was in the lower portion of the photo. The locating of the target stimulus, the blue book, during this task is known as a feature conjunction task.

The purpose of this study was to use various mediums in the feature conjunction task testing the upper field advantage. One of the mediums was color/orientation and the other was size/orientation. The color/orientation task is the same as the example of a feature conjunction task given at the beginning of the introduction. The size/orientation task is similar to the color/orientation task except that the distractors, other books on the bookcase, only differ by their size; not by color.

METHOD

Subjects

Six employees at Brooks Air Force Base volunteered to be subjects in the study. The subjects were required to have 20/30 corrected vision. Five of the subjects were right-handed and one was left-handed. The subjects consisted of three females and three males. They had a mean age of 24. Three of the subjects had participated in previous studies concerning feature conjunction tasks.

Procedure

Each of the six subjects were screened with a vision test. The subjects had to have 20/30 corrected vision. The subjects came for three sessions. The first two sessions were training sessions consisting of two training blocks. Each of these sessions lasted twenty minutes. The final session was the actual test session consisting of four test blocks. Two of the test blocks were initialized with the right-hand and the remaining two were initialized with the left-hand. Two of the blocks were color/orientation and the remaining two were size/orientation. The order of the blocks were randomized in the A-B-B-A, B-A-A-B order. Three subjects started with size/orientation and the other three began with the color/orientation. The final session lasted about one hour.

A block consisted of 144 trials, in which a warning cross would appear, followed by a brief presentation of the target stimulus. The target stimulus was either a red diamond, a red square, a green diamond, or a green square in the color/orientation medium. If the subject was being tested in the size/orientation medium then the target stimulus was either a large square, a large diamond, a small square, or a small diamond. The target stimulus would be followed by a search field, consisting of the target and various numbers of distractors.

The subjects' task was to search for the target stimulus among the different distractors in the search field. When the subject located the target s/he was to the right button,labeled red, on the plain mouse with their index finger.

After the subject responded that s/he found the target, a screen shoeing four empty quadrants appeared. The subject was then required to move the mouse on the pad to the quadrant where the target appeared, and click the green labeled button.

The subject had three seconds to search for the target in the search field. If the subject did not respond within the three seconds, then the screen would go blank and would move on to the next trial. If the subject responded in time, then s/he would have two seconds to move the pointer to the quadrant where the target appeared. If the two seconds expired, then the screen would go blank and move on to the next trial. Only correct initial reaction times were used in the data.

The instructions were read to the subject at the beginning of each session, and afterwards any questions the subject had were answered. After the instructions were explained, the subject performed two dozen warm-up trials, and then the actual test block was run. The subject could pause the program at any time.

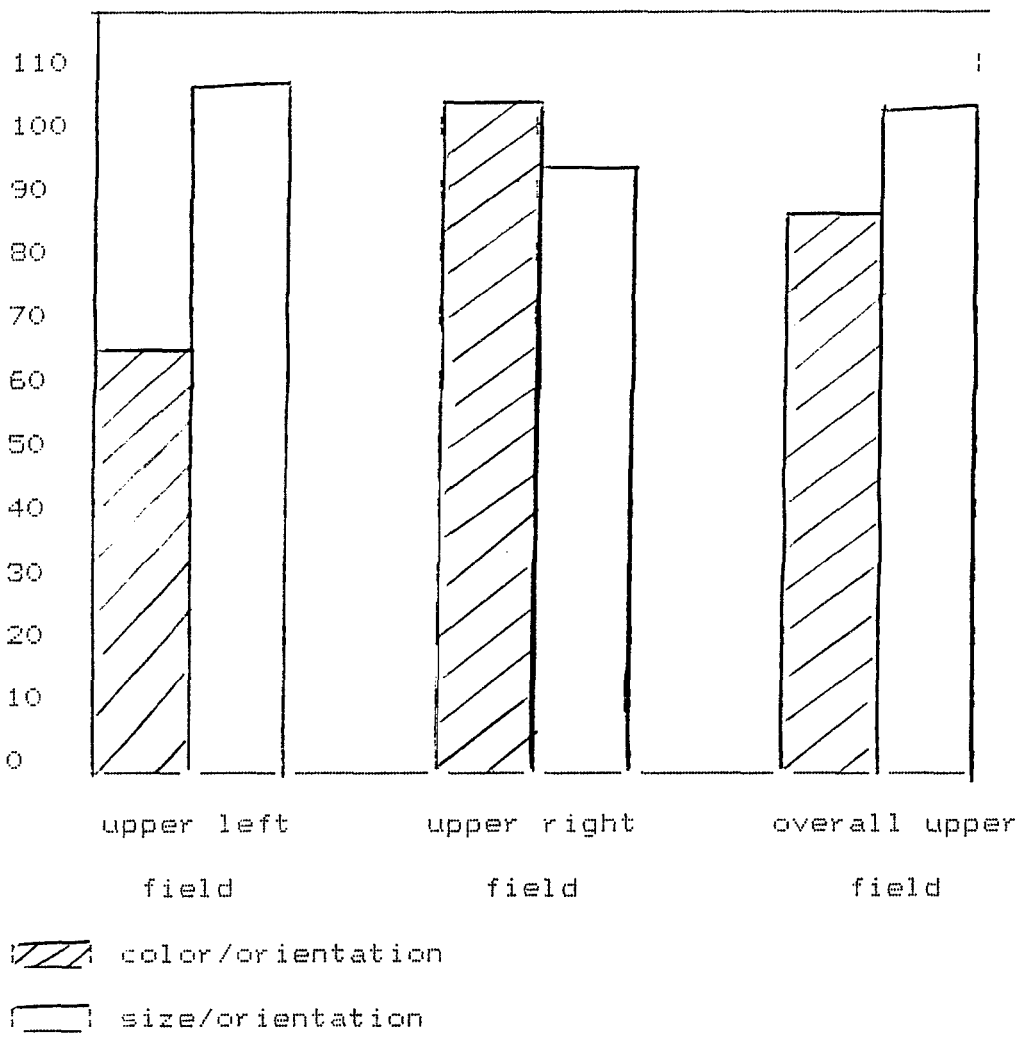
After the final test session was completed, all subjects were debriefed as to the hypothesis of the study.

RESULTS

From this study it was found that color had an effect on the subjects reaction time, but overall the size medium showed the greater upper field advantage. The color medium showed an upper right field advantage. No lower field advantage was shown.

Difference in Reaction Time in Milliseconds

Color/orientation vs. Size/orientation



CONCLUSIONS

From this study it can be concluded that color does have an affect in one's upper right visual field when searching for a specific target. This could mean that by using the appropriate colors in a cockpit display, the pilots' workload would be minimized since his cross-check would be easily identified. However, further studies must be conducted with a greater range of subjects.

ACKNOWLEDGEMENTS

The author would like to thank all those who helped to make my last summer at Brooks AFB a memorable one.

I'll miss you guys!

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Data Analysis For The Evaluation Of The Effects Of Variable Head-Mounted Weight On Human Response During +Gz Impact Acceleration

Quynh Trang Nguyen

High School Apprentice

Mentor: Chris E. Perry

West Carrollton High School

5833 Student Street

West Carrollton, OH 45449

Final Report for:

High School Apprenticeship Program

Armstrong Laboratory

Sponsored By:

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Bolling Air Force Base, Washington, D.C.

August 1993

Data Analysis For The Evaluation Of The Effects Of Variable Head-Mounted Weight On Human Response During +Gz Impact Accelerations

Quynh Trang Nguyen
High School Apprentice
West Carrollton High School

Abstract

"The Evaluation Of The Effects Of Variable Head-Mounted Weight On Human Response During +Gz Impact Acceleration" is a research project that deals with the hazards of helmet enhancements such as night vision devices and helmet mounted displays. During a seat ejection, the pilot has a potentially higher risk of developing neck and spinal injury because of the increased mass, moment of inertia, and shifted center-of-gravity placed upon the head. My research included analyzing the data from of the human test subjects and the Advanced Dynamic Anthropomorphic Manikin (ADAM) after they were tested on the Vertical Deceleration Tower (VDT).

Data Analysis For The Evaluation Of The Effects Of Variable Head-Mounted Weight On Human Response During +Gz Impact Accelerations

Quynh Trang Nguyen

INTRODUCTION

Automatic escape systems are essential to an aircraft because most of the time, an emergency aircraft crash landing is not possible and over-the-side bailouts are outdated. The only way to escape from the aircraft is with an ejection seat. With today's high level of technology, a pilot must have an edge over his competitor with the use of night vision systems and helmet-mounted displays.

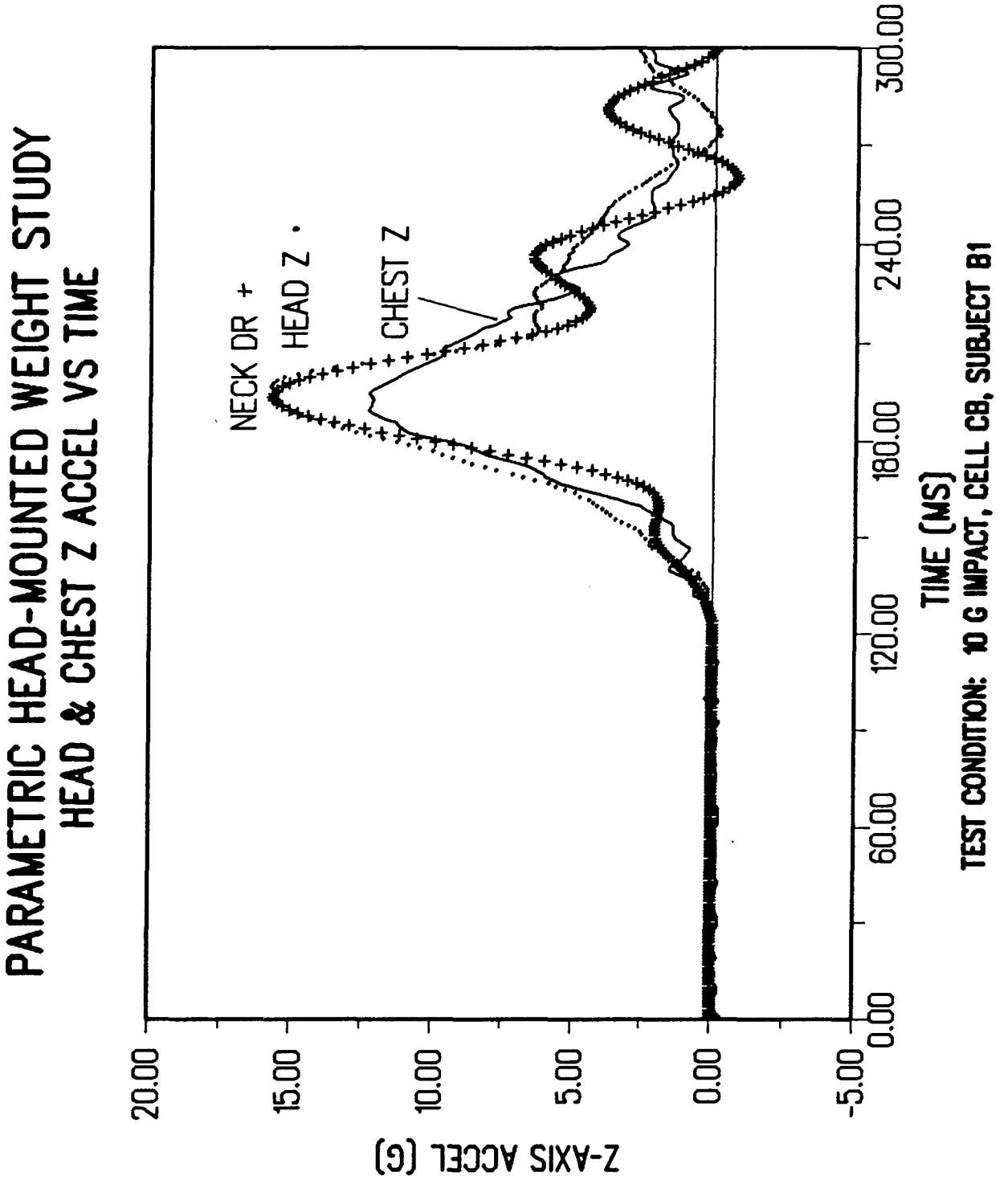
DISCUSSION OF PROBLEMS

If the pilot ejects with the helmet-mounted enhancements, he will have an increased risk of developing neck and spinal injury versus if he was not wearing these two devices. The Crew Systems Directorate of US Air Force Armstrong Laboratory is very involved with in-house research to solve these potential problems. The laboratory is concerned with the safe total helmet mass and a safe center-of-gravity.

METHODOLOGY

After the data was received from the human test subjects and the ADAM, it was used to graph the head acceleration, chest acceleration, and the computer representation of the calculated movement of the neck on the software Tech Graph Pad by Binary Engineering. Please see Figure 1 for an example. I also tabulated the principles moments in the three axes, the combined center of gravity in the three axes, the maximum value acceleration in the x-axis, the minimum value in the z-axis, and the maximum resultant value.

Figure 1


PARAMETRIC HEAD-MOUNTED WEIGHT STUDY
HEAD & CHEST Z ACCEL VS TIME
NECK DR +
HEAD Z •
CHEST Z
Z-AXIS ACCEL (G)
20.00
15.00
10.00
5.00
0.00
-5.00
0.00
60.00
120.00
180.00
240.00
300.00
TIME (MS)
TEST CONDITION: 10 G IMPACT, CELL CB, SUBJECT B1

RESULTS

The results will directly be used to find the human response to the varying center of gravity and predict the potential injury due to the wearing of the night vision devices and the helmet-mounted displays.

CONCLUSIONS

The night vision devices and the helmet-mounted displays are essential to the pilot while he is flying, and he should not have any additional fears when he ejects. Only more research such as research done at Armstrong Laboratory, Wright Patterson Air Force Base can be done to reach the goal of ejecting with helmet-mounted systems.

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The Study of Dyslexic Spelling Patterns

Luis M. Rodriguez

Final Report for:
High School Apprentice Program
Armstrong Laboratory

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

August 1993

The Study of Dyslexic Spelling Patterns

Luis M. Rodriguez

Abstract

The Pattern Recognition and Artificial Intelligence Spelling Experiment (PRAISE) is a project running at the Air Force Institute of Technology (AFIT) by Mr. Craig Arndt, the project director. Mr. Craig Arndt is a scientist from the Armstrong Laboratory's Human Engineering Division (AL/CFHI) on Wright-Patterson Air Force Base (WPAFB). The purpose of PRAISE is to study the different variations of dyslexic spelling patterns to better understand dyslexia. PRAISE also intends to help build a spell checker that would recognize the dyslexic spelling patterns and produce alternatives for a correctly spelled word or words for the user. There are many adult dyslexics in the professional world. This spell checker would be extremely helpful for the many adult dyslexics in any profession. In order to start the project a data base consisting of the 5000 most commonly used words in the English language was developed. A plethora of documents, notes, letters, and various other forms of literature were read so as to find the incorrect spelling patterns. These patterns were extracted and inserted into our data base where they were sorted into twelve different misspelling categories such as:

1. ADDITION OF UNNEEDED LETTERS.
2. OMISSIONS OF NEEDED LETTERS.
3. REFLECTIONS OF CHILD'S MISPRONUNCIATIONS.
4. REFLECTIONS OF DIALECTICAL SPEECH PATTERNS.
5. REVERSALS OF SMALL WORDS.
6. REVERSALS OF CONSONANT ORDER.
7. REVERSALS OF CONSONANT OR VOWEL DIRECTIONALITY.
8. REVERSALS OF SYLLABLES.
9. PHONETIC SPELLING OF NON PHONETIC WORDS OR PART THERE OF.
10. WRONG ASSOCIATIONS OF A SOUND WITH A GIVEN SET OF LETTERS.
11. "NEOGRAPHISMS" SUCH AS LETTERS PUT IN WHICH BEAR NO DISCERNIBLE RELATIONSHIP WITH WORD DICTATED.
12. VARYING DEGREES AND COMBINATIONS OF THESE OR OTHER POSSIBLE PATTERNS.

The Study of Dyslexic Spelling Patterns

Luis M. Rodriguez

Introduction

Dyslexia is a condition in which one's ability to master written language is affected, not just reading and writing but also constant thinking and composing in words and other skills of language. Most dyslexics are usually thought of as having below average intelligence, but in reality a large number of dyslexics are described of as having average or above average intelligence, but suffer from some degree of brain dysfunction that creates reading and writing difficulties.

Most of the research revolves upon the common understanding that dyslexia is a reading based problem. It has been documented that dyslexics experience more problems in spelling and writing than in reading. As a child learns to read, write, and spell they experience various stages of spelling. These stages can be categorized by specific spelling patterns or error patterns. Normally readers and spellers go through these stages and do not return back to them, while dyslexic spellers usually demonstrate any or all of these early stages.

Data Base

When I first started my tour here at Armstrong Laboratory, I was issued a 486 Gateway 2000 personal computer to work with during the summer. The first thing on the agenda was to build an extensive data base on this computer to help categorize and organize the different dyslexic spelling patterns. This data base was to consist of 5000 of the most commonly used words in the English language (#1 being "the", and #5000 being "lover"). Throughout the summer, the dyslexic spelling patterns were obtained by reading many forms of literature created by dyslexics. The

literature used consists of anything from reports, rough drafts of reports, letters, and notes. Once many dyslexic spelling patterns were obtained they were added to the corresponding word in the data base, and categorized to their specific spelling pattern. There are twelve specific dyslexic spelling patterns:

1. ADDITION OF UNNEEDED LETTERS.
2. OMISSIONS OF NEEDED LETTERS.
3. REFLECTIONS OF CHILD'S MISPRONUNCIATIONS.
4. REFLECTIONS OF DIALECTICAL SPEECH PATTERNS.
5. REVERSALS OF SMALL WORDS.
6. REVERSALS OF CONSONANT ORDER.
7. REVERSALS OF CONSONANT OR VOWEL DIRECTIONALITY.
8. REVERSALS OF SYLLABLES.
9. PHONETIC SPELLING OF NON PHONETIC WORDS OR PART THERE OF.
10. WRONG ASSOCIATIONS OF A SOUND WITH A GIVEN SET OF LETTERS.
11. "NEOGRAPHISMS" SUCH AS LETTERS PUT IN WHICH BEAR NO DISCERNIBLE RELATIONSHIP WITH WORD DICTATED.
12. VARYING DEGREES AND COMBINATIONS OF THESE OR OTHER POSSIBLE PATTERNS.

This data base that was created is the initial dictionary and will generate approximately 30,000 tokens.

Programming in C language

In the later weeks I learned the C programming language by reading many books on the subject. The purpose was to be able to create simple programs to use on the data base. The first program I created, was a program that would take each word, break it down into its letters, and convert the letters into its corresponding number (a=1, b=2, z=26). Once it was converted, the data had to be immediately transferred into a text file for further manipulation (See Figure 1).

The numbers produced by the program are going to be inserted into a separate computer. Because the words are now a set of numbers there was a need for another program to process the numbers and convert the numbers back to their corresponding letter in the alphabet (See Figure 2).

This program came off the original conversion program, but now it has a few revisions to basically reverse the action of the previous program.

The purpose of both these C language conversion programs is to provide an interface between a word processing system, the user, and a neural network which identifies and corrects dyslexic spelling patterns.

Figure 1

```
/* letter to number conversion program*/
#include <stdio.h>
#include <io.h>
#include <string.h>
main()
{
FILE *fp;

        char str[80];
        int letter;


        if((fp = fopen("c:\\winword\\words.asc", "a+")) != NULL)
        {

        strcpy(str, "");
        while ((letter=getchar()) != EOF)

                switch(letter) {
                        case 'a':
                                strcat(str, "1 ");break;
                        case 'b':
                                strcat(str, "2 ");break;
                        case 'c':
                                strcat(str, "3 ");break;
                        case 'd':
                                strcat(str, "4 ");break;
                        case 'e':
                                strcat(str, "5 ");break;
                        case 'f':
                                strcat(str, "6 ");break;
                        case 'g':
                                strcat(str, "7 ");break;
                        case 'h':
                                strcat(str, "8 ");break;
                        case 'i':
                                strcat(str, "9 ");break;
                        case 'j':
                                strcat(str, "10 ");break;
                        case 'k':
                                strcat(str, "11 ");break;
                        case 'l':
                                strcat(str, "12 ");break;
                        case 'm':
                                strcat(str, "13 ");break;
                        case 'n':
                                strcat(str, "14 ");break;
                        case 'o':
                                strcat(str, "15 ");break;
                        case 'p':
                                strcat(str, "16 ");break;
```

Figure 1 (con't)

```
case 'q':
        strcat(str, "17 ");break;
case 'r':
        strcat(str, "18 ");break;
case 's':
        strcat(str, "19 ");break;
case 't':
        strcat(str, "20 ");break;
case 'u':
        strcat(str, "21 ");break;
case 'v':
        strcat(str, "22 ");break;
case 'w':
        strcat(str, "23 ");break;
case 'x':
        strcat(str, "24 ");break;
case 'y':
        strcat(str, "25 ");break;
case 'z':
        strcat(str, "26 ");break;
case 'A':
        strcat(str, "1 ");break;
case 'B':
        strcat(str, "2 ");break;
case 'C':
        strcat(str, "3 ");break;
case 'D':
        strcat(str, "4 ");break;
case 'E':
        strcat(str, "5 ");break;
case 'F':
        strcat(str, "6 ");break;
case 'G':
        strcat(str, "7 ");break;
case 'H':
        strcat(str, "8 ");break;
case 'I':
        strcat(str, "9 ");break;
case 'J':
        strcat(str, "10 ");break;
case 'K':
        strcat(str, "11 ");break;
case 'L':
        strcat(str, "12 ");break;
case 'M':
        strcat(str, "13 ");break;
case 'N':
        strcat(str, "14 ");break;
case 'O':
        strcat(str, "15 ");break;
case 'P':
```

Figure 1 (con't)

```
                        strcat(str, "16 ");break;
                case 'Q':
                        strcat(str, "17 ");break;
                case 'R':
                        strcat(str, "18 ");break;
                case 'S':
                        strcat(str, "19 ");break;
                case 'T':
                        strcat(str, "20 ");break;
                case 'U':
                        strcat(str, "21 ");break;
                case 'V':
                        strcat(str, "22 ");break;
                case 'W':
                        strcat(str, "23 ");break;
                case 'X':
                        strcat(str, "24 ");break;
                case 'Y':
                        strcat(str, "25 ");break;
                case 'Z':
                        strcat(str, "26 ");break;
                case '-':
                        strcat(str, "");break;
                case '\n':
                        fputs(str, fp);
                        fputs(", ", fp);
                        fputs(str, fp);
                        fputs("\n", fp);
                        strcpy(str, "");
                case '1':
                        fflush(fp);
                        fclose(fp);
                        exit(letter);
                        break;
}
}
        else
                printf("error message\n");
}
```

Figure 2

```
#include <stdio.h>
#include <io.h>
#include <string.h>
main()
{
FILE *fp;

        char str[80];
        int number, def, there;

        if((fp = fopen("c:\\winword\\numbers.asc", "a+")) != NULL)
        {
        strcpy(str, "");
        while ((number=getchar()) != EOF)

                switch(number) {
                        case '1':
                                while ((number=getchar()) !=EOF)
                                switch(number){
                                        case ' ':
                                                strcat(str,"a");goto def;
                                        case '0':
                                                strcat(str,"j");goto def;
                                        case '1':
                                                strcat(str,"k");goto def;
                                        case '2':
                                                strcat(str,"l");goto def;
                                        case '3':
                                                strcat(str,"m");goto def;
                                        case '4':
                                                strcat(str,"n");goto def;
                                        case '5':
                                                strcat(str,"o");goto def;
                                        case '6':
                                                strcat(str,"p");goto def;
                                        case '7':
                                                strcat(str,"q");goto def;
                                        case '8':
                                                strcat(str,"r");goto def;
                                        case '9':
                                                strcat(str,"s");goto def;
                                        def:
                                                goto there;
                                        }
                        case '2':
                                while ((number=getchar()) !=EOF)
                                switch(number){
                                        case ' ':
                                                strcat(str,"b");goto def1;
```

Figure 2 (con't)

```
                                        case '0':
                                                strcat(str,"t");goto def1;
                                        case '1':
                                                strcat(str,"u");goto def1;
                                        case '2':
                                                strcat(str,"v");goto def1;
                                        case '3':
                                                strcat(str,"w");goto def1;
                                        case '4':
                                                strcat(str,"x");goto def1;
                                        case '5':
                                                strcat(str,"y");goto def1;
                                        case '6':
                                                strcat(str,"z");goto def1;
                                        def1:
                                                goto there;
                                        }
                        there:
                                break;
                        case '3':
                                strcat(str,"c");break;
                        case '4':
                                strcat(str,"d");break;
                        case '5':
                                strcat(str,"e");break;
                        case '6':
                                strcat(str,"f");break;
                        case '7':
                                strcat(str,"g");break;
                        case '8':
                                strcat(str,"h");break;
                        case '9':
                                strcat(str,"i");break;
                        case ' ':
                                strcat(str,"");break;
                        case '\n':
                                fputs(str, fp);
                                fputs("\n", fp);
                                strcpy(str, "");break;
                        case 'x':
                                fflush(fp);
                                fclose(fp);
                                exit(number);
                                break;
}
}
        else
                printf("error message\n");
}
```

SUMMARY

Half-way through my AFOSR tour I had the opportunity to work with the Silicon Graphics UNIX computer. As its name implies, it is dedicated to process all types of graphics. This computer along with the programs I created will be an essential part of Mr. Arndt's project.

My AFOSR Summer Research Program tour has been a very educational experience. I learned about dyslexia, C programming language, and how to program in C. I also acquired an extensive knowledge of how to operate different types of computers. Most importantly, I was able to expand my knowledge of the human engineering research field.

Luis M. Rodriguez

Craig M. Arndt P.E. AL/CFHI

A COMPARISON OF THREE TEMPERATURE TRANSDUCERS

Carol A. Salinas

Research Assistant

Sustained Operations Research Branch

Armstrong Laboratory/CFTO

Brooks Air Force Base, Texas

Final Report for:

Summer Research Extension Program

Armstrong Laboratory

Sponsored by:

Air Force Office of Scientific Research

Bolling Air Force Base, Washington, D.C.

and

Brooks Air Force Base

August 1993

ABSTRACT

In order to better understand the physiological challenges Air Force personnel face, there is a need for accurate assessment of body temperature during field studies. US Air Force aircrew frequently encounter life-threatening temperature extremes. Body temperature is a also a good indicator of 'jet lag' or circadian dysrhythmia for crews that travel across many time zones to do their jobs. Two temperature transducers were compared to the standard rectal or core body temperature recording device. The digital oral thermometer was found to satisfactorily compare with the core device for temperature and variability of readings. The tympanic temperature probe was faster to use than the oral device but was highly variable in its readings. It was concluded that the oral temperature device is satisfactory for field use where core temperature devices are not practical.

Acknowledgements:

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2. This research was approved by the Advisory Committee on Human Experimentation (ACHE) at Brooks Air Force Base on July 1991 under Protocol number 91-028.

INTRODUCTION

The temperature of the human body provides important information about underlying physiological processes. For example, body temperature has always been an important indicator of fever. Body temperature also follows a circadian pattern in that the lowest values occur during the early morning hours when metabolic rates are lowest and returns to the highest values in the early afternoon (Guyton, 1986). This means that body temperature can be a simple and accurate means to identify of circadian dysrhythmia or 'jet lag' (Shanahan, et al., 1991). The US Air Force has an interest in temperature assessment since many aircrew are exposed to great temperature extremes and to circadian dysrhythmia. A simple to use body temperature gauge would facilitate research that seeks to reduce some of the physiological challenges faced by Air Force personnel.

Current methods of obtaining field temperature estimates of core temperature are difficult. The best means to assess core temperature is with an esophageal probe since it provides an approximation of the temperature of blood leaving the heart (Edwards, 1978) but is impractical in the field. Rectal measurements are close estimates of core temperature but are difficult to use in the field and are associated with some discomfort (Gibson, 1981). Other devices have been tried but have not been demonstrated to approximate core temperature very well. For example, auditory temperature probes are subject to wind and

ambient temperature and are difficult to use when subjects wear a helmet in field studies (Morgan, 1982). The standard digital oral thermometer is reasonably accurate but subjects must be careful to not eat or drink nor keep their mouths open for some time prior to measurement. Other devices are still in the development stage and have not been fully evaluated for field use. Sparling(1993), for example has found that the use of an ingested radio telemetered temperature pill is consistently lower than a rectal thermistor. The device is difficult to use in field since an array of antennas must be worn but may have application for medical monitoring. Also, Falk (1989), evaluated the use of exhaled air temperature as a means of assessing core temperature, but again the device is cumbersome to use and has not been as well tested as some of the more traditional devices. The purpose of this report was to evaluate the tympanic and oral temperature transducers since these are the least invasive by comparing them to the well established rectal thermistor.

Methodology

Four civilian and military personnel in the Sustained Operations Branch of Armstrong Laboratory served as subjects in the experiment. Rectal temperature data from one subject was lost due to battery failure. All 4 males in the study wore actigraphs during the 24 hour test period to monitor daytime activity and to ensure a normal nights sleep. Subjects wore the actigraphs, the rectal probe and collected data for about a 48 hour period.

However, only the data collected during a 24 hour test period on the second day were used in the analysis. The first day was considered adjustment to the regimen of the study. The subjects also took oral temperature sublingually (OT) with a B/D digital Fever thermometer (Bectin Dickenson, Rutherford NJ, part number 2870) and tympanic temperature (TT) (Thermoscan Inc. San Diego CA, part number 421053A). Rectal temperatures (RT) were logged continuously (Science/Electronics Dayton OH, Squirrel, part number 1202) for the 24 hour recording period.

Procedures for the RT are presented in Appendix 1. Subjects were instructed to take OT and TT measurements twice as a control for errors in reading. These values were recorded on a data sheet every hour during the working day (between 0600-1700). For the OT subjects were instructed to not eat or drink anything for 15 minutes prior to taking their temperature. They were asked not to talk during the measurement and to be consistent in the sublingual location of the OT device. A probe cover was used on the TT device to protect against possible infection from one subject to the other. The TT probe was set to rectal equivalent and inserted into the inner canthus to the bony ear canal by the subject under the supervision of the experimenter. An effort was made to place the TT probe in the same place each time and at the same horizontal plane. All subjects complied with the instructions fully. Only 4 subjects could be found who were willing to participate. Reasons for the difficulty in obtaining subjects were primarily the

uncomfortableness anticipated in the RT device and because no monetary inducement was provided the subjects.

Results

All four subjects were found to be normally entrained to a diurnal cycle as shown by the actigraph data shown in Figure 1. The wrist-worn actigraph is a sensitive monitor of motion in a 3 dimensional plane. Figure 1 is a typical output from the device showing that the subject put on the actigraph on Day 1 at about 1530 and demonstrated normal activity until about 2300 when the amount of activity slowed, indicating sleep, until about 0730 the next day. The bars under the activity counts represent when the scoring algorithm determined the subject was asleep. In the example shown in Figure 1, the subject retired to bed earlier and earlier throughout the study, that is, at about 2230 on Day 2 and 2130 the third day. This subject wore the actigraph and the squirrel for a third day to comply with a companion study unrelated to the current study. The graph in Figure 2 shows that the average sleep for all 4 subjects occurred between 2300 and 0700. An actigraph score of over 20 minutes of scored sleep per hour was considered sleep. The graph in Figure 3 shows that the amount of activity during sleep also shows a trough in the activity pattern between 2300 and 0700 indicating a restful sleep for the four subjects. The actigraph indications are of a normal nights sleep for all subjects.

The comparisons between the RT and the OT are shown in Figure 3. The values for the RT show a normal circadian pattern in that the temperature trough appears about 2300 to 0700. A close correspondence can be seen between the temperature profile of the RT and the OT in Figure 3. Figure 4 contrasts the same RT data with that for the TT set to approximate a rectal temperature. This figure shows a poor correspondence between RT and TT in that the TT temperatures are sometimes above and sometimes below the RT data.

Measures of central tendency like standard deviations (SD) and standard error of the mean (SEM) provide an indication of the variability of the data. Table 1 compares the overall mean recorded by the three devices and the associated SD and SEM.
It can be seen from Table 1 that the average temperatures for OT (36.74 ° C) and the TT (36.99 ° C) were close to that for the RT at 37.06° C. However, Table 1 also shows that the greater variability in temperature recording, that is how much the temperature varied from the mean temperature, was associated with the TT. For example, the SEM for the RT was 0.034 and 0.033 for the OT but rose to 0.041 for the TT.

Conclusions

The data support the use of an oral temperature device, such as those used here for field studies. The OT device was easy to use and provided temperatures about a degree lower than the RT device. The TT device on the other hand was not considered

Table 1. Average temperature over 48 hours as measured by Rectal Temperature device (RT), Oral device (OT) and Tympanic device (TT). The standard deviations (STD) and standard error of the mean (SEM) are also shown.

	AVG (°C)	STD	SEM
RT	37.06	0.40	0.034
OT	36.74	0.40	0.033
TT	36.99	0.47	0.041

sufficient for field studies since the variability in the measurements was too high and the subjects had difficulty adjusting it to the same position every time. This device would also prove restrictive in the aircraft environment where flight helmets are frequently worn. It is unlikely that RT devices could be used in field studies of more than a few days due to the uncomfortability associated with them. It is concluded that the OT provides reasonably stable temperature measurements and can be readily transported to long duration field studies.

It is interesting that the circadian temperature trough times, as measured by RT, were consistent with when the subjects went to bed and awoke. This may indicate a greater level of fatigue associated with lower body temperature. Although there is some precedence for this in the literature (Shanahan et al., 1991) more research needs to be done quantifying the relationship between

fatigue and temperature, particularly during the daytime. Perhaps body temperature (oral temperature) could be used as an objective measurement of fatigue. Future studies should evaluate the temperature pill and breath temperature against the standard rectal temperature profile.

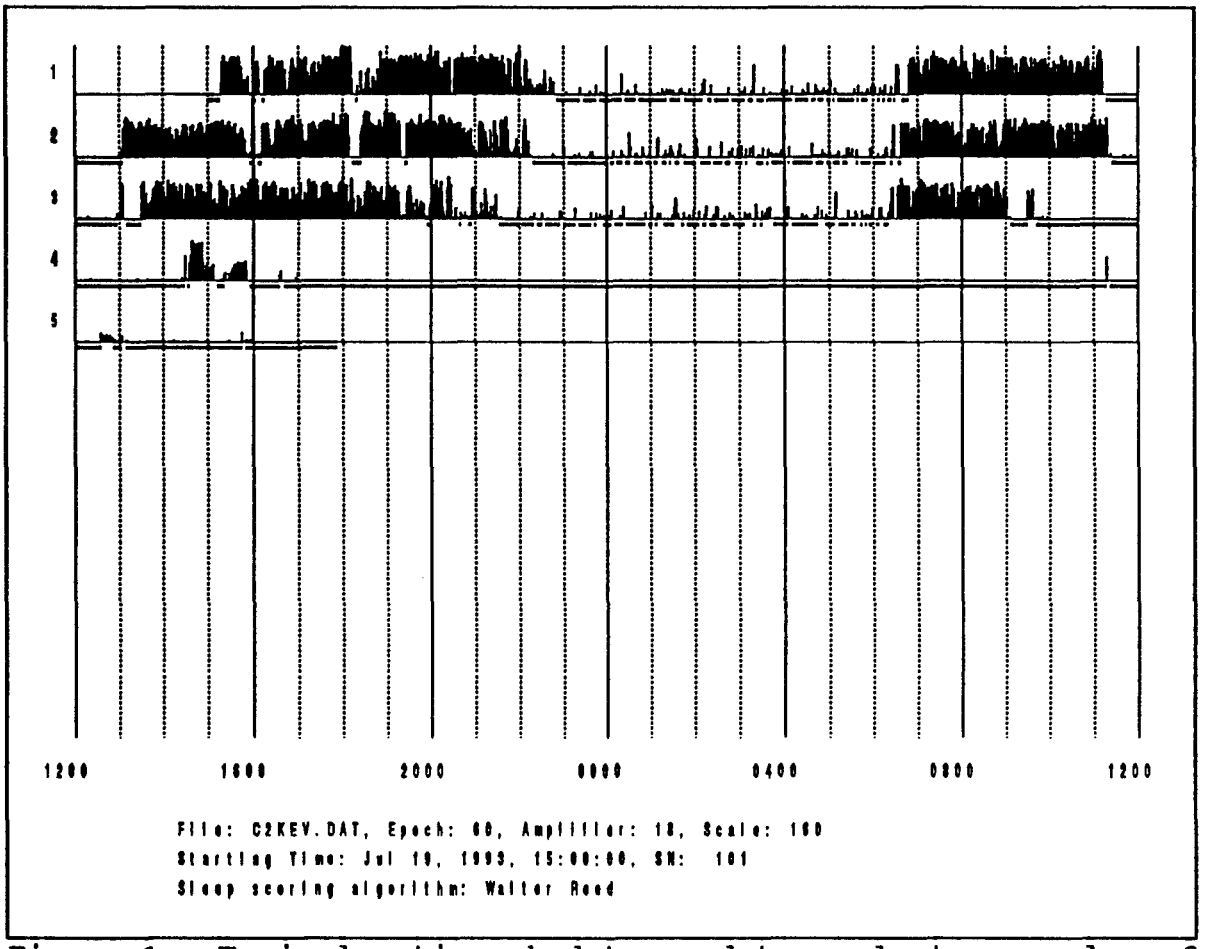

Figure 1. Typical actigraph data used to evaluate normalcy of sleep and activity.

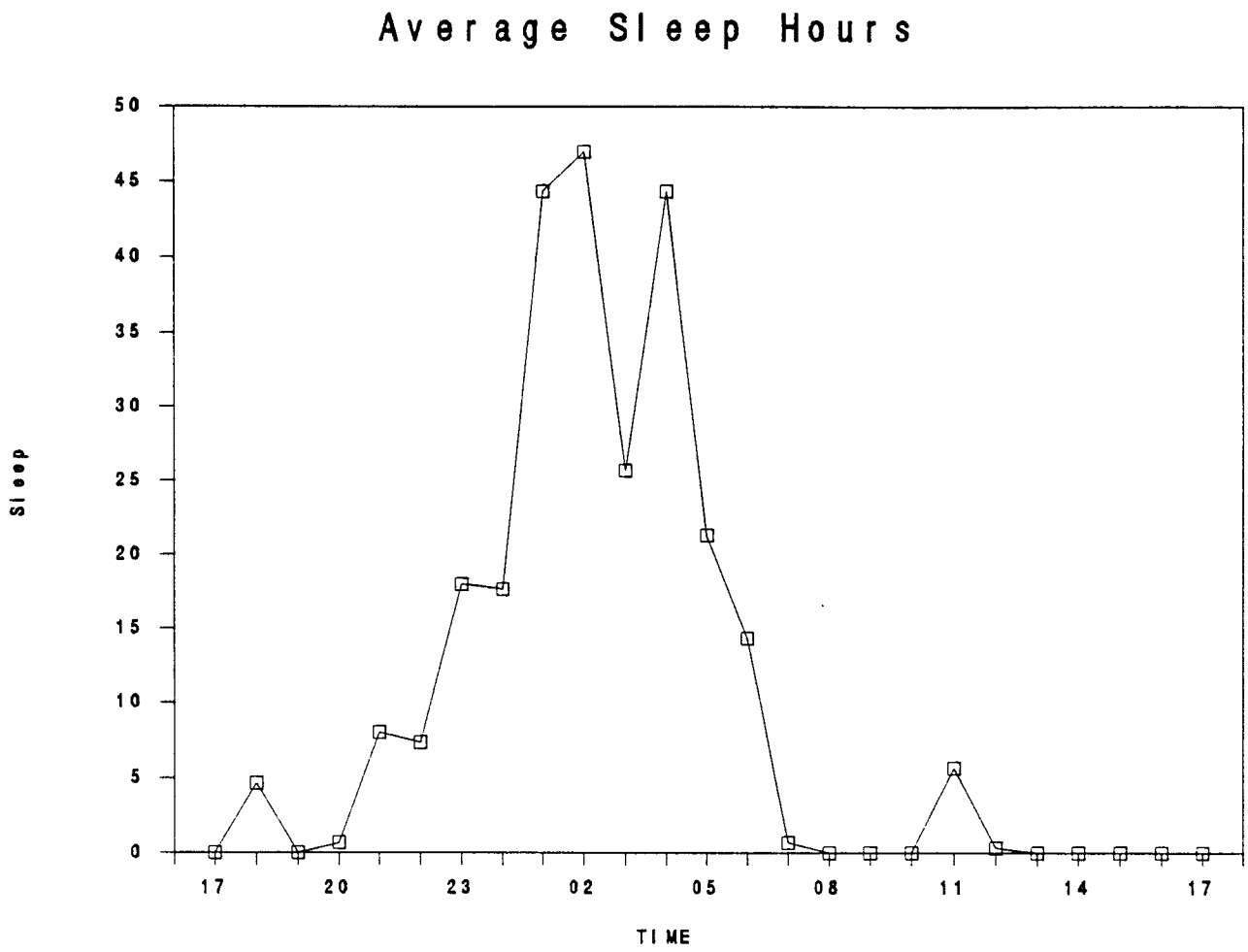

Figure 2. Actigraph scored sleep values for subjects in temperature study.

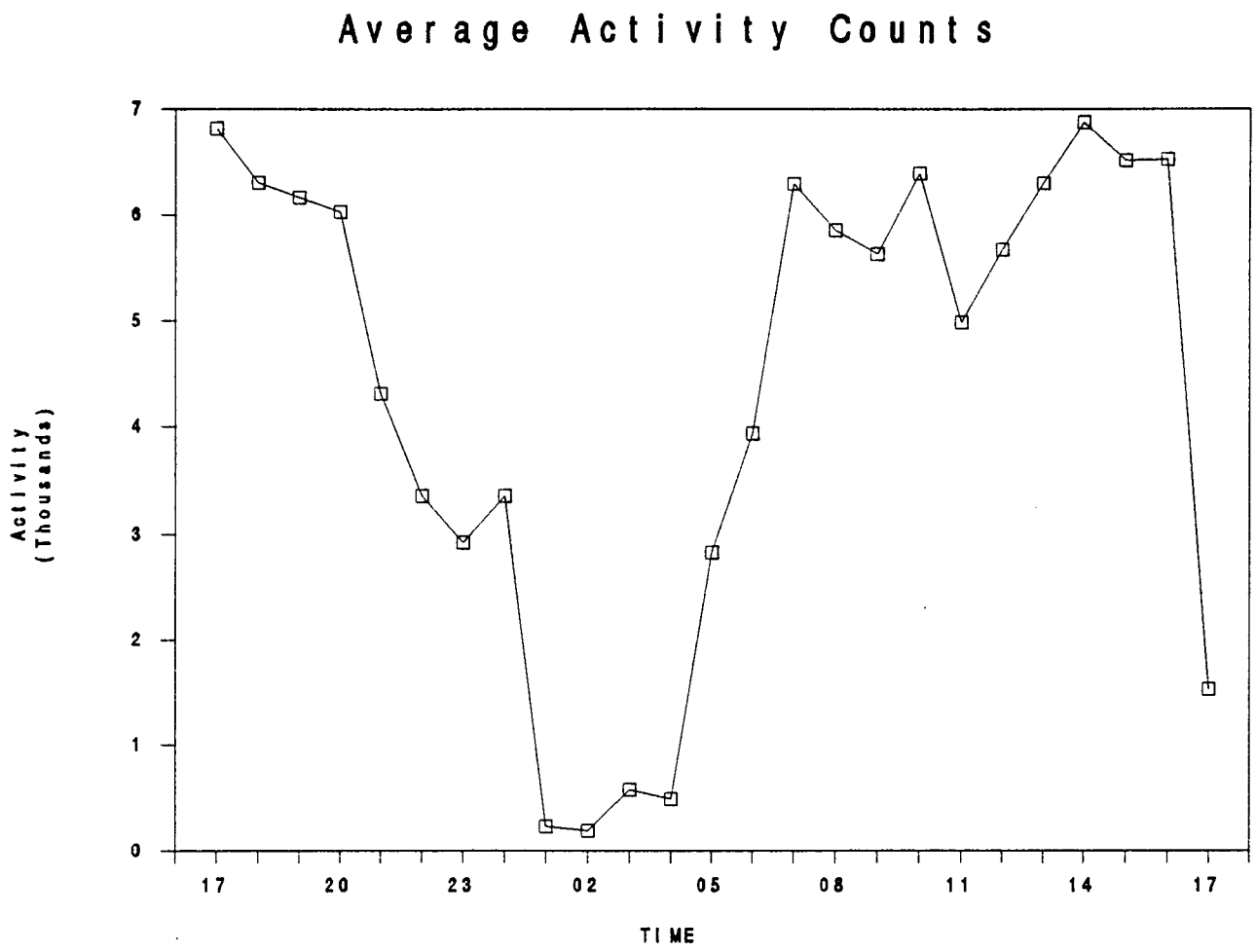

Figure 3. Average activity during scored sleep on actigraph.

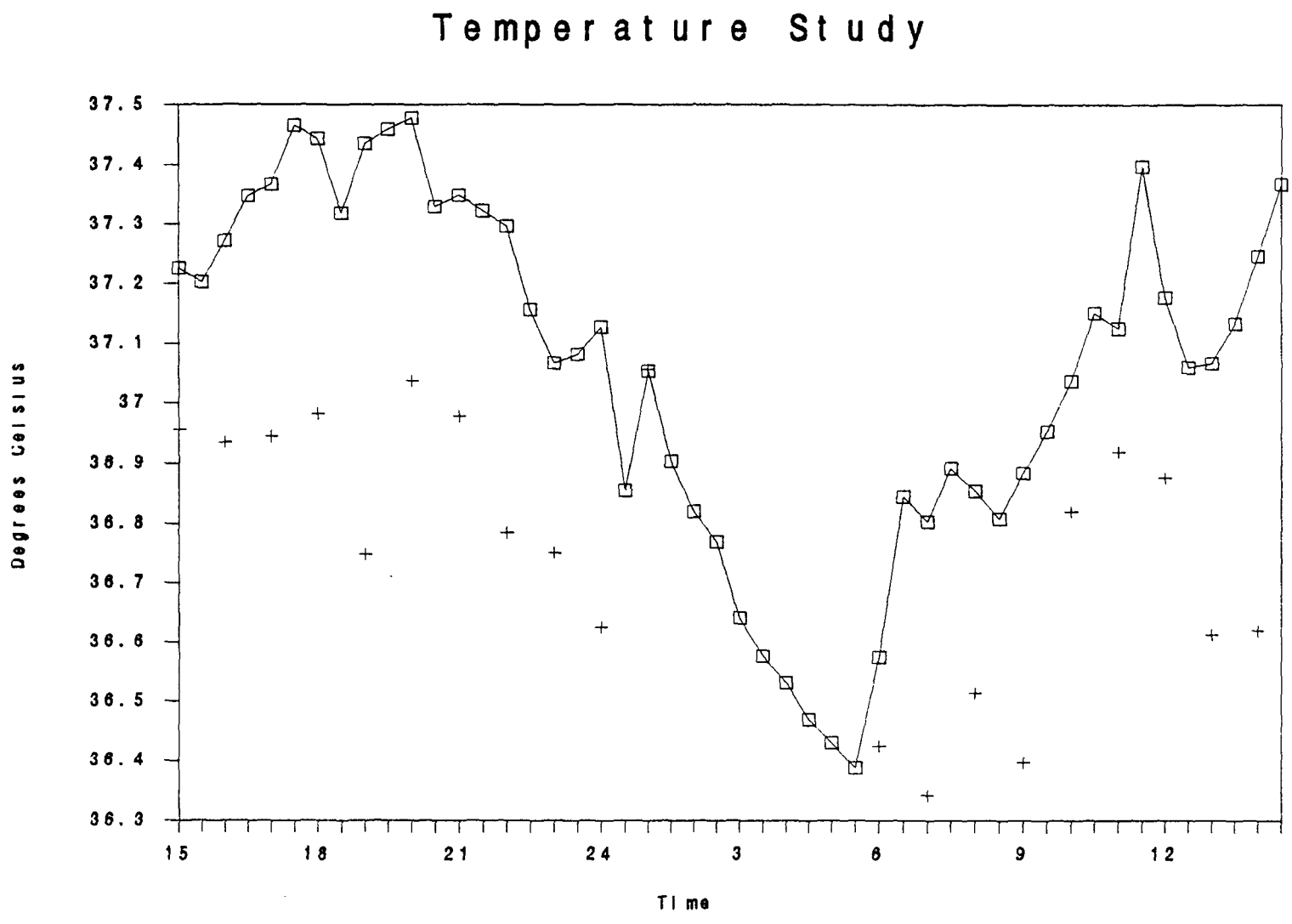

Figure 4. Rectal (RT) the open boxes (solid line) and Oral Temperature (OT) the +

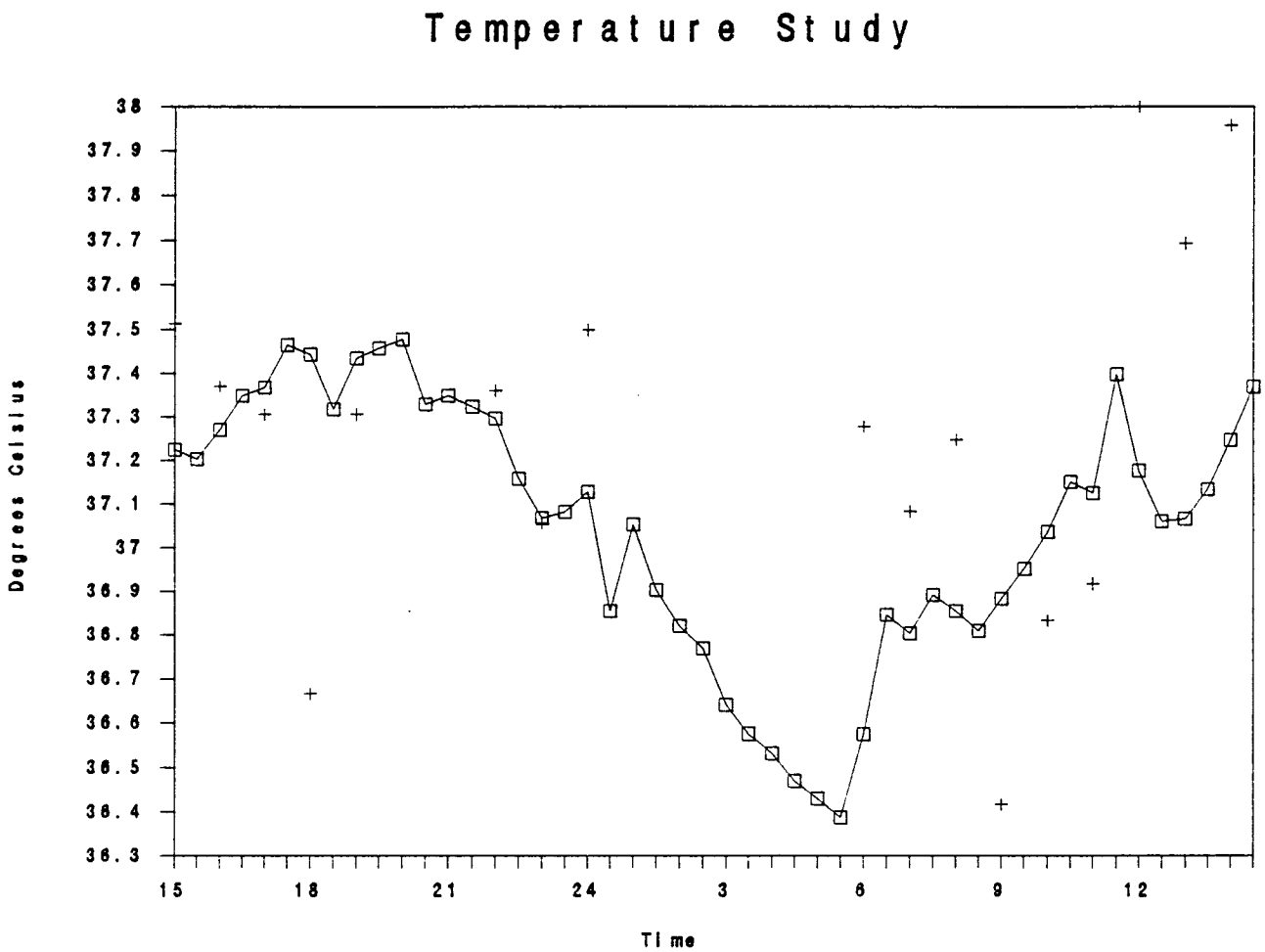

Figure 5. Rectal (solid line) and Tympanic (+) temperature values

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APPENDIX 1

Sally Schanding
High School Apprenticeship Program
RDL Summer 1993

Flight Motion Effects Branch
Crew Technology Division
Armstrong Laboratory
Brooks Air Force Base, Texas

I did not conduct an experiment this summer. I spent most of my time researching subjective contour illusions in preparation for an experiment that Dr. Previc now hopes to have me run next summer.

Humans perceive contours when there is a jump in stimulation between adjacent areas (Kanizsa, 82). Jumps may be caused by a change in the color of an image or the brightness of it. However, contours can be seen in an image that is completely homogeneous.

In Figure 1 the solid triangle appears to have very definite boundaries, but after close examination of the spaces where these boundaries cross an open area it is clear that the perceived contours have no physical basis. In fact, if you concentrate your gaze on one of the contours it disappears.

To understand subjective contours you must understand the concept of virtual lines. When we see three dots equidistant from each other our visual system automatically organizes the dots into a triangle and also, it assumes that the dots are connected by straight lines (Kanizsa, 83). The lines that our mind sees are called virtual lines, and in fact, they are not really seen, they are only a presence in our visual experience. Straight lines are easier and more compelling to visualize. For example, the dots could easily be part of a circle, but that is

too difficult to visualize. Because virtual lines are only phenomenally present and have no sensory modality, they are referred to as being amodal. Although the lines of the image are not there, they have a very strong phenomenal presence, and they have, in this way, gained modality.

Subjective contours have two major characteristics (Kanizsa, 87). First, the region or shape inside the contours appears to be brighter than the area around it even thought there is no difference. Second, the shape generally appears as an opaque surface on top of the other pictures in the image.

But not everything in life is straight, even imaginary lines. It is possible to create curved subjective contours. As demonstrated in Figure 2, it all depends on the shapes around the perceived figure. Some subjective contours even appear to pass under real lines that intersect them. This is one way to observe the degree of resistance to interference of a subjective contour. If a real line intersects a subjective contour and the region disappears, that is an indication of a low degree of resistance to interference (Kanizsa, 83,85). Figure 3 illustrates a subjective contour illusion with a high degree of resistance to interference.

Finally it is possible to create subjective angles. The incomplete cross in Figure 4 gives rise to such an effect (Kanizsa, 86). It is produced by the resistance of the arms of the cross to the subjective surface. Without the resistance, as in the narrower cross, the subjective surface appears circular because the invasion of the internal region has been minimized.

Incomplete shapes are more likely to form subjective contours than complete ones. In Figure 5 the four complete crosses do not create a very effective illusion because we tend to focus more on the crosses than on what is inside them. On the other hand, the four half crosses to the right create a very good rectangle because it is easier to see such a complete shape rather than an abstract shape such as half of a cross (Kanizsa, 85).

Basically, we like to close shapes. We see a triangle because the other broken shapes and segments suggest a triangle. It is easier to see the solid shape than it is to organize the broken fragments and shapes. Our mind, in an attempt to make things easier, creates a subjective contour.

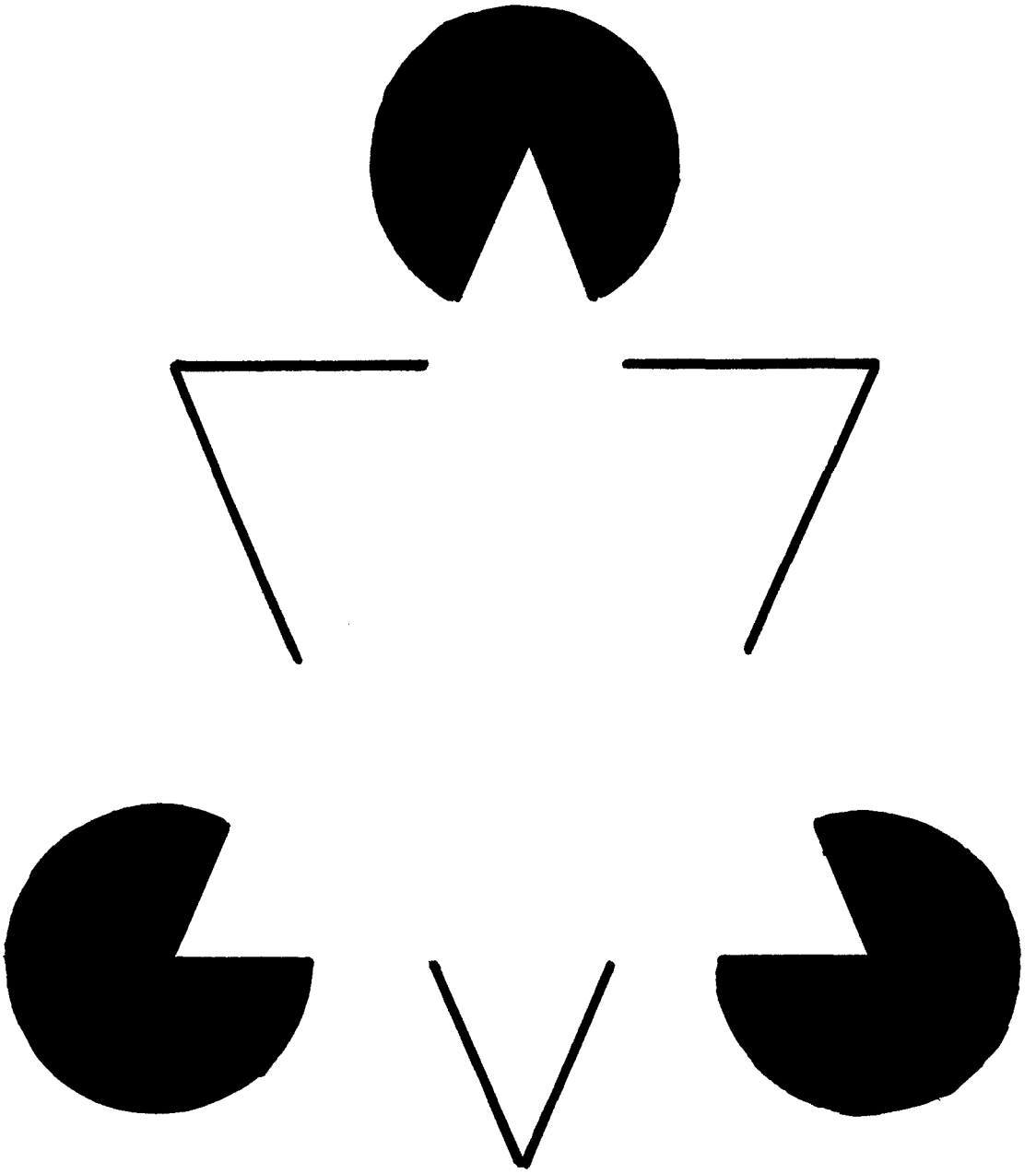


Figure 1

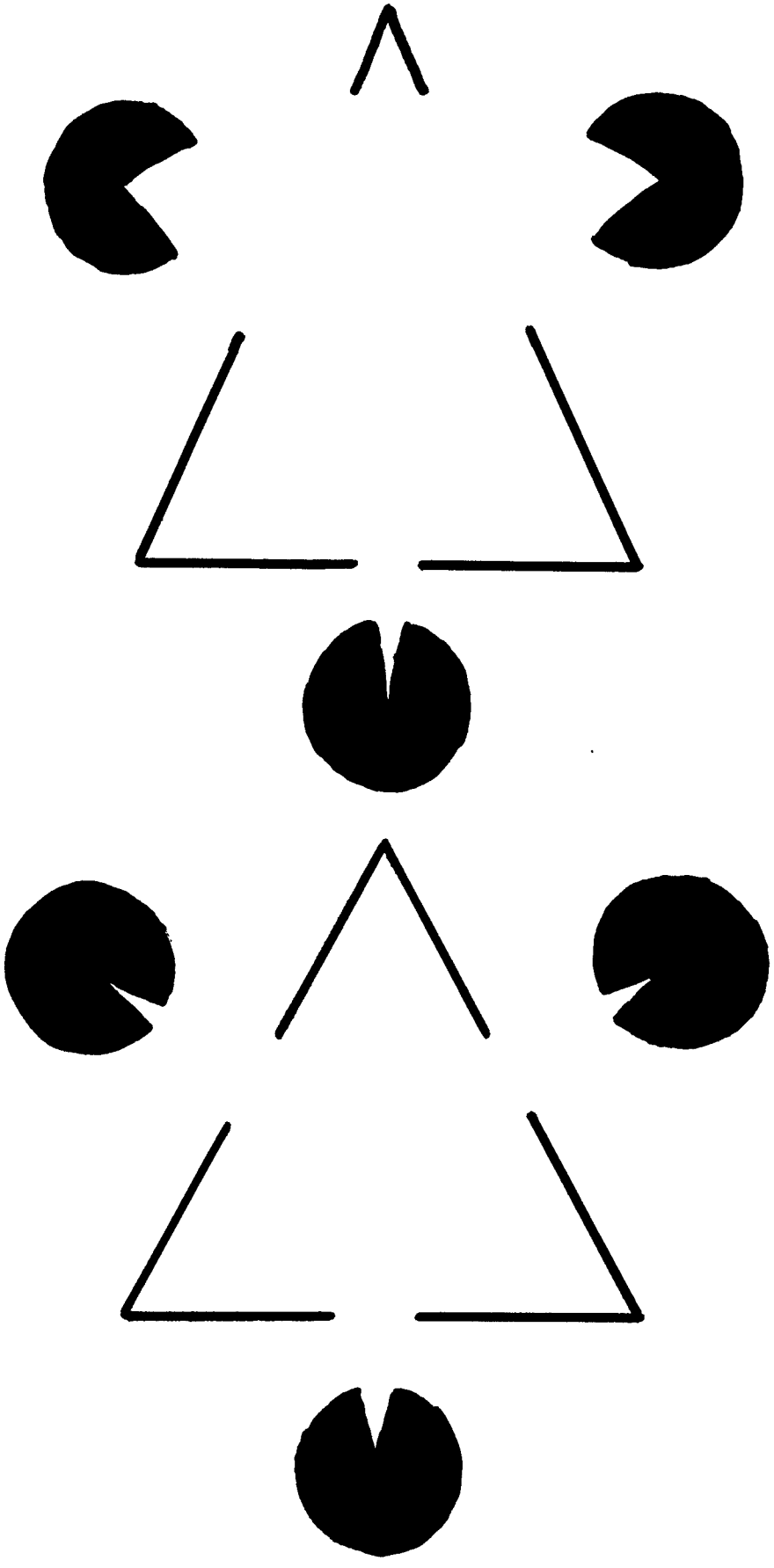


Figure 2

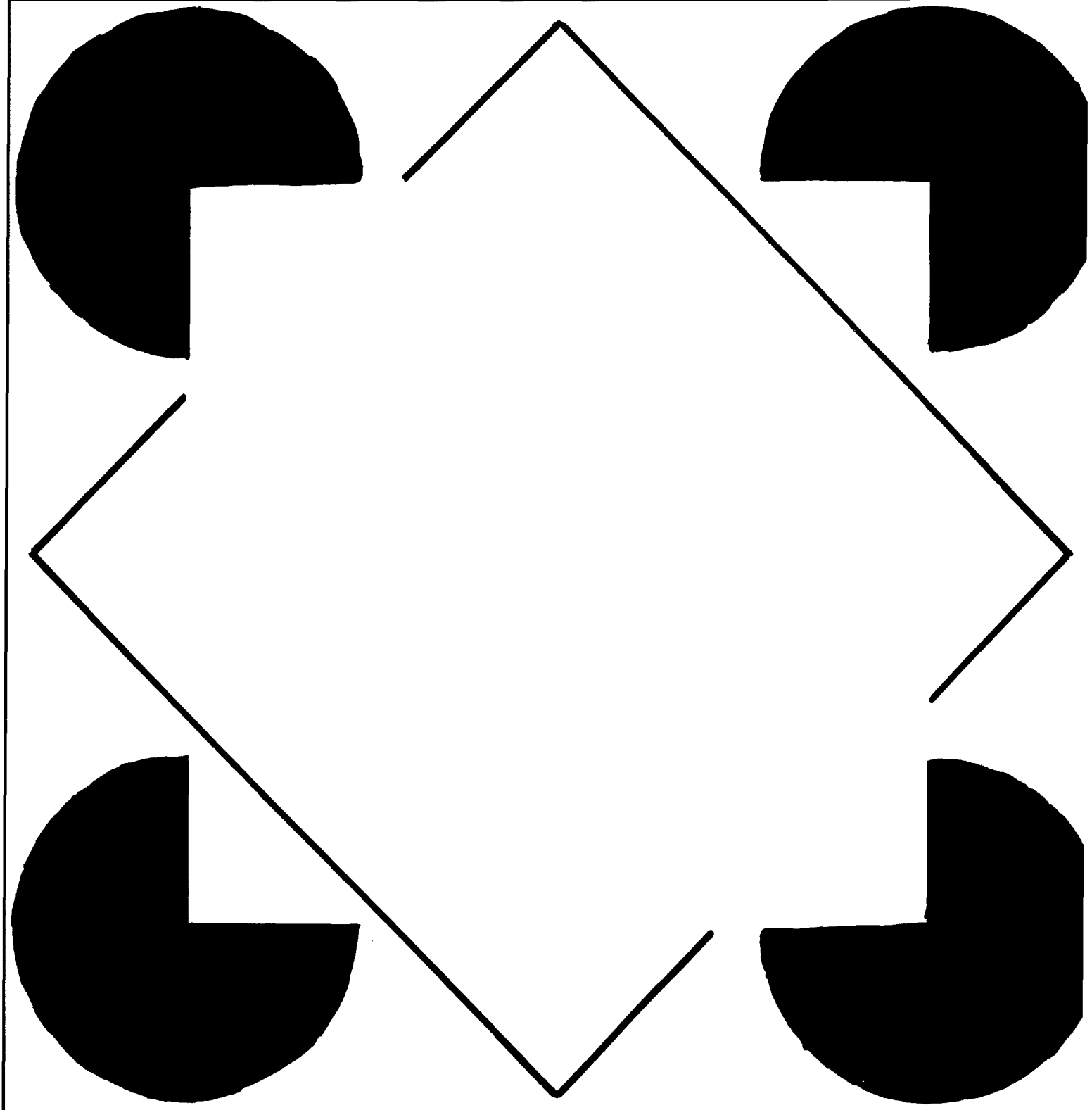


Figure 3

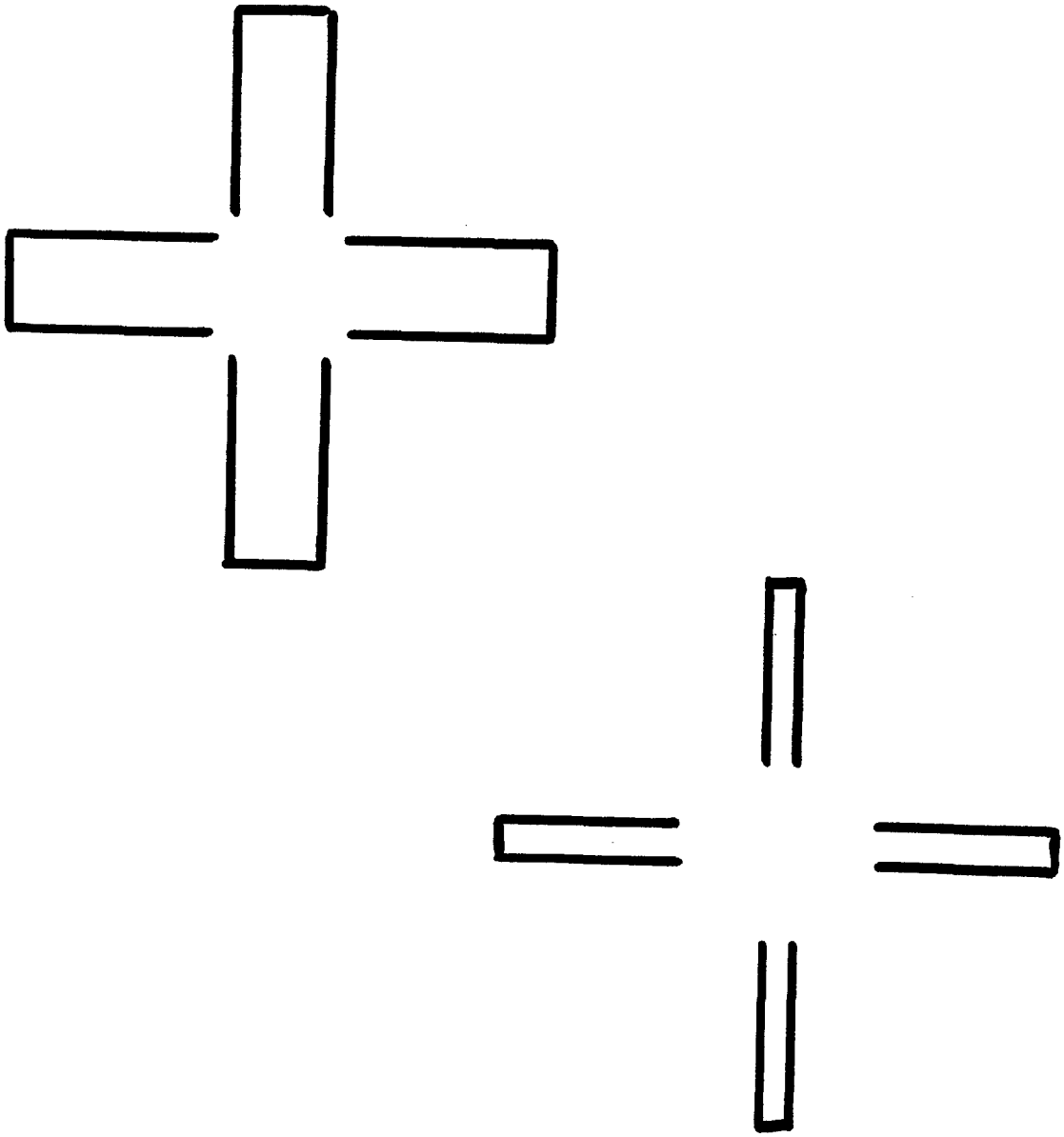


Figure 4

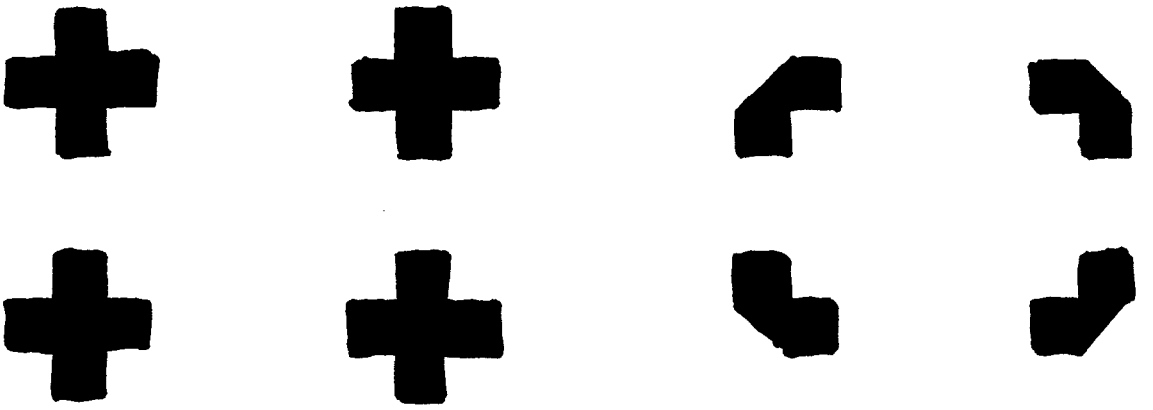


Figure 5

ACTIVE NOISE REDUCTION

Amy Zimmerman

Final Report for:
Summer Research Program
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Wright Patterson Air Force Base, Dayton, Ohio

August 1993

Active Noise Reduction

Amy Zimmerman

Abstract

Active noise reduction (ANR) is the wave of silence to the future. While passive techniques act as a barrier to noise, ANR equipment mirror images noise waves and sends the waves back at the noise obstruction, cancelling out part or all of the noise. ANR techniques also prove to work better at lower frequencies where passive control fails. For this experiment, a speaker was placed at the end of a 17'9.5" PVC pipe and a second speaker was placed 10 feet from the first. The first speaker was turned on and the second was phase and volume adjusted to cancel out the highest level of noise (only sine waves were used). This was repeated at three different locations on the pipe to check for global cancellation. The results showed that there was cancellation over a five foot area. Over all the trials, there was about a 30 dB reduction average. It can be concluded that a large amount of noise can be eliminated from this technique. This type of equipment can prove to be very beneficial for workers in noisy environments.

Active Noise Reduction

Amy Zimmerman

Introduction

Researchers all over the world have been dealing with a problem called noise for years now, noise simply being defined as unwanted sound. Often referred to as environmental noise or noise pollution, noise is produced by cars, factories, and even household appliances, causing an unpleasant environment in which to work and live. Now there is a better way of eliminating noise than simply unplugging or turning off the obstruction(machines, household appliances, etc.). Work can continue in silence as the world of active noise reduction (ANR) begins to expand.

Active noise reduction is a method of eliminating unwanted noise in which a second noise(anti-noise) cancels out unwanted noise by sending back the same signal the ANR circuitry receives, only 180 degrees out of phase. Theoretically ($x + (-x) = 0$) noise + anti-noise = silence. Refer to Figure 1. This technique works best at lower frequencies where the wavelengths are longer, so the resolution of the control signal does not have to be as refined.(Purdue Notes) Lower frequencies of sound also tend to radiate uniformly throughout a duct of uniform cross section. The traditional passive techniques for noise control consist of using acoustic foam, fiberglass, or any other substance as a

barrier for noise and only work at higher frequencies. The active and passive techniques combined together can cut the majority of noise from a loud environment. The first patents for ANR technology were granted in the 1930's when vacuum tube technology was used to create mirror image waves.(Dutton 187)

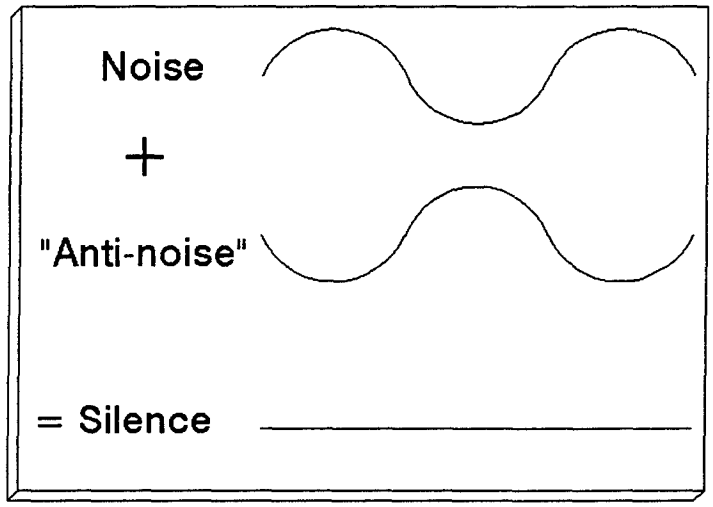


Figure 1. Summation of two wave forms tends to zero-silence

The problem of noise was not solved then and still remains partially unsolved. In 1970, the government attempted to solve the problem. Congress started the Occupational Safety and Health Administration in order to set limits on the amount of noise allowable in the workplace and other work conditions. In 1972, the Noise Control Act was passed and the Environmental Protection Agency was established. The staff of the office had difficulty defining noise and setting limits on what was extraneous noise and what was necessary sound, which made it more difficult to establish any laws. Funding of the office came to a halt in 1982 when it was removed from the list of pressing

federal interests.(Sedgewich 52) Even though it was removed from one list, researchers continued to make advances individually.

Because of the many advances over the past ten years, ANR equipment has come into play in today's market. Active noise reduction systems hit the Japanese market when the equipment was installed in the Nissan Bluebird Sedan where it was found not only to reduce noise, but also to help improve gas mileage. Bose introduced the first aviation ANR headset in 1989 to improve hearing in the cockpit, thereby reducing fatigue on the pilot.(Dutton 188) In 1991, Toshiba announced a refrigerator with ANR technology.(Mayeasohn 84) Besides decreasing noise, ANR has proven to have many other benefits as mentioned. The main concerns now are not for commercial uses, but for mufflers on cars, factory jobs, and airplane groundsmen jobs; places where people have exposure to large amounts of noise on a daily basis.

Methodology

The goal of this ANR experiment was to reach the maximum cancellation possible in the area defined. The defined area was a 17'9.5" PVC plumbing pipe which roughly represented the area on the ground around the airplane engine where the crewmen work. Both local and global cancellation were tried. Local cancellation is formulated such that reduction is achieved at only the place desired, while global cancellation is formulated

such that noise reduction is achieved in the entire field.(Purdue Notes) Procedures and set-up will be described in the following paragraphs.

The main piece of equipment for the experimental set-up was a 20 foot PVC plumbing pipe. A Bose 4.5" diameter speaker was sealed to a flange at one end of the pipe and the other end of the pipe was cut down to help reduce the reverberation of sound travelling out of the pipe, bouncing off the wall, and travelling back into the pipe which could lead to inaccurate results. The pipe was then cut in half and reattached by a T-pipe. Refer to Figure 2. A second Bose speaker sealed to a flange was placed on the T-pipe, located 10 feet from the first speaker. Two half inch holes were drilled into the pipe, one at 14 feet and the other at 15 feet from the first speaker which was located at the end of the pipe. A Bruel and Kjaer half inch free-field pressure microphone was inserted one and one half inches into one of the holes and held in place by modeling clay, while the second hole was covered with two pieces of duct tape. The microphone was connected to a pre-amp and then to the microphone power supply. The power source was connected to a Larson Davis spectrum analyzer which measured the amount of sound present in the pipe with the sound source alone and then with the sound source and the anti-noise source.

For the sound, two 3325 Hewlett Packard function generators were used to generate sine waves, one for the sound source, and

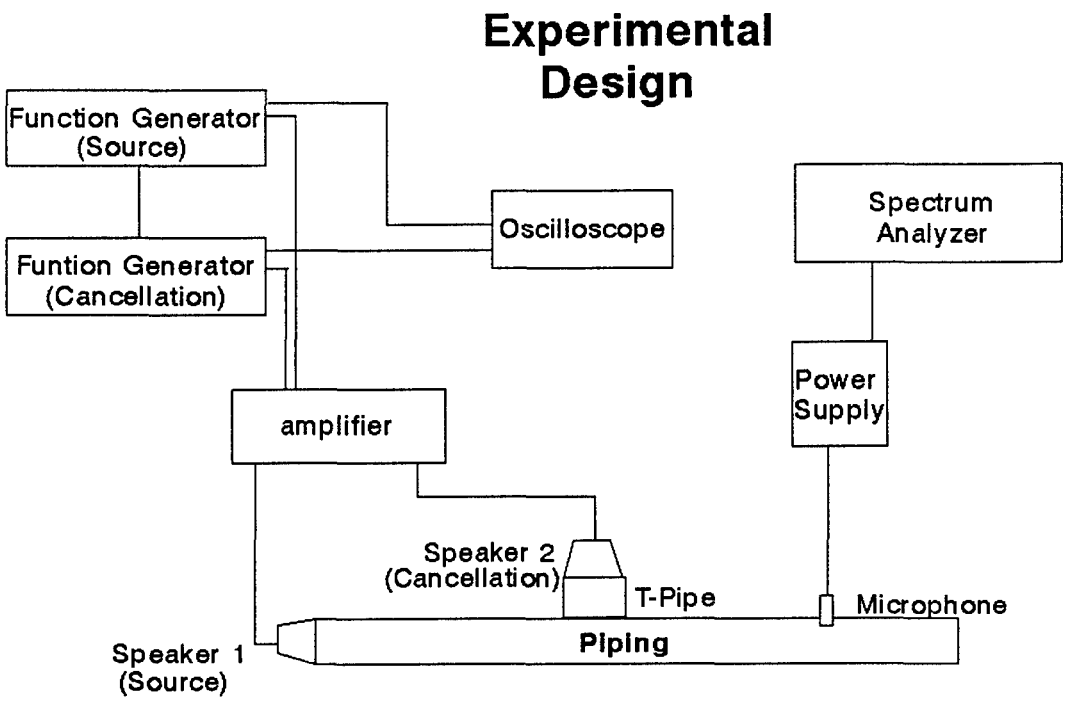


Figure 2

the second for the anti-noise source. This particular model was used because the sine waves from the two generators can be phase synchronized. The phase difference of the sine waves were then measured on a Tektronix 2205 20MHz oscilloscope. Each generator was connected to a separate channel in the amplifier which was connected to the speaker. The entire set-up is shown in Figure 2.

The procedure followed was based on information from literature about the topic and from scientists at WPAFB familiar with the equipment and the workings of ANR. Calibration of the equipment was the first concern. Most of the equipment had already been checked for calibration and remained calibrated for the duration of this experiment. The microphone was calibrated

with the analyzer at the beginning of each trial day and was then checked for correct calibration before each trial. The generators were set to the appropriate frequency and then to an amplitude of 5mV. The frequencies evaluated in this experiment were 100, 125, 200, 250, 300, 350, 400, 500 Hz. The wavelengths of these frequencies appear in Figure 3.

Frequency Vs. Wavelength

Frequency(Hz)	Wavelength(ft)
100	11.3
125	9.0
200	5.6
250	4.5
300	3.8
350	2.8
400	2.3
500	3.2

Figure 3

The waves were measured on the oscilloscope and the function generators were adjusted until the phases matched, then the two generators were locked together. The volume of the sound source on the amplifier was turned to the maximum volume of 30. The noise level in the pipe was measured with the spectrum analyzer. The volume and the phase of the anti-noise source were both

adjusted to find the minimum sound level. Once a relative low was reached, both the phase and the volume were double checked and the phase of the anti-noise wave was changed from 0 to 360 degrees by 10 degrees increments to search for other possible minimums. Each angle tested proved to have one minimum. After the minimum was found and checked, the amount of noise with both the sound source and the anti-noise source on was recorded. This measurement was then subtracted from the level of sound produced by the sound source alone to find the amount of sound attenuaton provided by ANR. The format in which the data was recorded can be seen in Figure 4. The abbreviations are the following: frequency,FREQ; amplitude,AMPTD; volume of channels 1 and 2,V CH1(2); sound source,dB PURE; sound source with cancellation,dB CANC; amount of ANR,ANR.

ANR

date:

FREQ:
AMPTD:
V CH1:
V CH2:
PHASE:
dB PURE:
dB CANC:
ANR:

Figure 4

Results

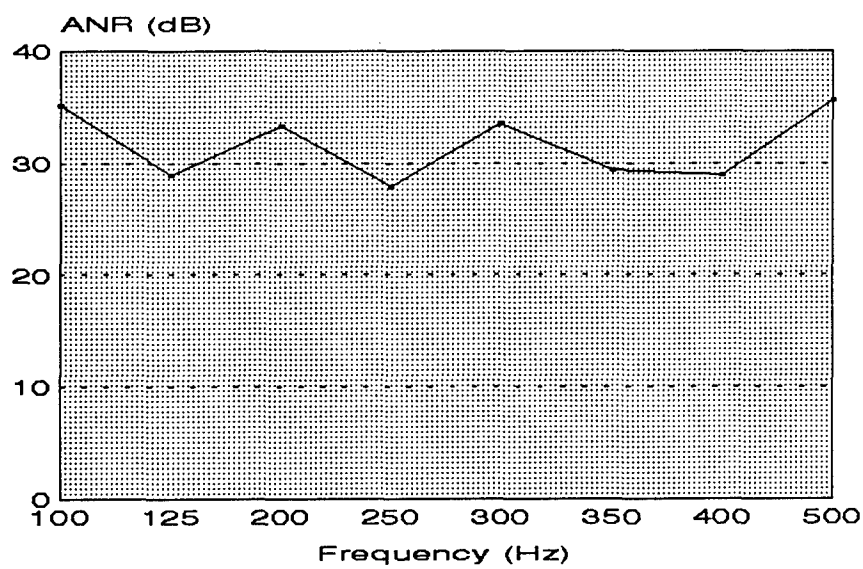
The following tables show the amount of ANR produced in each trial. For each location, ten trials were run and recorded in the tables. At the bottom of each table is the average reduction in dB of the ten trials including the standard deviation. Below each table is a graph of the data point averages. The average phase difference in degrees between the anti-noise source and the sound source is also presented in the table.

ACTIVE NOISE REDUCTION in dB
B&K MICROPHONE at 14 ft.

FREQ-	100Hz	125Hz	200Hz	250Hz	300Hz	350Hz	400Hz	500Hz
TRIAL								
1	33.0	28.2	37.6	27.2	28.8	26.9	31.0	34.1
2	37.9	30.7	34.1	27.1	32.1	27.0	27.4	32.9
3	37.8	32.4	32.0	27.4	33.1	26.1	26.5	32.9
4	35.5	33.3	29.0	27.7	29.0	27.6	25.3	30.3
5	39.9	27.1	33.9	29.2	35.4	35.7	30.4	32.3
6	34.3	29.1	31.0	27.4	36.1	33.6	30.7	48.1
7	33.7	25.1	39.1	30.7	30.6	24.6	33.3	35.0
8	32.7	26.6	35.4	25.8	31.1	27.1	29.6	44.4
9	33.9	28.3	30.0	26.8	39.1	31.9	29.7	36.6
10	32.9	28.8	30.8	29.8	40.0	33.3	24.8	29.7
AVG	35.16	28.96	33.29	27.91	33.53	29.38	28.87	35.63
SD+/-	2.5	2.6	3.3	1.5	4.0	3.8	2.8	6.0
AVG PHASE	198.0	159.1	238.9	117.6	355.2	226.2	131.6	172.0

Active Noise Reduction

14 feet

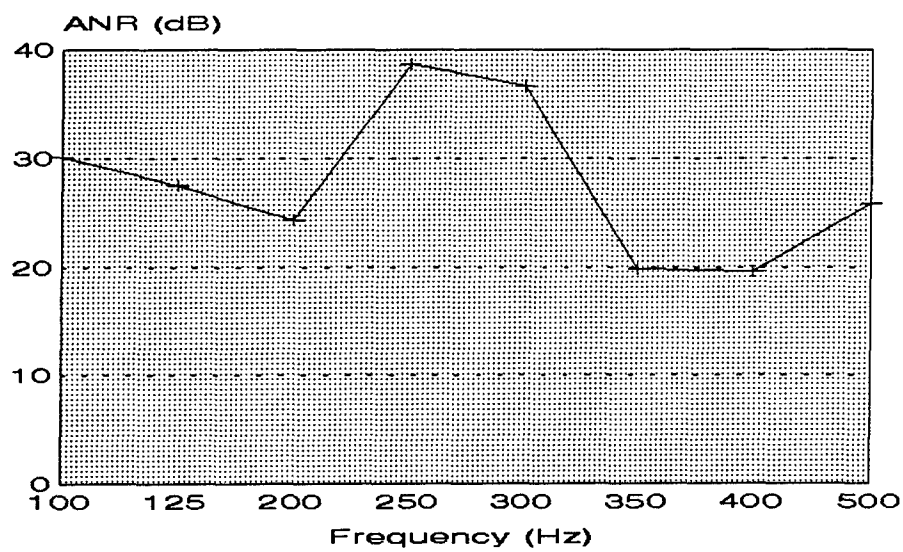


ACTIVE NOISE REDUCTION in dB
B&K MICROPHONE at 15 ft.

FREQ-	100Hz	125Hz	200Hz	250Hz	300Hz	350Hz	400Hz	500Hz
TRIAL								
1	29.0	25.6	22.8	36.2	36.5	20.7	18.0	26.0
2	29.9	26.0	23.9	37.3	35.9	19.5	22.3	25.4
3	31.2	33.2	23.8	36.4	35.1	19.9	20.6	25.1
4	30.8	31.0	23.4	35.8	34.4	20.9	20.6	24.9
5	29.7	27.7	24.4	36.7	40.4	21.7	19.9	24.2
6	29.1	26.3	24.8	36.8	35.1	19.1	17.3	25.5
7	30.1	26.9	24.7	38.7	36.9	19.4	18.6	26.5
8	28.6	27.3	25.2	43.9	38.0	20.2	19.1	27.5
9	31.0	25.9	25.2	42.4	35.5	17.3	19.8	27.2
10	30.0	25.5	24.9	42.6	38.1	20.2	20.0	26.1
AVG	30.14	27.54	24.31	38.68	36.59	19.89	19.62	25.84
SD+/-	1.0	2.6	0.8	3.1	1.8	1.2	1.4	1.0
AVG PHASE	198.5	159.0	233.6	117.4	352.1	224.9	112.8	169.9

Active Noise Reduction

15 feet

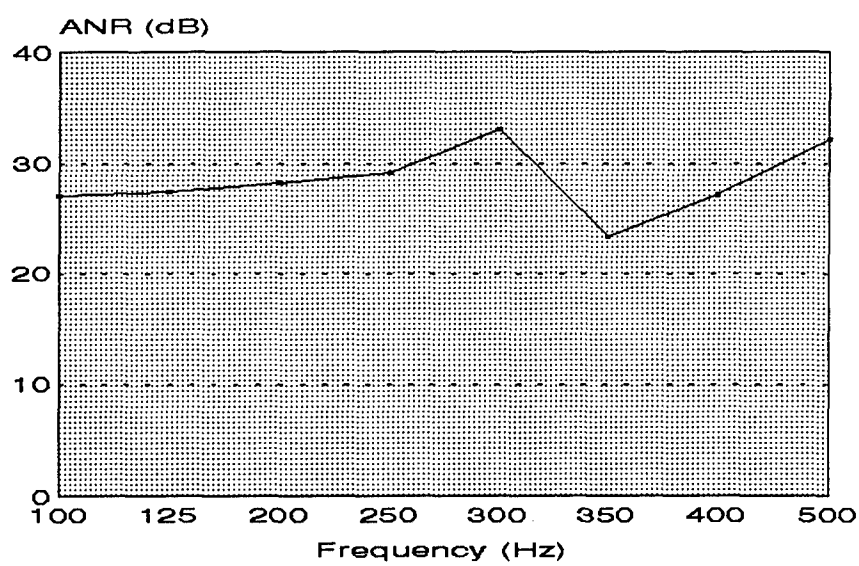


ACTIVE NOISE REDUCTION in dB
B&K MICROPHONE at END OF PIPE

FREQ-	100Hz	125Hz	200Hz	250Hz	300Hz	350Hz	400Hz	500Hz
TRIAL								
1	24.0	28.6	27.2	31.1	29.4	22.5	26.4	40.6
2	24.3	29.0	27.2	33.1	33.7	21.7	29.1	28.6
3	26.5	26.4	30.7	29.2	28.9	22.9	27.6	32.8
4	28.9	29.2	30.0	27.9	27.9	23.1	27.6	27.5
5	29.7	27.8	28.5	29.7	30.4	24.8	25.5	32.3
6	29.3	26.9	29.2	27.3	31.4	26.2	24.5	32.4
7	29.0	23.9	29.8	27.1	28.9	23.9	23.5	33.1
8	25.7	28.0	27.8	28.2	40.3	24.0	30.8	30.4
9	27.2	28.1	27.0	27.3	45.1	21.8	30.6	32.4
10	26.4	26.4	25.3	30.5	35.3	22.2	25.7	32.1
AVG	27.10	27.43	28.27	29.14	33.13	23.31	27.13	32.22
SD+/-	2.1	1.6	1.7	2.0	5.6	1.4	2.5	3.5
AVG PHASE	196.4	171.5	233.2	115.7	354.0	216.0	133.5	175.5

Active Noise Reduction

End of Pipe

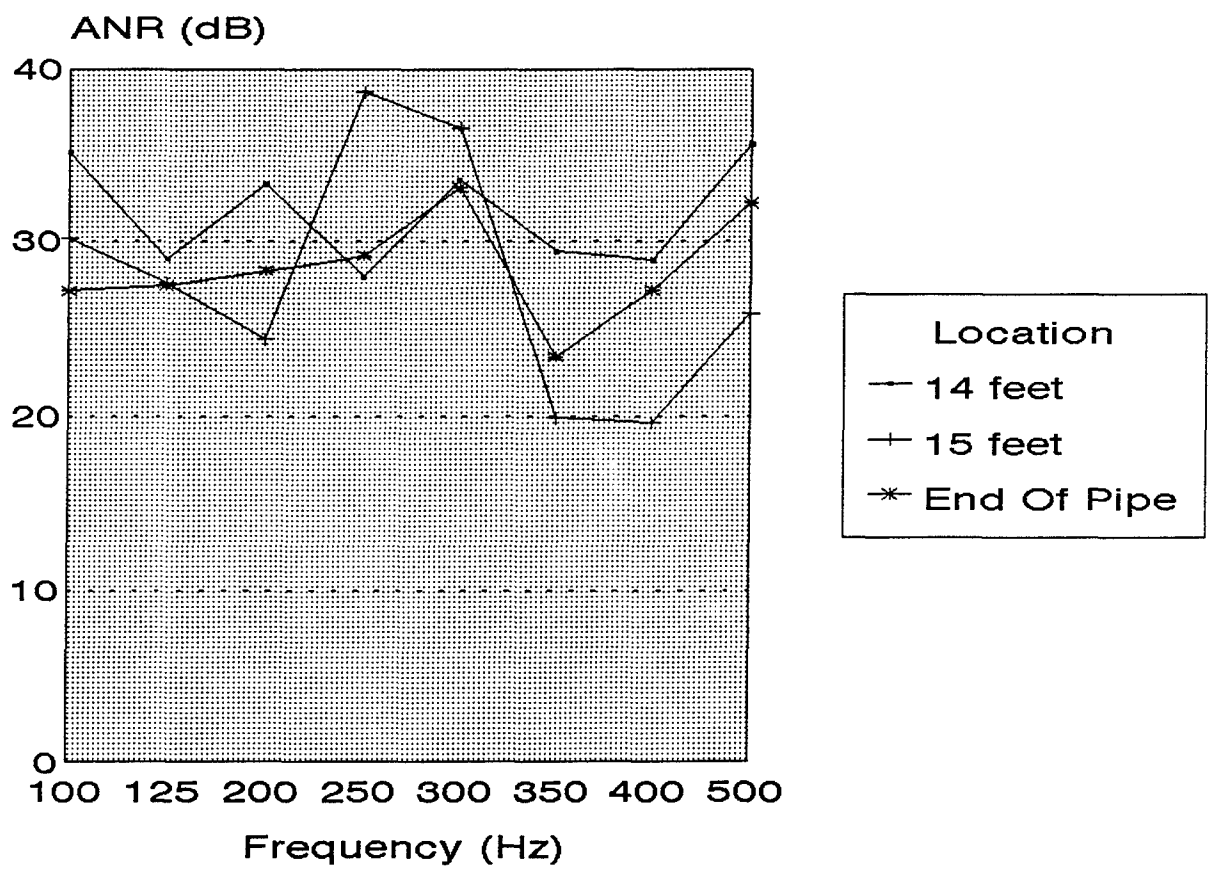


PHASE DIFFERENCE in DEGREES

	100Hz	125Hz	200Hz	250Hz	300Hz	350Hz	400Hz	500Hz
14 ft	198.0	159.1	238.9	117.6	355.2	226.2	131.6	172
15 ft	198.5	159.0	233.6	117.4	352.1	224.9	112.8	169.9
End	196.4	171.5	233.2	115.7	354.0	216.0	133.5	175.5
AVG	197.6	163.2	235.2	116.9	353.8	222.4	126.0	172.5

Active Noise Reduction

Global Cancellation



Discussion of Results

The results from this experiment show that at fourteen feet, the amount of reduction is fairly constant around 30 dB which is a relatively high level of reduction since noise is measured on a logorithmic scale. At 15 feet, the amount of reduction is also relatively high, but it is not as constant across all frequencies as the results at 14 feet show. At the end of the pipe, a large decrease in noise also appears. The amount of reduction in dB was more constant at the end of the pipe then at any other location as the graph shows. This shows that the cancellation did not only occur in one place, but across an area of almost 5 feet which is equal to almost half a wavelength for most of the lower frequencies. This would be enough room for the crewman to stand in while working under an airplane.

On all three graphs, a drop in reduction occurs between 300 and 350 Hz. Also between 400 and 500 Hz a consistent increase appears in all of the graphs. These are the only places that all three locations have in common.

The phase differences stayed about the same throughout each trial at each location and also across all of the locations. They do not appear to have any definite pattern.

Some possible sources of error could have occurred in the equipment, especially the microphone. Microphones have to be carefully calibrated and often times the balance inside of them can change with the relative humidity and room temperature causing them to become uncalibrated. Another source of error could be in the human determination of the phase synchronization.

To do so, the waves are judged for synchronization based on the oscilloscope display. The oscilloscope could have been slightly out of calibration.

Conclusion

ANR was achieved in a duct with the specified conditions and equipment. This experiment showed that both local and global cancellation can be reached over a five foot region. A large amount of reduction, approximately 30 dB, can be reached at all of the locations. In general and based on the data from this experiment, frequencies below 500Hz can be easily cancelled. From the data, many things besides the manual calibrations affect the level of ANR, such as wavelength and amplitude. The benefits for the workers around the airplanes would be at least an area of five feet of great reduction in which to work. This is just based on the three location trials from this experiment. This area could be a great deal larger.

For futher study, the defined area of the pipe could be enlarged to include an entire room. Another recommendation would be to examine different frequencies, amplitudes or volumes. The use of subjects could also be incorporated. Noise could be produced in a room and then include the anti-noise to see if the subject can tell a difference. They could also be asked to complete a task with a loud machine running and then one that has ANR and collect the subjects reactions.

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FIRE PROTECTION

Eugenia D. Baker

Summer Apprentice

Department of Defense

Final Report for:

AFOSR Summer Research Program

DF Directorate

Sponsored By:

Air Force Office of Scientific Research

Tyndall Air Force Base, Florida

August 1993

FIRE PROTECTION

Eugenia D. Baker
Summer Apprentice
Department of Defense
Tyndall Air Force Base, Florida

Abstract

During the course of eight weeks this summer, I was placed in the DF Directorate, referred to as Fire Protection. Here I was able to become more knowledgable about fire in general by assisting around the office with regular day to day work. I helped along with projects, including fire certification, and the development of tests to allow these firefighters certification. I also helped with manning DF Directorate phones, typing documents, sending faxes, and making copies. I believe that this was an exceptionally good and enlightening experience for me in that I became able to assume an overall better generalized assessment of the'working field.'

FIRE PROTECTION

Eugenia D. Baker

When I first got in touch with my mentor, Ms. Mary Reynolds, I was informed that I would be working for the DF Directorate. DF is the fire protection backbone of the Air Force civil engineer and all MAJCOM protection managers. Through this partnership DF has earned the respect of their customers, providing worldwide standards, performance criteria, and uncompromising service for global aerospace missions.

DF:

- Monitors the proficiency and well-being of more than 13,000 Air Force firefighters at 163 fire apartments worldwide
- Is the primary recommending agency for the procurement of all fire vehicles
- Manages the fire vehicle fleet which consists of 2,333 vehicles valued in excess of $360 million
- Oversees fire protection services for some 9,500 fixed wing aircraft with an uncomprehensible value
- Oversees fire protection services for facilities valued in excess of $279 billion
- Manages the annual fire protection operating budget of $250 million

DF Contributers are:

- Driven by aerospace mission and customer needs
- Fowardly focused, proactive and world class
- Relevant to the field, cost conscience and focused

The DF Team is:

- enhanced with a visible program review committee
- jointly focused and visionary
- empowered and fully motivated.

The first day I arrived to the directorate I was to be working at for the following eight weeks, I was given a tour of the building by my lab focal point, Mrs. Evelyn Berkley. I was shown all of the available facilities, and introduced to my fellow employees, if that's what I'm to call them. They all seemed very friendly and bussinesslike, yet relaxed enough for me to know that I would indefinately learn something from each one of them, which I was very willingly able to do.

After my tour, we proceeded down to computers, where I was given a loggon code allowing me to enter the WANG system our department is most familiar with. Through the WANG system I learned how to handle mail management, including any mail I myself recieved, entirely through the computer. I was also able to send a memo to anyone worldwide, who was listed on the WANG system. I could relay phone messages throught his same process. Distribution lists were provided to local correspondents, whereas I could create my own list and send information to a larger quantity of people. Bulletin services were also provided to update anyone on briefings, meetings, training workshops, and social gatherings, including greeting or farewell parties, etc. I could also keep track of my own own schedule through time management allowing me to make a daily, weekly, monthly, or yearly calendar. It was also possible to schedule meetings, make reminders, or invitations.

In our heading, AFCESA Applications standing for Air Force Civil Engineering Support Agency, I learned how to get a telephone control number to make a government official call or a commercial fax. Although this was just a learning experience, it proved in becoming very useful in my regular day to day work. During which I made many faxes and official calls. Another item I became very familiar with was Word Processing Plus in which, I typed edited and printed a number of documents. I also created many office labels. Another simple thing I learned to do, was installing Microsoft Word, Microsoft Excel, and Microsoft Powerpoint into the program manager, which I did for our new Lt. Col.

The smaller or less meaningful or maybe more meaningful jobs depending on how you viewed the situation, that I accomplished include manning of all the DF Directorate phones and keeping a log of all the calls. Also when most of the officers needed to be ot leave in their offices, or sit down to concentrate in an attempt to take care of excess business matters, many of them would then transfer their calls to my office, so I was able to receive their messages and maybe be of some help to the caller. I would also have to be alert and listen for the calls of the officers who happened to be on leave or TDY for that particular day.

While I wasn't answering phones there was always something else I was actively doing. For instance, I helped in doing much of the file organization in our directorate, and the one thing that consumed most of my working hours for the first couple of weeks, were the directorates' the smaller or less meaningful or maybe more meaningful jobs depending on how you view the situation that I accomplished include, manning of all the DF Directorate phones and keeping a log of all the AFR's (Air Force Regulations.) I posted all of these publications which had yet to be done, only because they had been put off so many times in the past with other things which at the time must have seemed to be of a greater necessity. Posting these "pubs" meant making all of these changes necessary sent in Air Force supplements. Which for the first week or so meant days of monotonous, but useful work.

In comparison to the things listed on the pervious pages along with the things listed above, I also reached the completion of many projects I worked on throughout the eight week period, through a learning process and set goals. One of the first of these I was able to accomplish after learning how to operate Microsoft Excel on the computer. After doing this I became a big asset to CMSgt Bob Reyff. I made a number of spreadsheets, which included charts of Fire Fighter information throughout the operational bases. This was mainly very important to him in that

most of his charts had somehow been lost from memory on some of his disks. When he wasn't able to recover any of the data, I then came into the picture and therefore was able to redo most of them for the Chief.

Another one of these projects came into existence after I was taught the basics of Microsoft Power point , by SMSgt John Staub who seemed to be the specialist in that area of work, along with SMSgt Pete Wilson who is head over the Graphics Department. In taking advantage of my newly acquired knowledge, I was able and excited to make and help in designing slides for a presentation in Dallas, Texas in September for one of the civilians in the directorate, a Mr. Hugh Pike. While still in Microsoft Power point after all of my slide data had been input into the computer, I got a chance to go back and watch in an orderly sequence what would be called by the program, a "practice rehearsal" of the slide show in preparation for Mr. Pikes presentation. This was a key in altering or deciding an allotted time frame in which the presentation was to take place. These slides would be used in presenting the New DoD Fire Fighter Certification Program, which is the basis of what my next projects revolved around.

During the course of my eight weeks stay, we had the company of four sergeants form Mansfield, Ohio Air Guard Base, each staying for a two week period. During the time they were there I was able to assist them in the developing, editing, and thorough review for duplicate test questions, answers, etc. of a test they were working on in cooperation for the New DoD Fire Fighter Certification Program. The first of them wrote test questions, while the latter subjected most of their time towards digging up references. It became much of a dependence upon team effort , and I was glad to have been a part of it.

The latter part of my stay was subjected to a very meaningful project which was in need of immediate attention. It was the Fire Fighter certificate data entry for operational bases worldwide. In working at this continuously I was able to

complete well over 400 certificates. I worked off of a program designed entirely by SMSgt John Staub. The personnel records included such levels of certification as; Fire Officer I & II, Fire Fighter I & II, Driver Operator/ ARF, and Driver Operator/ Pumper, as well as Airport Fire Fighter. It was a very knowledgeable and rewarding experience. Especially rewarding after realizing the sum of my completion.

In consideration of all of my projects mentioned thus far, I would say my most important task was in working with CMSgt Jim Podolske. I was able to help accommodate Chief Podolske with the preparation of the FFCS, Fire Fighter Certification Implementation Guide. This guide outlines the Fire Fighter Certification Program entirely. The Certification Implementation Guide was to be shipped to every operational base containing the program My part in making this possible was helping in the editing and preparation of the guide. The preparation included making mailing labels for the proper bases, and making the correct number of copies necessary and then in turn, putting them together properly in booklets. All in all, I put together over 500 Implementation Guides. Needless to say, I felt very appreciated. Therefore, I have included in the following five pages a run-off copy of the first five pages including the cover page of the FFCS Implementation Guide to give you, Research and Development Laboratories a better understanding of what I worked with this summer. I do thank you all at the laboratory for an incalculably great summer, and I would much enjoy working for you again next summer, 1994.

Headquarters Air Force Civil Engineering Support Agency

Fire Protection Directorate
Tyndall Air Force Base

Implementation Guide

5 Apr 93

CHAPTER I

1.0 INTRODUCTION

1.1 SCOPE. This operational guide outlines the Fire Fighter Certification Program. It is not the intent of this document to conflict with, be used in lieu of, or supersede other Air Force training directives. Report any conflicts to HQ AFCESA/DF, 139 Barnes Drive, Suite 1, Tyndall AFB, Florida 32403-5319.

1.2 PURPOSE. The purpose of this program is to enhance the training process, improve performance, and strengthen the professionalism of all Air Force fire fighters. The program measures the competence of fire fighters and also provides a quality control element for the training process. These measurement and quality control elements will be accomplished through the administration of standardized written and performance evaluations. This comprehensive program uses the National Fire Protection Association's (NFPA) national consensus professional qualification standards. It has the rigors and standards necessary to meet today's downsized operational requirements. With the restructure of the fire protection flight, we no longer have the latitude to devote large numbers of manhours to proficiency training. Fire fighters must be trained and able to perform both individually and as a member of a fire fighting team. This program is part of the Department of Defense (DoD) fire fighter certification program and is the only program that will be used by the US Air Force.

1.3 PROFESSIONAL QUALIFICATION. This program meets the NFPA's Professional Qualification Standards. The NFPA requirements as outlined in the 1000 series standards were reviewed and enhanced, as necessary, to meet specific operational requirements. The Air Force will develop standards when NFPA standards do not exist for specific positions.

1.4 ELIGIBILITY. Military and civilian fire fighters, including civilian contractors, who have successfully passed the written and performance evaluations are eligible for certification. Eligibility for an individual to be administered the written and performance evaluations is based on completion of a study program. This study program can be formal classroom instruction, formal schools, a self-study program, or a combination of these. The program will not be used to render invalid any rank, qualification, certification, or appointment acquired prior to the implementation of this program.

1.5 AUTHORITY. DoD Instruction 6055.6, contains the requirement and authority for implementing the fire fighter certification program. This guide was approved for use by HQ USAF/DPPE, office of primary responsibility for the Air Force OJT program.

1.6 ADMINISTRATION. The certification program will be administered and operated by HQ AFCESA/DF, 139 Barnes Drive, Suite 1, Tyndall AFB, Florida 32403-5319 (hereafter referred to as the Administration Center). Additionally, the fire fighter certification program will be included in the CerTest program presently being used by the Civil Engineering community.

CHAPTER II

2.0 PROGRAM DESCRIPTION

2.1 OBJECTIVES. The Fire Fighter Certification System objectives are as follows:

2.1.1 Satisfy formal and upgrade training requirements through a nationally accredited training and certification program.

2.1.2 Provide quality fire protection services for Air Force assets.

2.1.3 Improve the quality of training afforded to all Air Force Fire Fighters.

2.1.4 Standardize the quality and efficiency of training programs.

2.1.5 Provide national professional recognition for Air Force fire protection personnel.

2.1.6 In accordance with the Fire Protection Career Field Education and Training Plan, provide a comprehensive and fair career progression program for both military and civilian fire fighters.

2.1.7 Encourage and enhance the professional development of Fire Fighters.

2.2 STANDARDS. The NFPA 1000 series standards are used as the framework for the development of this program. The standards are developed at the level of performance required for a fire fighter to function effectively at the different levels. These standards were developed by individuals throughout the fire protection training and education community who have broad backgrounds in fire protection, education, and training. These standards represent the best there is to offer in fire protection training. The standards broadly encompass the worldwide needs of the Air Force. Major commands and base level fire chiefs may establish separate training and evaluation programs for requirements that are unique to their specific operation. Additional requirements of this nature are not considered an official part of the certification program.

2.3 EVALUATIONS. Knowledge objectives are examined through objectively scored evaluations. Manipulative skills objectives are examined through a process of practical evaluations. Knowledge examinations are graded with a predetermined grade level (65 percentile) denoting the passing score. Practical examinations are graded on a pass/fail basis.

2.3.1 Career development course (CDC) examinations are administered in accordance with AFI 36-2202, Managing and Conducting Military Training Programs.

2.3.2 Performance evaluations have been developed for each of the certification levels, with objectives that are best evaluated by the demonstration of a skill. Each objective is evaluated through the accomplishment of tasks that are further detailed into elements or steps required for successful task accomplishment. The performance evaluations are administered at base level and follow specific guidelines, checklists, procedures, and policies. As with the written evaluations, the performance evaluations are based on the NFPA 1000 series standards, enhanced as necessary, to meet DoD operational requirements. The performance tests for the 57130 and 57150A thru E CDC courses are identified as critical, major, and general. The critical "C" rating is assigned to items which, if omitted or performed incorrectly, would result in severe injury or death of an individual. Should a fire fighter fail to perform any one item rated critical, the fire fighter would be unsuccessful in attaining the required proficiency level for that standard. The major "M" rating is assigned to items which are very important to the general safety of personnel and successful completion of the evolution. Should a fire fighter fail to perform any three items rated "major", the fire fighter would be unsuccessful in attaining the required proficiency level for that standard. The "general" rating (which has no symbol) has been assigned to all remaining items that in combination are relevant to the successful completion of the evolution. Should a fire fighter fail to perform any four items rated as "general," the fire fighter would be unsuccessful in attaining the required proficiency level for that standard. Should a fire fighter fail to perform any combination of "major" or "general" rated items for a sum total of four, the fire fighter would be unsuccessful in attaining the required proficiency level for that standard.

2.4 PREREQUISITES. There are several prerequisites that must be met before an individual desiring certification can be administered the written and performance evaluations. To be eligible to take the written examination, personnel must enroll in the CDC for that specific certification level. Additional prerequisites are included in the program operation section (Chapter IV), of this document.

BIODEGRADATION OF SOLID ROCKET PROPELLENTS (NH_4ClO_4)

James E. Davis Jr.
Laboratory Investigator
Final Report for High School Aprenticeship Program
Armstrong Labs, Environics Directorate

August 1993

BIODEGRADATION OF SOLID ROCKET PROPELLENTS (NH_4ClO_4)

James E. Davis Jr.
Laboratory Investigator
Environics Directorate
Armstrong Labs

Abstract

Since the U.S Governments focus has shifted from the Arms Race to advocating a new world order, there have been many concerns regarding the environmental consequences arising from years of weapons development. Several components of various weapon systems must now be disposed of, many of which are potentiallly hazardous to humans. These components enter the environment as contaminates in ground water, the atmosphere, or in the soil itself. One such chemical is ammonium perchlorate (NH_4ClO_4); the main component of the solid rocket fuel used in most class 1.3 missles. A microorganism capible of reducing ammonium perchlorate as a food source in combination with brewer's yeast has been isolated. Unfortunatly, brewer's yeast has a high solids content though it provides favorable conditions for the bacteria. Previously, the brewer's yeast nutrient contained large amounts of solids and had to be agitated. This study determined that most of the solids are not necessary for perchlorate reduction to occur in a continuous culture. Two experiments were conducted. One using a well mixed suspension of Brewer's yeast solids at 30g/L and another using only the supernate after 24 hours of acid extraction. Perchlorate degradation rates were calculated for both experiments. The pH, temperature, and agitation were controlled at ~7.1, 40°C, and 200rpm, respectively.

Biodegradation of Solid Rocket Propellants (NH_4ClO_4)

James E. Davis Jr.

The biodegradation process, which is composed of an anaerobic and aerobic reactors, is especially important due to recent cutbacks in our military and due to the large number of missles which must be decommissioned. Previously the fuel was simply burned away, in a process called open burn/open detonation. This method is no longer acceptable because of the large amount of Hydrogen Chloride gas and NO_x released during the burning. The biological process will safely degrade Ammonium Perchlorate in solution by bacterial action.

A continuous flow system has been developed to use anaerobic bacteria to reduce Ammonium Perchlorate. Ammonium Perchlorate is suspected of being toxic to humans. If ingested it targets the thyroid and disrupts the chemical balance of the body. If crystals of ammonium perchlorate are heated or placed in the presence of certain metals or other reduced compounds it will ignite and the resulting blaze will be very difficult to extinguish since the compound has its own oxygen source and therefore cannot be deprived of oxygen. The bacteria use brewer's yeast as a nutrient source in conjunction with the ammonium perchlorate. In prior experiments this nutrient solution was heavily laden with solids and had to be well stirred at all times to keep the solids suspended. An eight week study

was conducted to determine if current bioreactors are able to function as efficiently using brewer's yeast supernate in the feed.

A continuous run is used to collect data concerning flow rates, efficiency, and costs of operations. Also it simulates how the reactor will behave in an industrial environment and serves to illustrate problems that ma arise from continuous operation of the unit. In this study, the continuous run began as a batch run. The media was added to the reactor and inoculum was added. After ~24-48 hours, when the perchlorate concentration reached the 25ppm mark, the feed pumps are engaged. At low flow rates the perchlorate concentration in the reactor remained under 25ppm even though more ClO_4^- was being continuously added from the inffluent pump. As the flow rate is increased the reactor reached a point at which the bacteria could not degrade all the perchlorate and the perchlorate concentration in the reactor increased. At this point flows are approaching the critical dilution rate. If the critical dilution rate is achieved the bacteria will wash out of the reactor and all degradation will cease.

To understand dilution rates you must first understand retention time. Retention time is the measure of how long it takes to displace the total volume of media in the reactor. The equation for retention time is shown under equation 2.

$$(\text{Volume/Flow rate}) \ / \ (60\text{min/hr})$$

The dilution rate is the inverse of the retention time.

In previous studies, the feed for the reactors contained Ammonium Perchlorate, which is soluble in water, and brewer's yeast. Only some components of brewer's yeast are soluble. The study served the purpose of determining whether the component of the yeast that the anaerobic bacteria require to carry out ClO_4^- reduction is soluble or associated with the suspended solids.

A solid free feed tank would be beneficial in several ways. First it would lower operating costs since agitation requirements will be reduced. In addition, using solid free media reduces the chance of an infflent line or connection plugging up because of accumulated solids. An aerobic reactor, used to reduce the oxygen demand from the anaerobic reactor, may be made smaller due to the reduced load. The left over solid yeast, which is not sent to the anaerobic reactor, may be recycled as fertilizer or animal feed.

Procedure

The procedure for the study is as follows. A VerTis Bioreactor having a 1.5 liter capacity with agitation and temperature controllers was used. In addition an external pH controller regulated the flow of caustic to maintain the pH at approximately 7.1. The operating conditions for the anaerobic reactor are found on table 1.

Table 1

pH: 7.1

Temperature: 40^0C

Agitation: 200rpm

The reactor was fed by a single tank within which all of the ingredients were mixed. The composition of the feed is represented in table 2.

Table 2

30g/L Coors Brewers Yeast
1.0g/L K_2HPO_4 (buffer)
1.5g/L Na_3PO_4 (buffer)
3.55g/L NH_4ClO_4
1.0ml/L Rezasurin Dye
20.0ml/L 5N HCl

This media yields a feed perchlorate concentration of approximately 3000 parts per million(ppm). In larger scale reactors, the components of the feed would be contained in separate tanks and distributed with separate pumps. In this study, all components are combined in one feed tank.

For the baseline study the media was constantly stirred in order that the solids in the media were uniformly distributed and stayed suspended. However, for the extract study the media was allowed to settle for 24 hours, the supernate was then pumped away and the remaining solids were discarded.

An ion sensitive electrode was used for perchlorate analysis. The electrode has a lower measuring limit of 10ppm. The perchlorate concentrations are measured every day in both the reactor and the feed tank. samples are taken from both and diluted based on the suspected concentration. The feed tank sample is diluted 1/50 because it contains a relatively high

concentration of perchlorate. For this study the feed was ~3000ppm. The reactor sample is diluted 1/10 because if it is working properly the perchlorate should be very low. The probe is submerged in the sample and an initial millivolt is obtained then 5ml of a known standard is added and a millivolt change is observed. Perchlorate concentration is calculated using this change.

A continuous run was employed in this experiment. The first objective was to establish a baseline with the brewer's yeast solids present in the reactor. The reactor was batched with feed containing brewer's yeast solids until the perchlorate concentration decreased below ~30ppm then the feed pump was started. The pump was initially set at 1.0 ml/min. The reactor level was maintained at 1250ml. Every five washouts or 6250ml displaced the flow was increased by .5 ml/min. After the perchlorate concentration increased beyond 1000ppm the reactor was terminated. The second experiment was identical to the first except media containing only the supernate from the acid extracted brewer's yeast was used. A solution of 30g/L brewer's yeast was allowed to settle for at least 16 hours before the supernate was transferred to the media tank and the solids discarded. The procedure of increasing flow rates every five washouts until it broke through was repeated.

To establish the baseline, data was recorded at different flow rates. In the begining of the experiment the flow rate is very low; for the VerTis reactor it was about 1ml/min. The flow

rate is increased by .5ml/min every 5 washouts which is the time it takes to displace five times the reactor's volume. The flow is only changed however if the reactor is in steady state, which means the perchlorate concentration has stabilized at a point and is not increasing or decreasing. The extract study was then run at the same flow rates as the baseline and the data was compared.

By using the volume of media in the reactor, the flow rate and the perchlorate concentrations from the reactor and the feed tank the volumetric degradation rate can be calculated. the equation for calculating the volumetric degradation rate is found under equation 1.

Equation 1

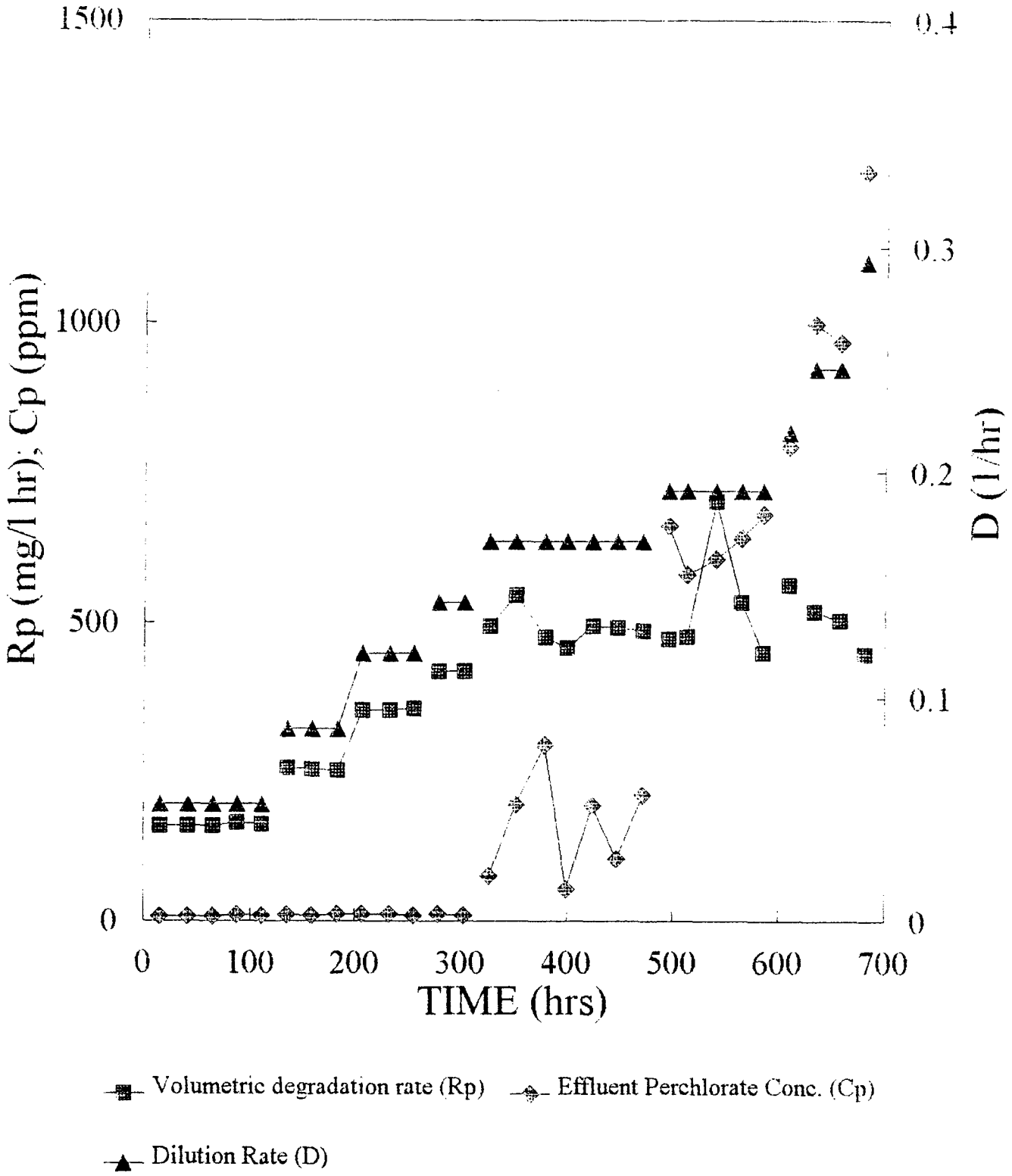
$$R_p = Q/V \times (C_{feed} - C_{reactor}) \times 60\text{min/hr}$$

R_p= Volumetric Degradation Rate (mg/L hr)
Q = Flow Rate (ml/min)
V = Reactor Liquid Volume (ml)
C_{feed}= ClO_4^- in feed tank
$C_{reactor}$= ClO_4^- in reactor

Results

On page 20-9 there is a graph illustrating my baseline run. It shows the Dilution rate, Degradation rate, and the reactor or effluent concentration vs. time. Until reaching a dilution rate of .175/hr the perchlorate concentration stayed very close to

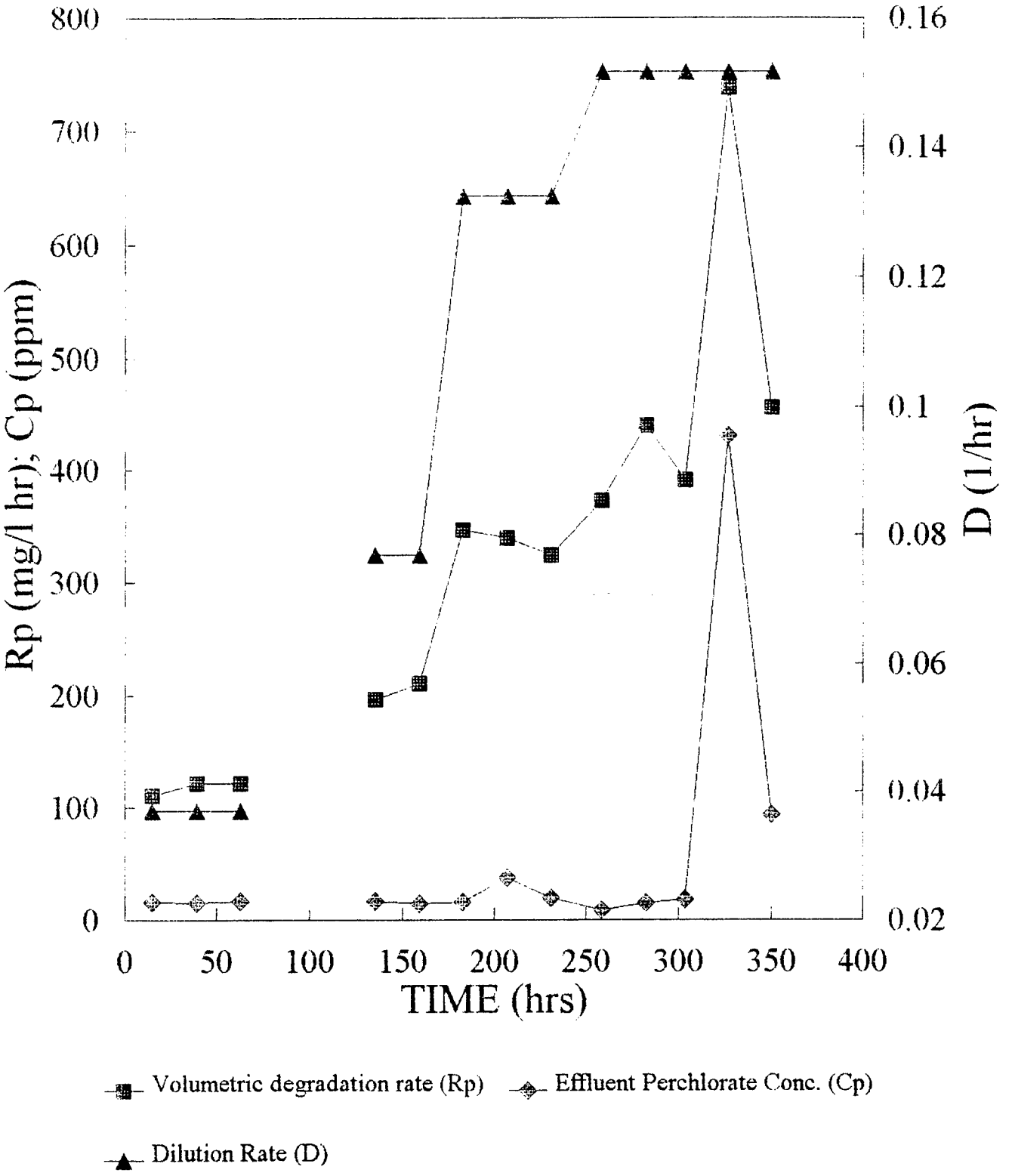
BASE-LINE CONTINUOUS RUN



zero, however, upon reaching .175/hr the concentration increased to ~200ppm. The reactor was not being washed out, but the dilution rate was getting close to its critical value. When the dilution rate was increased to .190/hr another spike occurred but it stabilized at ~650ppm and the reactor did not wash out. Even at .290/hr the concentration jumped to another plateau. It was here that the experiment was terminated with a final concentration of ~1250ppm. Interestingly, the degradation rate continues to increase in the reactor despite the fact that perchlorate concentration is increasing in the reactor. This is because the bacteria are processing perchlorate at higher rates.

On page 20-11 are the results of the run using the brewer's yeast supernate or extract. The extract performed as well as the baseline throughout the run. The perchlorate concentration remained low at .15/hr which was identical to the baseline study. The spike at T=325 hours was the result of placing twice the normal perchlorate into the feed tank. The media was replaced and the reactor concentration returned to values below 30ppm. It was unnecessary to go beyond .15/hr with the extract as this would be the dilution rate most likely used in the industrial scale of the reactor. On the last day of the run(5-Aug-93) we took the media one step further and ran it through a tangential microfiltration system with a membrane pore size of .45 microns to remove remaining solids which did not settle out. This final test added further confidence that the

EXTRACT CONTINUOUS RUN



component was truly water soluble and not an unsettled particle with a size greater than .45 microns. We chose this last day and dilution rate because the perchlorate concentration would increase if the filtered media was deficient in an essential nutrient. The filtered media is represented by the last two data points on the graph.

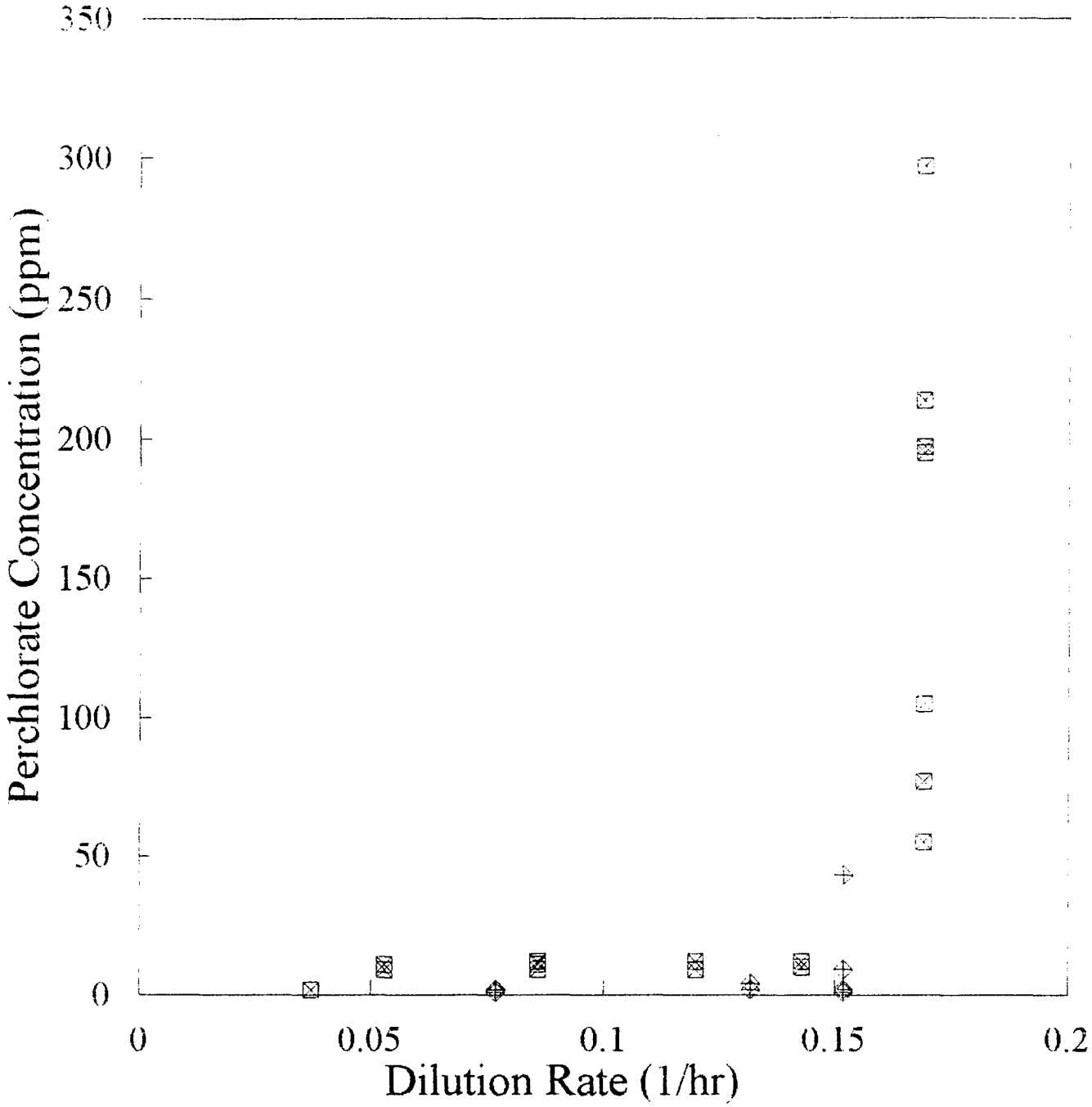
The graph on page 20-13 illustrates just how close the extract performed as compared to the baseline. Notice that the curves essentially overlap through dilution rates up to .15/hr. This demonstrates that the supernate from pre-settled media is an acceptable substitute.

Conclusions

The information gained by this experiment will greatly enhance the biological process by which ammonium perchlorate is degraded. The lab reactors will soon all be using extracted media instead of media with solids and all further studies will very likely be conducted with the settled media.

This summer has been very rewarding for me. I've learned not only about wastewater treatment and biodegradation, but also I've gained true lab experience and exposure to various testing methods and chemical procedures that I had never heard of previously. In closing I would like to thank everyone here at Armstrong Lab on Tyndall A.F.B. for their knowledge. Especially

Effluent Perchlorate vs. Dilution Rate



⊠ Using Brewer's yeast with solids

⊕ Using supernate from settled Brewer's yeast

my mentor John Shanahan, Advanced Sciences Inc, who has shown me how, not only these chemical processes work, but also a little about how life works to.

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ANALYSIS OF AQUEOUS FILM FORMING FOAM WITH THE 960 AUTOCHEMISTRY SYSTEM

Angela D. Foth

High School Apprenticeship Program

A. Crawford Mosley High School
3418 North Palo Alto Avenue
Lynn Haven FL 32444

Final report for:
Dr. Brewer
Summer Research Program
Tyndall AFB Environmental Laboratory

Sponsored by:
Headquarters, Air Force Civil Engineering Support Agency
Tyndall Air Force Base, Florida

August, 1993

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ANALYSIS OF AQUEOUS FILM FORMING FOAM WITH THE 960 AUTOCHEMISTRY SYSTEM

Angela D. Foth
High School Apprenticeship Program
A. Crawford Mosley High School

Abstract

A study of anionic and non-ionic surfactants was conducted on a variety of samples using the first derivative titration method. All samples were analyzed using the same sample technique, yet each method was developed to optimize the analysis for each sample. The study was conducted using the ORION 960 Autochemistry system and the ORION surfactant electrode. Prior to this study, methods had already been developed and verified by ORION to test for surfactants using the first derivative titration method with the ORION surfactant electrode. The purpose of the study was to see how much surfactant is left in waste water after it has extinguished fire so it can be safely released to waste water treatment plants.

1.0 Introduction

A study of anionic and non-ionic surfactants in the surfactant/extinguishing agent Aqueous Film Forming Foam (AFFF) was conducted to determine the amount of concentration, in parts per million (ppm), that remains in Tyndall Air Force Base's Fire Training Facility holding pond and oil/water separator after a fire is extinguished. Much of the technical information on the chemical composition of AFFF needed to conduct a thorough study was not available because the manufacturer of AFFF, 3M, would not allow proprietary information to be released. Since limited information was available, the study was conducted assuming potential numbers.

The method used to calculate AFFF concentration in a sample was the First Derivative titration method. The First Derivative method is a technique of adding small aliquots of a titrant to the sample, recording the potential changes, and applying a first derivative analysis to the data, from which the endpoint is calculated. The technique assumes that the change in millivolt reading per volume of titrant added will be greatest at the endpoint. This technique is a very precise and well-known technique for performing routine titrations.

2.0 Discussion of Problem

Some Fire Training Facilities do not have a holding pond, so after a fire the waste water and AFFF mixture which was used must go to a municipal waste water treatment plant. Many treatment plants do not allow more than 150 ppm of AFFF to go through the plant because concentrations higher than 150 ppm of AFFF disrupt

the waste water treatment process. Testing is being done to see how much surfactant is left in waste water after it has extinguished fire and has gone through an oil/water separator so it can be safely released to water treatment plants.

3.0 Apparatus

The ORION 960 Autochemistry System consists of the ORION 960 Module and an EA 940 pH/ISE Meter, which is placed on top of the module base. The module consists of a microprocessor, which controls the system, an autodispenser, and an electrode tower. The EA 940 provides the display and keyboard for entry of information. The EA 940 pH/ISE Meter is the heart of the ORION 960 Autochemistry System, see Figure 1.

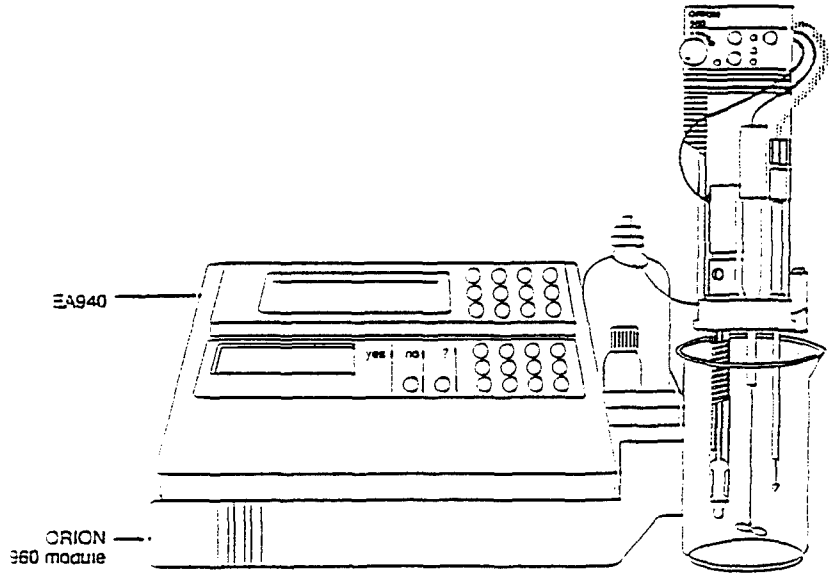


Figure 1.
Proper Placement of EA 940 Onto ORION 960 Base.

4.0 Standards

Before the actual testing of the anionic and non-ionic surfactants in AFFF, two different standards were run several times to establish baseline numbers to compare against. The first standard was Linear Alkylate Sulfonate (LAS) used to establish a baseline for anionic samples. Triton X-100 was used to develop the baseline for the non-ionic samples.

5.0 Methodology

There are two steps that must be taken before a sample is actually run. First, obtain or make up the samples that are to be analyzed. Second, write a method to run and calculate the samples. These steps are outlined in paragraphs 5.1 - Sample Preparation, and 5.2 - Writing the Method.

5.1 Sample Preparation

The sample preparation is dependent on the surfactants of the ion that is being tested. The two surfactants that were being tested were anionic and non-ionic. Additionally, there were two basic sample preparations for each of the two surfactants 1) deionized water and, 2) water from the holding pond or oil-water separator. This brought the total to four different sample preparations. The sample preparation procedures for each are outlined on the following pages.

ANIONIC

a. Anionic using deionized water.

To prepare this sample, the following steps are performed:

1) Take 50 milliliters of deionized water,
2) add a known amount of AFFF (between 50 and 500 ppm),
3) add 3 milliliters of 0.01 M of HCl (to bring the pH level down to 4)
4) add 1 milliliter of NaCl, and finally,
5) add 1 milliliter of diluted Triton X (to keep the electrode clean)

b. Anionic using water from the holding pond or the oil/water separator.

To prepare this sample, the following steps are performed:

1) Take 50 milliliters from the pond or oil/water separator,
2) add 6 milliliters of 0.1 M of HCl,
3) add 1 milliliter of NaCl, then
4) add 1 milliliter of diluted Triton X

Titrate anionic samples with Hyamine 1622 solution.

NON-IONIC

c. Non-ionic using deionized water.

To prepare a non-ionic sample using deionized water, the following steps are performed:

1) Take 100 milliliters of deionized water,
2) add a known amount of AFFF in ppm wanted
3) add 3 milliliters of 0.01 M of HCl,
4) add 2 milliliters of NaCl, finally,
5) add 5 milliliters of non-ionic reagent

d. Non-ionic using water from the holding pond or the oil/water separator.

1) Take 100 milliliters from the pond or oil/water separator,
2) add 6 milliliters of 0.1 M of HCl,
3) add 1 milliliter of NaCl, then
4) add 5 milliliter of non-ionic reagent

Titrate non-ionic samples with the non-ionic titrant.

5.2 Writing the Method

Writing a method using the ORION 960 is the process of choosing the parameters which will define the measurement procedure. Using the ORION 960 program to make these choices is called "writing a method". The questions which are asked, and the answers, depends upon the technique that is selected. For many questions, the answer "yes" may be pressed to agree with the current setting. To check what the current setting is, press and hold the "?" key. If you don't agree with the current setting, simply put in the correct setting, then press "yes".

6.0 Results

Anionic and non-ionic surfactants in the extinguishing agent AFFF were studied. The samples studied were obtained from Tyndall Air Force Base's Fire Training Facility's holding pond and oil/water separator. A small amount of anionic surfactants were found in both the holding pond and oil/water separator, but not enough to disrupt the water treatment process. Non-ionic surfactants were not found.

7.0 Conclusion

From this study it is concluded that there is less than 150 ppm of AFFF in both the holding pond and oil/water separator. Anionic surfactants were found, but non-ionic surfactants were not. This may be due to the fact that the non-ionic surfactants are more bio-degradable than the anionic surfactants so the micro-organisms in the holding pond would have eaten the non-ionic surfactants first.

8.0 Recommendations

Since only a few samples were analyzed, it is recommended that this study be continued under other conditions to generate enough additional data to solidify exactly what percentage of surfactants dissipate. Samples from the holding pond and oil/water seperator should be tested at various stages of time to determine if any biodegradation is occurring, and if so, at what rate.

Appendix A-1: Pond Sample Anionic Concentration

OVERVIEW: AFFF anionic surfactant concentration was determined using the First Derivative titration method with an ORION surfactant electrode, and Hyamine 1622 solution as the titrant. The ORION Autochemistry System determines the endpoint and calculates the concentration of the anionic surfactant in AFFF in the sample.

ELECTRODE SET-UP: To set up the electrodes attach the ORION surfactant electrode and the double-junction reference electrode to either input 1 or 2 as described in the ORION 960 Autochemistry instruction manual. Define the electrode as X-.

TITRANT PREPARATION: Dilute 0.05 M Hyamine 1622 to approximately 0.01 M or .005 M depending on the concentration of the sample, then standardize the titrant using the standardization method (which is technique 11 on the ORION 960 Autochemistry System) with sodium lauryl sulfate (SLS).

SAMPLE PREPARATION:

To prepare this sample, the following steps are performed:

1) Take 50 milliliters from the pond
2) add 6 milliliters of 0.1 M of HCl,
3) add 1 milliliter of NaCl, then
4) add 1 milliliter of diluted Triton X

IMPORTANT NOTES: Rinse the electrodes, stirrer and dispenser probe thoroughly between measurements with acidic deionized water.

METHOD SUMMARY (unsaved method)

TEST: POND SAMPLE #5 ANIONIC
SITE:
ANALYST:
12:21 08-02-93 ELECTRODE: 1:X-
TECHNIQUE 6 FIRST DERIVATIVE
SAMPLE VOLUME 50.000 mL
TITRANT .004980 M of _____
CONST INCREMENT 0.250 mL
MAX TITRANT VOL 10.000 mL
TIMED READINGS 8.0 sec
PRESTIR 10.0 sec
CONTINUOUS STIRRING
REACTION RATIO 1.0000
MOLECULAR WEIGHT 560.00
CAL CONSTANT 1.00000

electrode check:+/- 1.2 mV

0	v=	0.000 mL	E=	178.0 mV
1	v=	0.250 mL	E=	191.5 mV
2	v=	0.500 mL	E=	212.6 mV
3	v=	0.750 mL	E=	239.1 mV
4	v=	1.000 mL	E=	263.5 mV
5	v=	1.250 mL	E=	290.9 mV
6	v=	1.500 mL	E=	292.8 mV
7	v=	1.750 mL	E=	301.7 mV
8	v=	2.000 mL	E=	308.9 mV
9	v=	2.250 mL	E=	314.5 mV
10	v=	2.500 mL	E=	319.1 mV
11	v=	2.750 mL	E=	323.0 mV
12	v=	3.000 mL	E=	326.3 mV
13	v=	3.250 mL	E=	329.2 mV
14	v=	3.500 mL	E=	331.8 mV
15	v=	3.750 mL	E=	334.1 mV
16	v=	4.000 mL	E=	336.2 mV
17	v=	4.250 mL	E=	338.1 mV
18	v=	4.500 mL	E=	339.8 mV
19	v=	4.750 mL	E=	341.4 mV
20	v=	5.000 mL	E=	342.9 mV
21	v=	5.250 mL	E=	344.2 mV
22	v=	5.500 mL	E=	345.3 mV
23	v=	5.750 mL	E=	346.4 mV
24	v=	6.000 mL	E=	347.5 mV
25	v=	6.250 mL	E=	348.4 mV
26	v=	6.500 mL	E=	349.3 mV
27	v=	6.750 mL	E=	350.3 mV
28	v=	7.000 mL	E=	351.1 mV
29	v=	7.250 mL	E=	351.9 mV
30	v=	7.500 mL	E=	352.6 mV
31	v=	7.750 mL	E=	353.3 mV
32	v=	8.000 mL	E=	354.0 mV
33	v=	8.250 mL	E=	354.7 mV
34	v=	8.500 mL	E=	355.3 mV
35	v=	8.750 mL	E=	355.9 mV
36	v=	9.000 mL	E=	356.4 mV
37	v=	9.250 mL	E=	357.0 mV
38	v=	9.500 mL	E=	357.6 mV
39	v=	9.750 mL	E=	358.2 mV
40	v=	10.000 mL	E=	358.7 mV

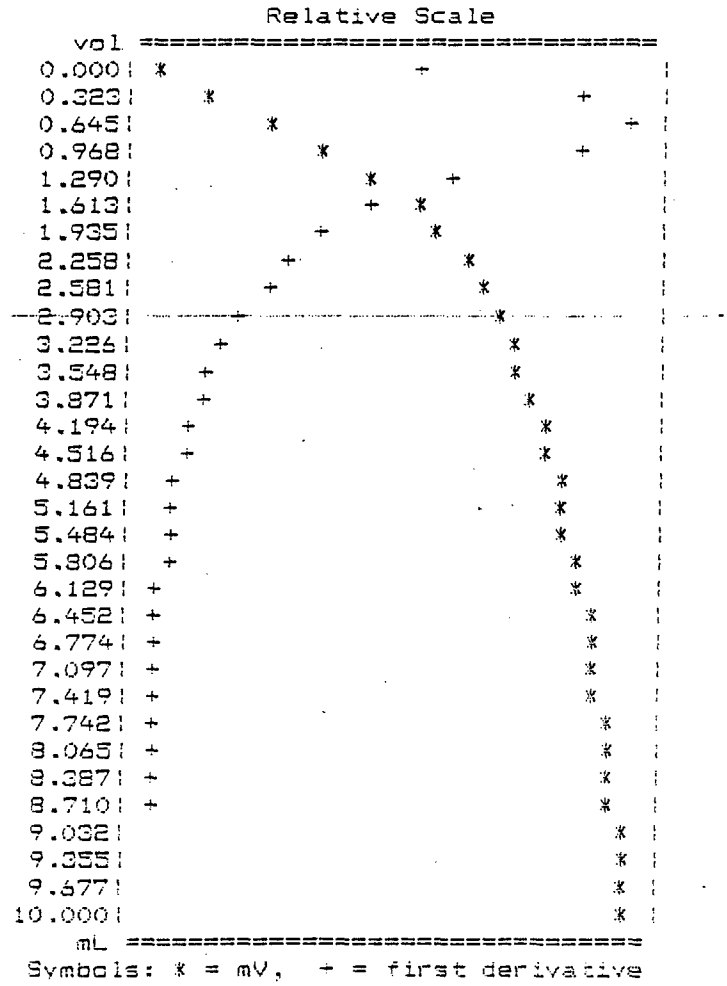
12.4 min

FIRST DERIVATIVE ANALYSIS

0	dE/dv=	54.0	d2E/dv2=	60.8
1	dE/dv=	69.2	d2E/dv2=	82.4
2	dE/dv=	95.2	d2E/dv2=	65.2
3	dE/dv=	101.8	d2E/dv2=	-23.2
4	dE/dv=	83.6	d2E/dv2=	-86.4
5	dE/dv=	58.6	d2E/dv2=	-84.0
6	dE/dv=	41.6	d2E/dv2=	-52.8
7	dE/dv=	32.2	d2E/dv2=	-32.0
8	dE/dv=	25.6	d2E/dv2=	-23.6
9	dE/dv=	20.4	d2E/dv2=	-17.2
10	dE/dv=	17.0	d2E/dv2=	-12.0
11	dE/dv=	14.4	d2E/dv2=	-9.2
12	dE/dv=	12.4	d2E/dv2=	-6.8
13	dE/dv=	11.0	d2E/dv2=	-5.2
14	dE/dv=	9.8	d2E/dv2=	-4.4
15	dE/dv=	8.8	d2E/dv2=	-3.6
16	dE/dv=	8.0	d2E/dv2=	-3.2
17	dE/dv=	7.2	d2E/dv2=	-2.8
18	dE/dv=	6.6	d2E/dv2=	-2.0
19	dE/dv=	6.2	d2E/dv2=	-2.0
20	dE/dv=	5.6	d2E/dv2=	-2.8
21	dE/dv=	4.8	d2E/dv2=	-2.4
22	dE/dv=	4.4	d2E/dv2=	-0.8
23	dE/dv=	4.4	d2E/dv2=	-0.8
24	dE/dv=	4.0	d2E/dv2=	-1.6
25	dE/dv=	3.6	d2E/dv2=	-0.4
26	dE/dv=	3.8	d2E/dv2=	0.0
27	dE/dv=	3.6	d2E/dv2=	-1.2
28	dE/dv=	3.2	d2E/dv2=	-1.2
29	dE/dv=	3.0	d2E/dv2=	-0.8
30	dE/dv=	2.8	d2E/dv2=	-0.4
31	dE/dv=	2.8	d2E/dv2=	-0.0
32	dE/dv=	2.8	d2E/dv2=	-0.4
33	dE/dv=	2.6	d2E/dv2=	-0.8
34	dE/dv=	2.4	d2E/dv2=	-0.8
35	dE/dv=	2.2	d2E/dv2=	-0.4
36	dE/dv=	2.2	d2E/dv2=	0.4
37	dE/dv=	2.4	d2E/dv2=	0.4
38	dE/dv=	2.4	d2E/dv2=	-0.4
39	dE/dv=	2.2	d2E/dv2=	-0.8
40	dE/dv=	2.0	d2E/dv2=	-0.8

SAMPLE = 38.6 ppm (v)
END POINT VOL= 9.692 mL (232.2 mV)
Excess Titre= 9.308 mL

Signal/Noise= 25


Relative Scale
vol
0.000
0.323
0.645
0.968
1.290
1.613
1.935
2.258
2.581
2.903
3.226
3.548
3.871
4.194
4.516
4.839
5.161
5.484
5.806
6.129
6.452
6.774
7.097
7.419
7.742
8.065
8.387
8.710
9.032
9.355
9.677
10.000
mL
Symbols: * = mV, + = first derivative

Appendix A-2: Oil/Water Separator Anionic Concentration

OVERVIEW: AFFF anionic surfactant concentration was determined using the First Derivative titration method with an ORION surfactant electrode, and Hyamine 1622 solution as the titrant. The ORION Autochemistry System determines the endpoint and calculates the concentration of the anionic surfactant in AFFF in the sample.

ELECTRODE SET-UP: To set up the electrodes attach the ORION surfactant electrode and the double-junction reference electrode to either input 1 or 2 as described in the ORION 960 Autochemistry instruction manual. Define the electrode as X-.

TITRANT PREPARATION: Dilute 0.05 M Hyamine 1622 to approximately 0.01 M or .005 M depending on the concentration of the sample, then standardize the titrant using the standardization method (which is technique 11 on the ORION 960 Autochemistry System) with sodium lauryl sulfate (SLS).

SAMPLE PREPARATION:

To prepare this sample, the following steps are performed:

1) Take 50 milliliters from oil/water separator,
2) add 6 milliliters of 0.1 M of HCl,
3) add 1 milliliter of NaCl, then
4) add 1 milliliter of diluted Triton X

IMPORTANT NOTES: Rinse the electrodes, stirrer and dispenser probe thoroughly between measurements with acidic deionized water.

==========

METHOD SUMMARY (unsaved method)

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TEST: O.W. Sep SAMPLE #3 ANIONIC

SITE:

ANALYST:

13:13 08-02-93 ELECTRODE: 1:X-

TECHNIQUE 6 FIRST DERIVATIVE

SAMPLE VOLUME 50.000 mL

TITRANT .004980 M of

CONST INCREMENT 0.250 mL

MAX TITRANT VOL 10.000 mL

TIMED READINGS 3.0 sec

PRESTIR 10.0 sec

CONTINUOUS STIRRING

REACTION RATIO 1.0000

MOLECULAR WEIGHT 560.00

CAL CONSTANT 1.00000

electrode check:+/- 0.4 mV

ok

0	v=	0.000 mL	E=	265.3 mV
1	v=	0.250 mL	E=	270.9 mV
2	v=	0.500 mL	E=	281.7 mV
3	v=	0.750 mL	E=	290.6 mV
4	v=	1.000 mL	E=	300.5 mV
5	v=	1.250 mL	E=	307.8 mV
6	v=	1.500 mL	E=	313.4 mV
7	v=	1.750 mL	E=	317.8 mV
8	v=	2.000 mL	E=	322.1 mV
9	v=	2.250 mL	E=	325.3 mV
10	v=	2.500 mL	E=	328.4 mV
11	v=	2.750 mL	E=	331.0 mV
12	v=	3.000 mL	E=	333.3 mV
13	v=	3.250 mL	E=	335.2 mV
14	v=	3.500 mL	E=	337.2 mV
15	v=	3.750 mL	E=	338.7 mV
16	v=	4.000 mL	E=	340.2 mV
17	v=	4.250 mL	E=	341.7 mV
18	v=	4.500 mL	E=	343.0 mV
19	v=	4.750 mL	E=	344.1 mV
20	v=	5.000 mL	E=	345.2 mV
21	v=	5.250 mL	E=	346.2 mV
22	v=	5.500 mL	E=	347.2 mV
23	v=	5.750 mL	E=	348.2 mV
24	v=	6.000 mL	E=	349.0 mV
25	v=	6.250 mL	E=	349.8 mV
26	v=	6.500 mL	E=	350.5 mV
27	v=	6.750 mL	E=	351.4 mV
28	v=	7.000 mL	E=	352.1 mV
29	v=	7.250 mL	E=	352.7 mV
30	v=	7.500 mL	E=	353.4 mV
31	v=	7.750 mL	E=	354.0 mV
32	v=	8.000 mL	E=	354.7 mV
33	v=	8.250 mL	E=	355.3 mV
34	v=	8.500 mL	E=	355.8 mV
35	v=	8.750 mL	E=	356.5 mV
36	v=	9.000 mL	E=	357.0 mV
37	v=	9.250 mL	E=	357.5 mV
38	v=	9.500 mL	E=	358.0 mV
39	v=	9.750 mL	E=	358.5 mV
40	v=	10.000 mL	E=	359.0 mV

13.6 min

==========

FIRST DERIVATIVE ANALYSIS

==========

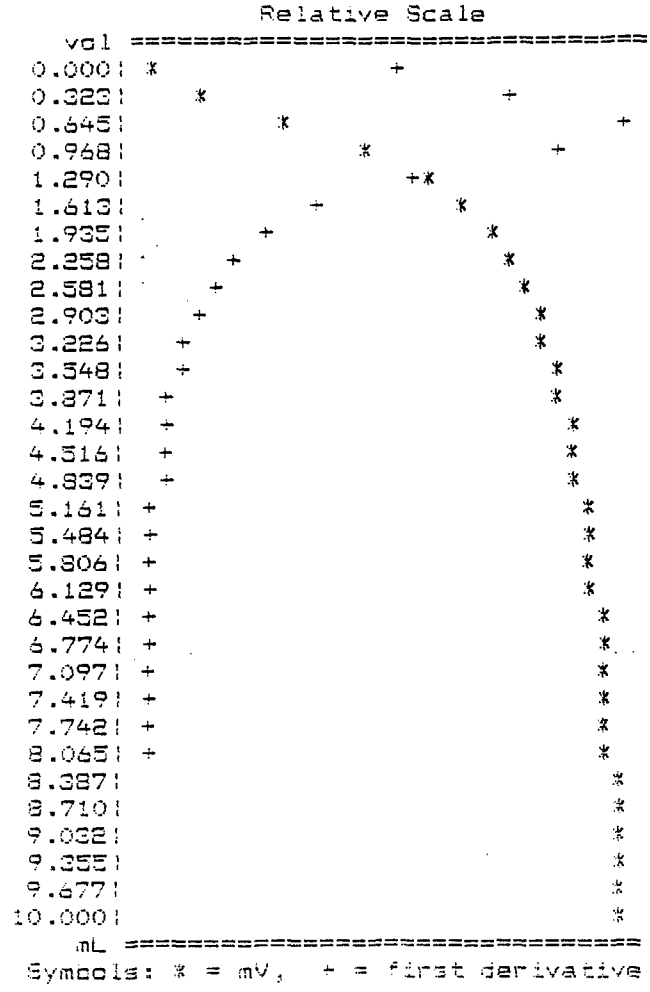
0	dE/dv=	28.4	d2E/dv2=	41.6
1	dE/dv=	32.8	d2E/dv2=	34.0
2	dE/dv=	39.4	d2E/dv2=	9.6
3	dE/dv=	37.6	d2E/dv2=	-10.0
4	dE/dv=	34.4	d2E/dv2=	-22.6
5	dE/dv=	25.8	d2E/dv2=	-28.8
6	dE/dv=	20.0	d2E/dv2=	-16.8
7	dE/dv=	17.4	d2E/dv2=	-10.0
8	dE/dv=	15.0	d2E/dv2=	-9.6
9	dE/dv=	12.6	d2E/dv2=	-7.2
10	dE/dv=	11.4	d2E/dv2=	-5.6
11	dE/dv=	9.8	d2E/dv2=	-6.0
12	dE/dv=	8.4	d2E/dv2=	-4.0
13	dE/dv=	7.8	d2E/dv2=	-2.8
14	dE/dv=	7.0	d2E/dv2=	-3.6
15	dE/dv=	6.0	d2E/dv2=	-2.0
16	dE/dv=	6.0	d2E/dv2=	-0.8
17	dE/dv=	5.6	d2E/dv2=	-2.4
18	dE/dv=	4.8	d2E/dv2=	-2.4
19	dE/dv=	4.4	d2E/dv2=	-1.2
20	dE/dv=	4.2	d2E/dv2=	-0.8
21	dE/dv=	4.0	d2E/dv2=	-0.4
22	dE/dv=	4.0	d2E/dv2=	-0.8
23	dE/dv=	3.6	d2E/dv2=	-1.6
24	dE/dv=	3.2	d2E/dv2=	-1.2
25	dE/dv=	3.0	d2E/dv2=	-0.0
26	dE/dv=	3.2	d2E/dv2=	0.4
27	dE/dv=	3.2	d2E/dv2=	-1.2
28	dE/dv=	2.6	d2E/dv2=	-1.2
29	dE/dv=	2.6	d2E/dv2=	0.0
30	dE/dv=	2.6	d2E/dv2=	0.0
31	dE/dv=	2.6	d2E/dv2=	0.0
32	dE/dv=	2.6	d2E/dv2=	-0.8
33	dE/dv=	2.2	d2E/dv2=	-0.4
34	dE/dv=	2.4	d2E/dv2=	0.4
35	dE/dv=	2.4	d2E/dv2=	-0.8
36	dE/dv=	2.0	d2E/dv2=	-0.8
37	dE/dv=	2.0	d2E/dv2=	0.0
38	dE/dv=	2.0	d2E/dv2=	0.0
39	dE/dv=	2.0	d2E/dv2=	0.0
40	dE/dv=	2.0	d2E/dv2=	0.0

SAMPLE = 31.9 ppm (v)

END POINT VOL= 0.571 mL (283.7 mV)

Excess Titre= 9.429 mL

Signal/Noise= 13


Relative Scale
vol
0.000
0.323
0.645
0.968
1.290
1.613
1.935
2.258
2.581
2.903
3.226
3.548
3.871
4.194
4.516
4.839
5.161
5.484
5.806
6.129
6.452
6.774
7.097
7.419
7.742
8.065
8.387
8.710
9.032
9.355
9.677
10.000
mL
Symbols: * = mV, + = first derivative

Appendix A-3: Pond Sample Non-Ionic Concentration

OVERVIEW: AFFF non-ionic surfactant concentration was determined using the First Derivative titration method with an ORION surfactant electrode, and non-ionic solution as the titrant. The ORION Autochemistry System determines the endpoint and calculates the concentration of the non-ionic surfactant in AFFF in the sample.

ELECTRODE SET-UP: To set up the electrodes attach the ORION surfactant electrode and the double-junction reference electrode to either input 1 or 2 as described in the ORION 960 Autochemistry instruction manual. Define the electrode as X-.

TITRANT PREPARATION: Dilute 0.0202 M non-ionic titrant to approximately 0.00202 M, then standardize the titrant using the standardization method (which is technique 11 on the ORION 960 Autochemistry System) with sodium lauryl sulfate (SLS).

SAMPLE PREPARATION:

To prepare this sample, the following steps are performed:

1) Take 50 milliliters from the pond
2) add 6 milliliters of 0.1 M of HCl,
3) add 1 milliliter of NaCl, then
4) add 5 milliliters of non-ionic reagent

IMPORTANT NOTES: Rinse the electrodes, stirrer and dispenser probe thoroughly between measurements with acidic deionized water.

METHOD SUMMARY (unsaved method)

TEST: POND SAMPLE #2 NON-
SITE: IONIC
ANALYST:
08:13 08-04-93 ELECTRODE: 1:X-
TECHNIQUE 6 FIRST DERIVATIVE
SAMPLE VOLUME 100.000 mL
TITRANT .002020 M of _____
CONST INCREMENT 0.150 mL
MAX TITRANT VOL 3.000 mL
TIMED READINGS 8.0 sec
PRESTIR 10.0 sec
CONTINUOUS STIRRING
REACTION RATIO 1.0000
MOLECULAR WEIGHT 560.00
CAL CONSTANT 1.00000

electrode check:+/- 0.6 mV

0	v=	0.000 mL	E=	38.7 mV
1	v=	0.150 mL	E=	41.8 mV
2	v=	0.300 mL	E=	42.8 mV
3	v=	0.450 mL	E=	42.6 mV
4	v=	0.600 mL	E=	42.2 mV
5	v=	0.750 mL	E=	41.0 mV
6	v=	0.900 mL	E=	39.9 mV
7	v=	1.050 mL	E=	39.6 mV
8	v=	1.200 mL	E=	39.0 mV
9	v=	1.350 mL	E=	38.9 mV
10	v=	1.500 mL	E=	38.7 mV
11	v=	1.650 mL	E=	38.9 mV
12	v=	1.800 mL	E=	39.3 mV
13	v=	1.950 mL	E=	39.3 mV
14	v=	2.100 mL	E=	39.7 mV
15	v=	2.250 mL	E=	40.1 mV
16	v=	2.400 mL	E=	40.3 mV
17	v=	2.550 mL	E=	40.7 mV
18	v=	2.700 mL	E=	41.2 mV
19	v=	2.850 mL	E=	41.8 mV
20	v=	3.000 mL	E=	42.1 mV

5.9 min

FIRST DERIVATIVE ANALYSIS

0	dE/dv=	20.7	d2E/dv2=	-46.7
1	dE/dv=	13.7	d2E/dv2=	-60.0
2	dE/dv=	2.7	d2E/dv2=	-52.2
3	dE/dv=	-2.0	d2E/dv2=	-26.7
4	dE/dv=	-5.3	d2E/dv2=	-18.9
5	dE/dv=	-7.7	d2E/dv2=	2.2
6	dE/dv=	-4.7	d2E/dv2=	15.6
7	dE/dv=	-3.0	d2E/dv2=	7.8
8	dE/dv=	-2.3	d2E/dv2=	5.7
9	dE/dv=	-1.0	d2E/dv2=	7.8
10	dE/dv=	0.0	d2E/dv2=	10.0
11	dE/dv=	2.0	d2E/dv2=	4.4
12	dE/dv=	1.3	d2E/dv2=	-2.2
13	dE/dv=	1.3	d2E/dv2=	4.4
14	dE/dv=	2.7	d2E/dv2=	2.2
15	dE/dv=	2.0	d2E/dv2=	-2.2
16	dE/dv=	2.0	d2E/dv2=	3.3
17	dE/dv=	3.0	d2E/dv2=	5.6
18	dE/dv=	3.7	d2E/dv2=	0.0
19	dE/dv=	3.0	d2E/dv2=	-5.6
20	dE/dv=	2.0	d2E/dv2=	-6.7

*** no inflection point found

*** analysis failed

Appendix A-4: Oil/Water Separator Non-Ionic Concentration

OVERVIEW: AFFF non-ionic surfactant concentration was determined using the First Derivative titration method with an ORION surfactant electrode, and non-ionic solution as the titrant. The ORION Autochemistry System determines the endpoint and calculates the concentration of the non-ionic surfactant in AFFF in the sample.

ELECTRODE SET-UP: To set up the electrodes attach the ORION surfactant electrode and the double-junction reference electrode to either input 1 or 2 as described in the ORION 960 Autochemistry instruction manual. Define the electrode as X-.

TITRANT PREPARATION: Dilute 0.0202 M non-ionic titrant to approximately 0.00202 M non-ionic titrant, then standardize the titrant using the standardization method (which is technique 11 on the ORION 960 Autochemistry System) with sodium lauryl sulfate (SLS).

SAMPLE PREPARATION:

To prepare this sample, the following steps are performed:

1) Take 50 milliliters from the oil/water separator,
2) add 6 milliliters of 0.1 M of HCl,
3) add 1 milliliter of NaCl, then
4) add 5 milliliters of non-ionic reagent

IMPORTANT NOTES: Rinse the electrodes, stirrer and dispenser probe thoroughly between measurements with acidic deionized water.

METHOD SUMMARY (unsaved method)

TEST: O.W. Sep SAMPLE #1 NON-IONIC
SITE:
ANALYST:
08:46 08-04-93 ELECTRODE: 1:X-
TECHNIQUE 6 FIRST DERIVATIVE
SAMPLE VOLUME 100.000 mL
TITRANT .002020 M of _____
CONST INCREMENT 0.100 mL
MAX TITRANT VOL 5.000 mL
TIMED READINGS 8.0 sec
PRESTIR 10.0 sec
CONTINUOUS STIRRING
REACTION RATIO 1.0000
MOLECULAR WEIGHT 560.00
CAL CONSTANT 1.00000

electrode check:+/- 0.3 mV
ok

0	v=	0.000	mL	E=	79.7	mV
1	v=	0.100	mL	E=	81.2	mV
2	v=	0.200	mL	E=	81.9	mV
3	v=	0.300	mL	E=	82.1	mV
4	v=	0.400	mL	E=	82.0	mV
5	v=	0.500	mL	E=	82.0	mV
6	v=	0.600	mL	E=	81.5	mV
7	v=	0.700	mL	E=	81.0	mV
8	v=	0.800	mL	E=	80.3	mV
9	v=	0.900	mL	E=	79.5	mV
10	v=	1.000	mL	E=	79.1	mV
11	v=	1.100	mL	E=	78.2	mV
12	v=	1.200	mL	E=	77.4	mV
13	v=	1.300	mL	E=	76.2	mV
14	v=	1.400	mL	E=	75.3	mV
15	v=	1.500	mL	E=	74.5	mV
16	v=	1.600	mL	E=	73.5	mV
17	v=	1.700	mL	E=	72.2	mV
18	v=	1.800	mL	E=	71.1	mV
19	v=	1.900	mL	E=	69.8	mV
20	v=	2.000	mL	E=	68.2	mV
21	v=	2.100	mL	E=	66.9	mV
22	v=	2.200	mL	E=	65.2	mV
23	v=	2.300	mL	E=	63.6	mV
24	v=	2.400	mL	E=	62.0	mV
25	v=	2.500	mL	E=	60.0	mV
26	v=	2.600	mL	E=	59.1	mV
27	v=	2.700	mL	E=	57.3	mV
28	v=	2.800	mL	E=	55.2	mV
29	v=	2.900	mL	E=	54.3	mV
30	v=	3.000	mL	E=	52.4	mV
31	v=	3.100	mL	E=	50.5	mV
32	v=	3.200	mL	E=	49.5	mV
33	v=	3.300	mL	E=	48.5	mV
34	v=	3.400	mL	E=	47.2	mV
35	v=	3.500	mL	E=	45.7	mV
36	v=	3.600	mL	E=	44.3	mV
37	v=	3.700	mL	E=	42.6	mV
38	v=	3.800	mL	E=	41.4	mV
39	v=	3.900	mL	E=	39.9	mV
40	v=	4.000	mL	E=	39.1	mV
41	v=	4.100	mL	E=	38.2	mV
42	v=	4.200	mL	E=	37.5	mV
43	v=	4.300	mL	E=	36.9	mV
44	v=	4.400	mL	E=	36.6	mV
45	v=	4.500	mL	E=	35.7	mV
46	v=	4.600	mL	E=	34.9	mV
47	v=	4.700	mL	E=	34.5	mV
48	v=	4.800	mL	E=	33.9	mV
49	v=	4.900	mL	E=	33.8	mV
50	v=	5.000	mL	E=	33.2	mV

15.4 min

FIRST DERIVATIVE ANALYSIS

0	dE/dv=	15.0	d2E/dv2=	-40.0
1	dE/dv=	11.0	d2E/dv2=	-52.5
2	dE/dv=	4.5	d2E/dv2=	-52.5
3	dE/dv=	0.5	d2E/dv2=	-25.0
4	dE/dv=	-0.5	d2E/dv2=	-15.0
5	dE/dv=	-2.5	d2E/dv2=	-22.5
6	dE/dv=	-5.0	d2E/dv2=	-17.5
7	dE/dv=	-6.0	d2E/dv2=	-12.5
8	dE/dv=	-7.5	d2E/dv2=	0.0
9	dE/dv=	-6.0	d2E/dv2=	5.0
10	dE/dv=	-6.5	d2E/dv2=	-12.5
11	dE/dv=	-9.5	d2E/dv2=	-17.5
12	dE/dv=	-10.0	d2E/dv2=	-10.0
13	dE/dv=	-10.5	d2E/dv2=	7.5
14	dE/dv=	-8.3	d2E/dv2=	7.5
15	dE/dv=	-9.0	d2E/dv2=	-15.0
16	dE/dv=	-11.5	d2E/dv2=	-15.0
17	dE/dv=	-12.0	d2E/dv2=	-2.5
18	dE/dv=	-12.0	d2E/dv2=	-12.5
19	dE/dv=	-14.5	d2E/dv2=	-12.5
20	dE/dv=	-14.5	d2E/dv2=	-2.5
21	dE/dv=	-15.0	d2E/dv2=	-10.0
22	dE/dv=	-16.5	d2E/dv2=	-5.0
23	dE/dv=	-16.0	d2E/dv2=	-7.5
24	dE/dv=	-18.0	d2E/dv2=	7.5
25	dE/dv=	-14.5	d2E/dv2=	22.5
26	dE/dv=	-13.5	d2E/dv2=	3.5
27	dE/dv=	-14.0	d2E/dv2=	3.0
28	dE/dv=	-12.5	d2E/dv2=	-37.5
29	dE/dv=	-19.5	d2E/dv2=	-35.0
30	dE/dv=	-19.5	d2E/dv2=	25.0
31	dE/dv=	-14.5	d2E/dv2=	37.5
32	dE/dv=	-13.0	d2E/dv2=	12.0
33	dE/dv=	-11.5	d2E/dv2=	-10.0

```
34 dE/dv=    -14.0  d2E/dv2=    -15.0
35 dE/dv=    -14.5  d2E/dv2=     -7.5
36 dE/dv=    -15.5  d2E/dv2=     -0.0
37 dE/dv=    -14.5  d2E/dv2=     10.0
38 dE/dv=    -13.5  d2E/dv2=     15.0
39 dE/dv=    -11.5  d2E/dv2=     25.0
40 dE/dv=     -8.5  d2E/dv2=     17.5
41 dE/dv=     -8.0  d2E/dv2=     10.0
42 dE/dv=     -6.5  d2E/dv2=     17.5
43 dE/dv=     -4.5  d2E/dv2=      2.5
44 dE/dv=     -6.0  d2E/dv2=    -20.0
45 dE/dv=     -8.5  d2E/dv2=      0.0
46 dE/dv=     -6.0  d2E/dv2=     17.5
47 dE/dv=     -5.0  d2E/dv2=     12.5
48 dE/dv=     -3.5  d2E/dv2=      7.5
49 dE/dv=     -3.5  d2E/dv2=    -12.5
50 dE/dv=     -6.0  d2E/dv2=    -25.0

*** no inflection point found


*** analysis failed
```

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

Mark W. Giles

High School Apprenticeship Program

Final Report for:

Summer Research Extension Program

Armstrong Laboratory

Sponsored by:

Air Force Office of Scientific Research

Tyndall Air Force Base, Florida

August 1993

AIR FORCE ARMSTRONG LABORATORY

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

ABSTRACT

This work was sponsored by the Armstrong Laboratory Environics Directorate at Tyndall AFB, Florida. Program management and environmental cleanup technologies for removing fuels and solvents from soils and groundwaters at contaminated Air Force Bases are the focus of this agency's research and development activities. The program documentation essential for the initiation and direction of the development efforts are explained, such as the Statement of Work preparation from contractor proposals. Two environmental technologies, Radio Frequency/Vapor Extraction (RF/VE) and Aqueous Film Forming Foam (AFFF) were observed at the division management (AL/EQW) and Technical Project Officer (TPO) levels during the period of June to August 93.

AIR FORCE ARMSTRONG LABORATORY

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

INTRODUCTION

This document is an overview of the organization, management and operational functions of the Armstrong Laboratory Environics Directorate involvement in Environmental Research and Development activities observed during an eight week period from June to August 1993.

Observations were made at the Laboratory Program Management Level where every activity from the initiation to termination of an Environmental Remediation R&D effort could occur. The overall result was a unique and rare view of the combined effort of scientific and engineering professionals interacting at all levels of R&D ranging from pure research, bench and pilot scale demonstrations, to final fielding of the total treatment system design accompanied with related technical information exchange and reporting activities.

Although these observations were made at an Air Force Program Management Office, cooperation and formal coordination occurred on a daily basis with virtually every environmental interest group across other government agencies such as the Environmental Protection Agency and the Department of Energy, and specialized R&D groups in industry and academia.

ORGANIZATION AND OBJECTIVES

The Environics Directorate

A subset of the Armstrong Laboratory headquartered at Brooks AFB, Texas, the Environics Directorate (AL/EQ) at Tyndall AFB, Florida is the Air Force's lead agency for Environmental Research and Development (R&D) to reduce the threat of hazardous materials released in past operations, and to upgrade system designs and maintenance methods which will reduce or totally eliminate toxic effluents to the environment.

The primary objective of the Environics Directorate is the development of environmental technologies that may provide an assortment of valuable tools to be applied in pure research, environmental compliance with existing laws and regulations, and new and innovative treatment methods to remove hazardous materials from air, soil and groundwater.

The Engineering Management and Research Laboratory Staff

Some of the methodologies and techniques that are used in the characterization and treatment of different kinds of pollutants fall mainly into five R&D thrust areas: Site Characterization and Monitoring Systems; Fate, Transport and Effect Investigations, Bioremediation Studies above (ex situ) and underground or in-place (in situ); Physical Treatment Process Development and Upgrades; and Chemical Treatment Studies. These five thrust areas are addressed in a matrix management approach among three divisions in the Environics Directorate: the Environmental Interactions Division (EQC), the Environmental Compliance Division (EQC), and the Site Remediation Division (EQW).

The above described organizational structure permits all of the laboratory's resources to focus on the environmental assessment of different kinds of pollutants and their sources during natural or mechanical transport, interaction with natural elements and other hazardous materials, and their ultimate decomposition into nontoxic states. Technical performance evaluations and cost effectiveness of new and innovative biological and chemical processing systems are of vital interest in scientific laboratory studies and engineering design and field demonstration evaluation exercises. Finally, the ability to control optimized systems and their operating methodologies to solve real hazardous waste contamination problems are transferred to Air Force Environmental Management Offices and facility operators in design handbooks and operating manuals.

The Program Planning, Technical Information Center, Contractor Support Staff

The Program Planning Office is responsible for laying out the strategy by which all R&D work is directed toward Air Force Site Restoration Requirements. Details of documentation involved are given below.

The Technical Information Center consists of all the technical library publication and computer information reference and retrieval services needed for literature searches and staying abreast of the latest periodical information. The Technical Information Center is a necessary and reliable source of valuable background information needed in order to start any project off in the right direction. With an in-house database system accessed by a Wang computer terminal, any number of books, reports, journals, and any other internal documents are available for use. The database system is expanded everyday by the addition into the system of detailed scientific reports from on going projects that produce published materials. The Technical Information Center has access to DTIC, the Defense Technical Information Center, which is a database provided by the Defense Department on CD-ROM and is searchable on any subject related to research. However, the majority of help provided by the Technical Information Center is through background searches that enable a more knowledgeable and practical effort be put forth in the application of the projects being conducted.

The Contractor Support Staff consists of management consulting services of BDM International Corporation, and technical laboratory and analytical services of Advanced Sciences Inc (ASI). These in-house contractor organizations provide the Air Force with support staff personnel on technical and management positions that would be impossible to operate without. The ASI contracting organization provides technical support of laboratory experiments, fire fighting support, and consultation to Air Force engineers. BDM provides a management support in planning, organizing and expanding the work already being done.

PROGRAM PLANNING

With the discovery of a problem, a plan and document trail, or "Program", is created. Program planning begins when a technical problem is identified with an Air Force requirement or statement of need to solve a site or process specific problem. To be able to actively pursue and find a solution for the problem, there must be enough money available to fund a program aimed at solving the Air Force's need. Following the necessary approvals regarding both the technical approach and the appropriate amount of funding, awarding of the contract and starting to work begins on a scheduled plan that includes completion of significant milestones such as conceptual design, pilot scale demonstration, full scale demonstration, and final project review of a detailed technical report.

STATEMENT OF WORK

In order to start work, a Statement of Work is written up by the contractor management (not BDM or ASI, but an outside independent firm or university) and usually is based on their initial proposal to the government for initiation of a beneficial environmental cleanup technology. The Statement of Work is the heart of the research and development procurement. The Statement of Work sets up the parameters for the work to be accomplished and presents it in a logical schedule of events to be followed without deviation. A precisely accurate and detailed Statement of Work is essential, because one must assume the contractor will give no more and no less than what is called for in the contract. The Statement of Work gives the details of what the contractor will accomplish in accordance with the objectives sought by the original Air Force requirement, regulations, guidance manuals and other government standards and specified instructions in the contract.

UNSOLICITED PROPOSALS

Unsolicited proposals are encouraged from universities, industry, and small businesses. They are logged in by an Environics Directorate Contracting Advisor, to ensure prompt replies and compliance with regulatory requirements. Current Air Force policies require that unsolicited proposals must by secured by being locked up to safeguard their contents. An exceptional unsolicited proposal is determined by studying if it is innovative, if the conceptual design is independently originated and developed concept, if the benefits to the government are clearly explained, and if the offeror's personnel and facilities capabilities are in line with the proposed work. Major factors that contribute to the decision on whether or not to fund an unsolicited proposal are if a similar proposal is available from another unrestricted source, or if the work has already been accomplished or is in progress.

Radio Frequency/Vapor Extraction (RF/VE) Technology R&D

The RF, or Radio Frequency, soil decontamination project is designed to identify, develop, and transition a microwave heating technology to remediate sites that have been contaminated by fuels and solvents at Air Force installations. The RF decontamination of contaminated sites by volatilizing most of the hazardous wastes that exists at the contaminated site. The RF project provides both an efficient (up to 99% contaminant removal) and cost-effective (as low as $40/ton of contaminated soil) decontamination method to installations that are required to cleanup and close hazardous waste sites according to the new environmental laws.

Radio Frequency (RF) heating is a pilot-scale, proven method for the thermal treatment of clay and sand soils containing volatile hazardous substances such as fuels, hydrocarbons, and solvents. The decontamination of soil is accomplished by volatilization and removal of the hazardous materials in a vaporized form. The heating mechanism is similar to that of a microwave oven, except that the frequency is different and the scale of operation is much larger. The gases and water vapor are recovered and collected from the heated zone and vacuum extracted to a cooling and treatment sub-system.

The RF heating of large well defined blocks, called modules, of soil is achieved by applying electromagnetic energy in an optimally selected RF band to an array of electrodes placed in drilled boreholes. The electrode array is enclosed within a vapor barrier which prevents hydrocarbon vapors from escaping to the outside environment and also facilitates the collection of the gases and vapors for subsequent treatment on or off site.

Aqueous Film Forming Foam (AFFF)

The future possible courses of action to be taken in regard to the improved use of Aqueous Film Forming Foam (AFFF), are currently being considered. AFFF, a complex mixture of hydrocarbon and fluorochemical surfactants is now being used to extinguish fires in training scenarios and those that erupt in aircraft hangers or during runway flight operations. Many questions are being posed in order to improve AFFF applications. The development methods of the product are being re-examined to determine how to analyze and detect a fluoro-hydrocarbon component. The fate and effects of AFFF in the area of soil and air contamination are being looked at. An alternative fire fighting system is under investigation.

SUMMARY

Overall, the combined laboratory and support services of the Environics Directorate form the nucleus of the lead research and development arm of the Air Force Armstrong Laboratory in the control and direction of Air Force Site Restoration Programs to protect the environment.

Radio Frequency/Vapor Extraction Technology is very much in the near term, commercially available phase of being transitioned from the laboratory to wide scale field implementation in the Air Force to recover aviation fuels and cleaning solvents from clay and sandy soils.

Aqueous Film Forming Foam for fire fighting purposes is being investigated for environmental fate and effects in soils and water, upgrading analytical techniques to detect fluorocarbon components, and evaluate proposed alternatives to the foam itself.

ACTIVITY COEFFICIENT DETERMINATION FOR 1-METHYL NAPHTHALENE AND HEXADECANE: WATER SYSTEM

Amanda L. Olson
High School Apprenticeship Program

Rutherford High School
1000 School Ave.
Panama City, Fla 32401

Final Report for:
Research and Development Laboratories
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Boiling Air Force Base, Washington, D.C.
and
Armstrong Laboratories

August, 1993

Activity Coefficient Determination for 1-Methyl Naphthalene and Hexadecane: Water System

Amanda L. Olson
High School Apprenticeship Program

Rutherford High School
1000 School Ave.
Panama City, Fla 32401

Abstract

A study of the partitioning of 1-methyl naphthalene between a layer of hexadecane and water was conducted. An amount of 1-methyl naphthalene was injected into a flask containing hexadecane and water. The solution was allowed to equilibrate for a minimum of 48 hours, an aliquot of the aqueous layer was then extracted and analyzed by injecting into a gas chromatograph to determine the aqueous phase concentration. The top layer was diluted and analyzed to determine the concentration in the organic phase. These values were then used to calculate the activity coefficient.

As part of this study, method development was performed to determine a qualitative and quantitative measurement by GC-FID. The extraction technique was demonstrated by an extraction study that proved acceptable recovery, reproducability, and accuracy.

Previous solubility studies have been conducted, but with pure forms of the chemicals. The results from this study will be incorporated into groundwater transport models. These models will help to determine the fate of groundwater contaminants, make contaminant cleanups more efficient, and help in developing methods for slowing down the spread of these contaminants.

Activity Coefficient Determination for 1-Methyl Naphthalene and Hexadecane: Water System

Amanda L. Olson

Introduction

Two phase equilibrium studies of a long chain hydrocarbon mixture in contact with water are important in determining the fate of groundwater contaminants in environmental and geological situations. Petroleum is primarily a liquid mixture of hydrocarbons, and studies have been performed to determine the aqueous solubilities of a single hydrocarbon. However, single compound solubility of a hydrocarbon may not be sufficient to determine its solubility when it is part of a mixture.

The saturation point of pure 1-methyl naphthalene is known, but it is important to find the activity coefficient for when it is combined with another substance. This activity coefficient can be entered into a groundwater transport model to ascertain the fate of the contaminant. A study was conducted on the aqueous solubility of a component of a liquid mixture (1-methyl naphthalene in hexadecane), and compared to its pure compound solubility (1-methyl naphthalene). Hexadecane was used to simulate undissolved fuel at a spill site. The mole fraction of the 1-methyl naphthalene in the hexadecane phase was compared to the aqueous solubility of pure 1-methyl naphthalene. The activity coefficient is the difference measured when the two are compared.

The activity coefficient is determined by using the formula:

$$C_i = X_{i(h)} Y_{i(h)} C^o_i$$

where: C_i= mixed compound water solubility

$X_{i(h)}$= mole fraction of the hydrocarbon

$Y_{i(h)}$= activity coefficient

C^o_i= aqueous phase concentration of the pure hydrocarbon

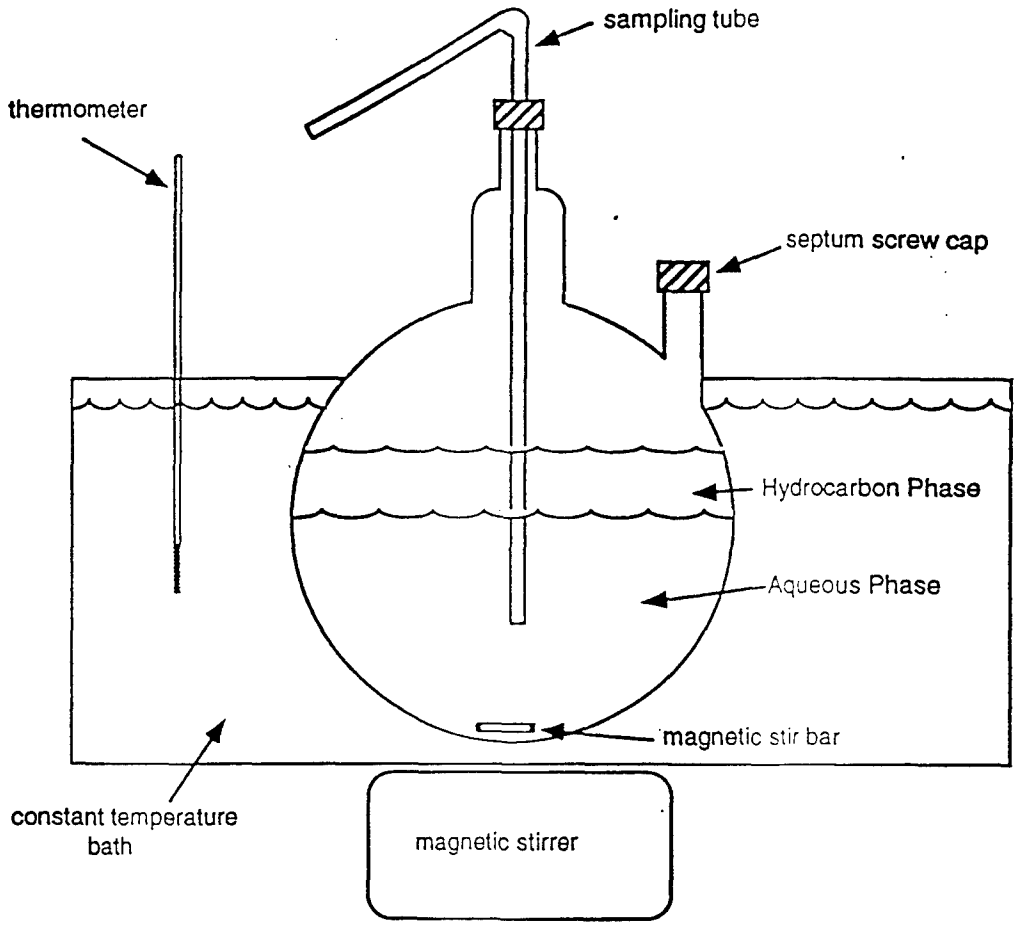
Activity coefficients can be a useful tool in determining the fate and transport of groundwater contaminants. For example, in the case of a spill, it would help determine the amount of contaminant that has dissolved into the water layer, and determine the time frame in which these contaminants would transfer into the water layer. Using the activity coefficient and other parameters, sorbent zones can be created by injecting a cationic surfactant solution onto an aquifer bed. This almost stationary zone of modified aquifer will slow down the transport of the contaminant, and allow microbial and abiotic degradation to occur. This application can then be used to contain contaminants inside of landfills sites. This information is also used in the development of contaminant capturing systems. Therefore, activity coefficient determination will assist us in the research of the fate and transport of contaminants.

Apparatus

The apparatus used in this study consisted of a 500 ml equilibration flask in a water bath. The water bath had magnetic stirring capabilities, and was kept at a constant 25-26°C. The flask contained ~400 ml water, ~50 ml hexadecane, and initially ~.01 ml of 1-methyl naphthalene was added (Figure 1). The instrument used to quantitatively and qualitatively identify the compounds that were analyzed was a HP5890 gas chromatograph with a FID detector. Data was collected and integrated using a Lab Automated System from Hewlett Packard.

Figure 1

EQUILIBRATOR FLASK



Methodology

The method used in this study was taken from the dissertation written by Dr. David Burris. In his publication, work was done to discover the activity coefficients of a mixture of hydrocarbons. There are several variations to Dr. Burris's method, such as the use of hexadecane instead of octane, and temperature differences.

A 500 ml equilibration flask was set up in a water bath set at 25° C ± 1° C. The flask was filled with 400 ml water, 50 ml hexadecane, and a known amount of 1-methyl naphthalene was added. The flask was allowed to sit for a minimum of 48 hours. Then both layers were analyzed. After each analysis, another known addition of 1-methyl naphthalene was added and then reanalyzed to measure the new concentration.

Extraction of the aqueous phase was performed using pentane with a known amount of internal standard. The extract was then analyzed by GC-FID, and the concentration of 1-methyl naphthalene in ppm was calculated. The mixed hydrocarbon phase was diluted and analyzed by GC-FID, and results reported in ppm. In order to calculate the mole fraction of 1-methyl naphthalene in the hexadecane phase, the ppm results needed to be converted to moles. The following calculations were used:

Results calculated by GC were in ppm = ug/ml. First we need to convert ug/ml to g/ml by using the formula:

x ug/ml x 1mg/1000ug x 1g/1000mg = x g/ml

Then to calculate the number of grams found in the 1 ul injection into the gas chromatograph we used the formula:

x g/ml x .001 ml = x g

To calculate the number of moles measured by the GC, divide the amount of grams calculated by the formula weight of the component to give the number of moles. The formula weight of

Hexadecane is 226.45, and the formula weight of 1-methyl naphthalene is 142.20. The formula is: x g / FW g/mole= x moles

Finally, to calculate the mole fraction of 1-methyl naphthalene:

$$\frac{\text{\# moles of 1-Methyl Napthalene}}{\text{\# moles of 1-Methyl Napthalene + moles of Hexadecane}} = \text{mole fractions}$$

The results are reported on Table 5. Results were plotted with the x axis being the mole fraction, and the y axis being the concentration in the aqueous phase (see figure 6).

Quality Control

Quality control used in this study included, an extraction study which demonstrates the ability to extract 1-methyl naphthalene from the aqueous phase. The instrument detection limit study shows that the GC could measure the concentration that we were extracting. The calculations made by using linear regression (3 point curve) and daily calibration checks were two other forms of quality control.

Extraction Study

The extraction study, which was conducted before the solubility study, was performed to check the percent recovery, and the consistancy of the method being used. Eight vials containing 20 ml of noncontaminated water were spiked by adding a known amount of a spike concentration of benzene, toluene, p-xylene, and 1-methyl naphthalene. The spike concentration was made in methanol to ensure that it the compounds being extracted would dissolve into the water layer. These four compounds were chosen to see how well the study would work on all of them. However, 1-methyl naphthalene is the only one being reported on at this time. The four compounds were then extracted from the water layer with 2 ml of pentane, containing 40 ppm of

chlorobenzene as an internal standard, and injected into the gas chromatograph. Results of the extraction study can be found in Table 2.

Accuracy and precision were demonstrated by a recovery of 85% and with a standard deviation of 1.75 among the eight results (See figures 3 and 4). Spike concentration for 1-methyl napthalene was 2 ppm, a mean of 23.8 ppm was recovered. The instrument detection limit ws calculated by using seven of the extracted samples and the measured standard deviation of 1.75 wsa multiplied by 3.14. The value 3.14 was taken from the table of one sided T distribution (Trussell, 1989).

Instrument Calibration

Linear regression was used to calculate the results. Three standards were prepared at three different concentrations and analyzed by the GC. A three point curve was plotted with benzene, toluene, p-xylene, 1-methyl naphthalene, and hexadecane (see Figure 7). All results shared a corrolation coefficient of .99 or greater. Chlorobenzene was used as an internal standard at a concentration of 40 ppm.

Daily calibration checks were run and found to be within 10 percent of the expected value. This ensures that we were in continuous calibration throughout this study.

Results

Two equilibrator flasks were studied, flask #1 contained pure 1-methyl naphthalene and water, flask #2 contained a mixture of 1-methyl naphthalene, hexadecane, and water. Flask #1 (pure 1-methyl naphthalene and water) was allowed to sit for 48 hours. The aqueous phase was then extracted and the concentration of 1-methyl naphthalene under our conditions was determined to be 35 ppm at one mole fraction. The theoretical line in figure 6 represents these results. The mixture of 1-methyl naphthalene and hexadecane with water (flask #2) was

sampled and analyzed throughout the study after various additions of 1-methyl naphthalene were made. The results were tabulated and graphed in table 5 and figure 6.

Figure 6 shows a theoretical line and a nonlinear actual data line. The difference betweem these two lines is what is measured as the activity coefficient. Activity coefficients for each mole fraction has been calculated and reported in table 5.

Conclusion

From the study we can conclude that activity coefficients are dependent on the mole fraction of 1-methyl napthalene in the hydrocarbon mixture. From the data, initially the activity coefficient has a value of one when the mole fraction is at zero. It then increases and begins to decrease as the mole fraction approaches one. This activity coefficient can now be used in groundwater transport models to determine the fate of contaminants.

Table 2

Results of 1-Methyl Naphthalene/Hexadecane: Water System

Addition:	Hexadecane		Methyl Naphthalene		Mole	Aqueous	Activity
Flask #1	ppm	Moles	ppm	Moles	Fraction	Methyl Napthalene	Coefficient
start	551790	2.4E-06	4227	3E-08	0.0121	0.637	1.50
add 5ml	766030	3.4E-06	46037	3.2E-07	0.0873	6.35	2.08
add 10ml	519250	2.3E-06	108410	7.6E-07	0.2495	21.3	2.44
add 15ml	476630	2.1E-06	189180	1.3E-06	0.3873	28.3	2.09
add 25ml	5043100	2.2E-05	5523400	3.9E-05	0.6356	34	1.53
Flask #2							
pure 1-Methyl Naphthalene					1	35	1.00

Figure 3

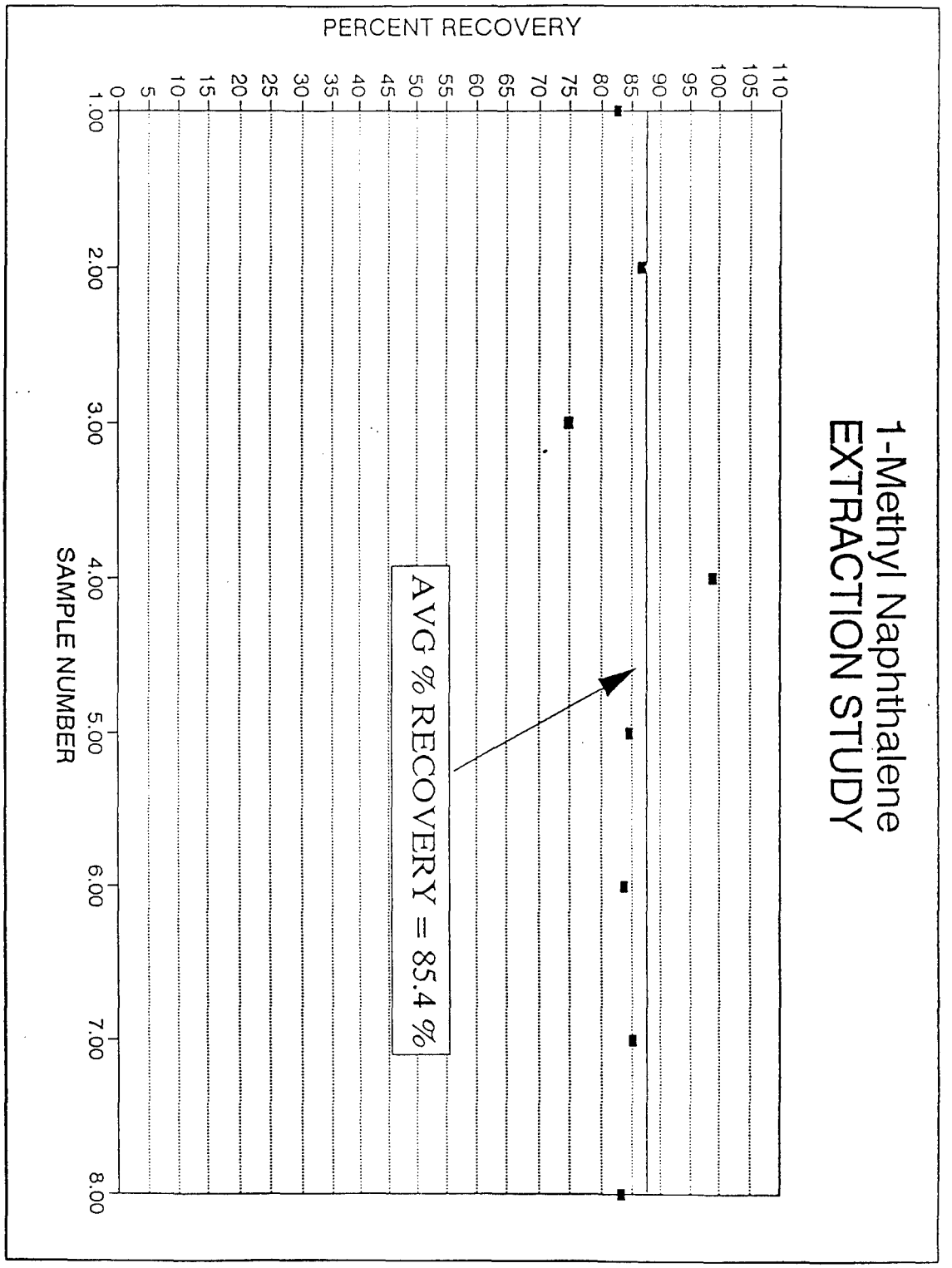

1-Methyl Naphthalene
EXTRACTION STUDY
PERCENT RECOVERY
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
SAMPLE NUMBER
AVG % RECOVERY = 85.4 %

Figure 4

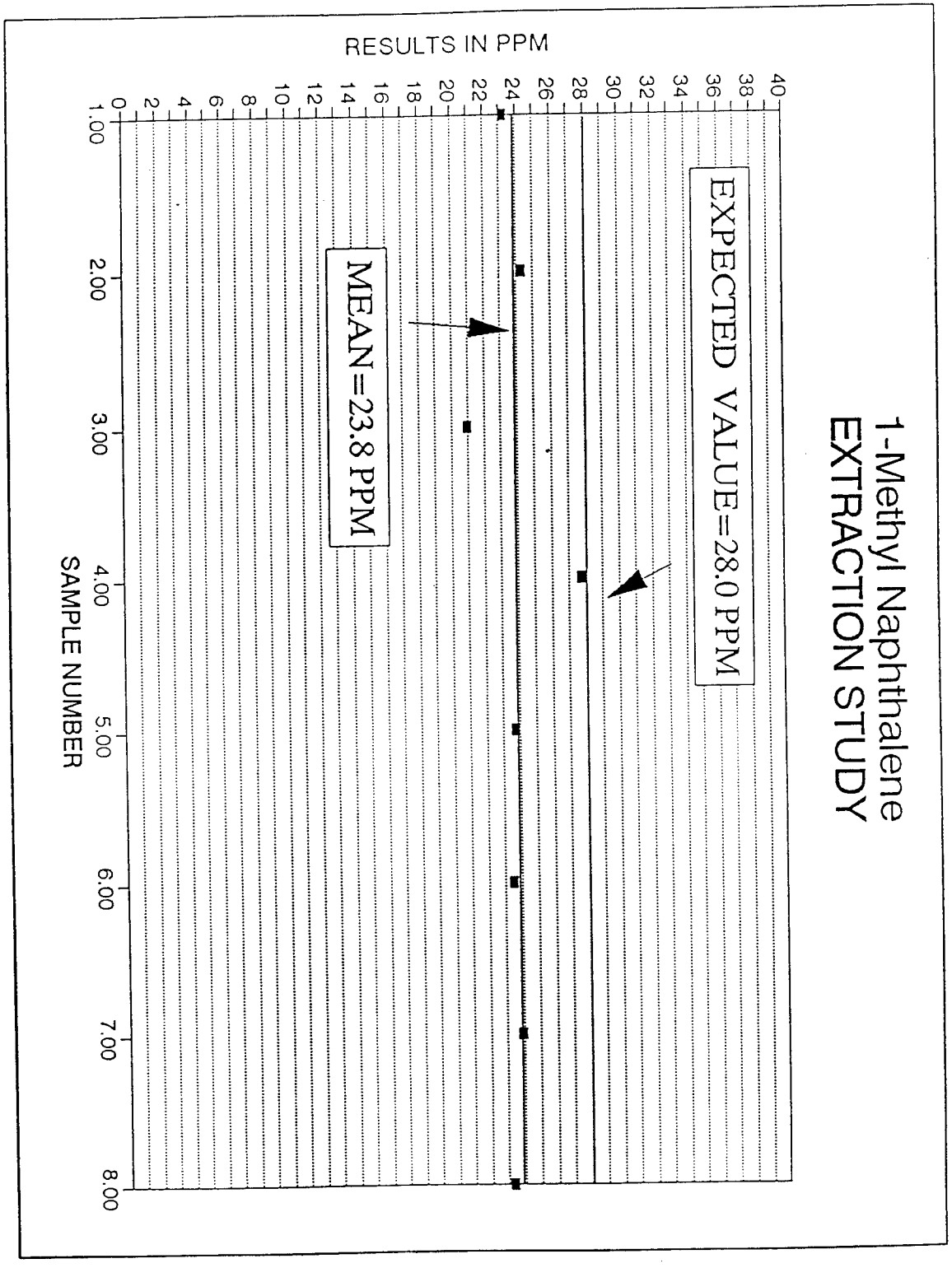

1-Methyl Naphthalene
EXTRACTION STUDY
EXPECTED VALUE=28.0 PPM
MEAN=23.8 PPM
RESULTS IN PPM
SAMPLE NUMBER
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

Table 5

Results of 1-Methyl Naphthalene/Hexadecane: Water System

Addition:	Hexadecane		Methyl Naphthalene		Mole	Aqueous
Flask #1	ppm	Moles	ppm	Moles	Fraction	Methyl Napthalene
start	551790	2.44E-06	4227	2.97E-08	0.0121	0.637
add 5ml	766030	3.38E-06	46037	3.24E-07	0.0873	6.35
add 10ml	519250	2.29E-06	108410	7.62E-07	0.2495	21.3
add 15ml	476630	2.1E-06	189180	1.33E-06	0.3873	28.3
add 25ml	5043100	2.23E-05	5523400	3.88E-05	0.6356	34
Flask #2						
pure 1-Methyl Naphthalene					1	35

Figure 6

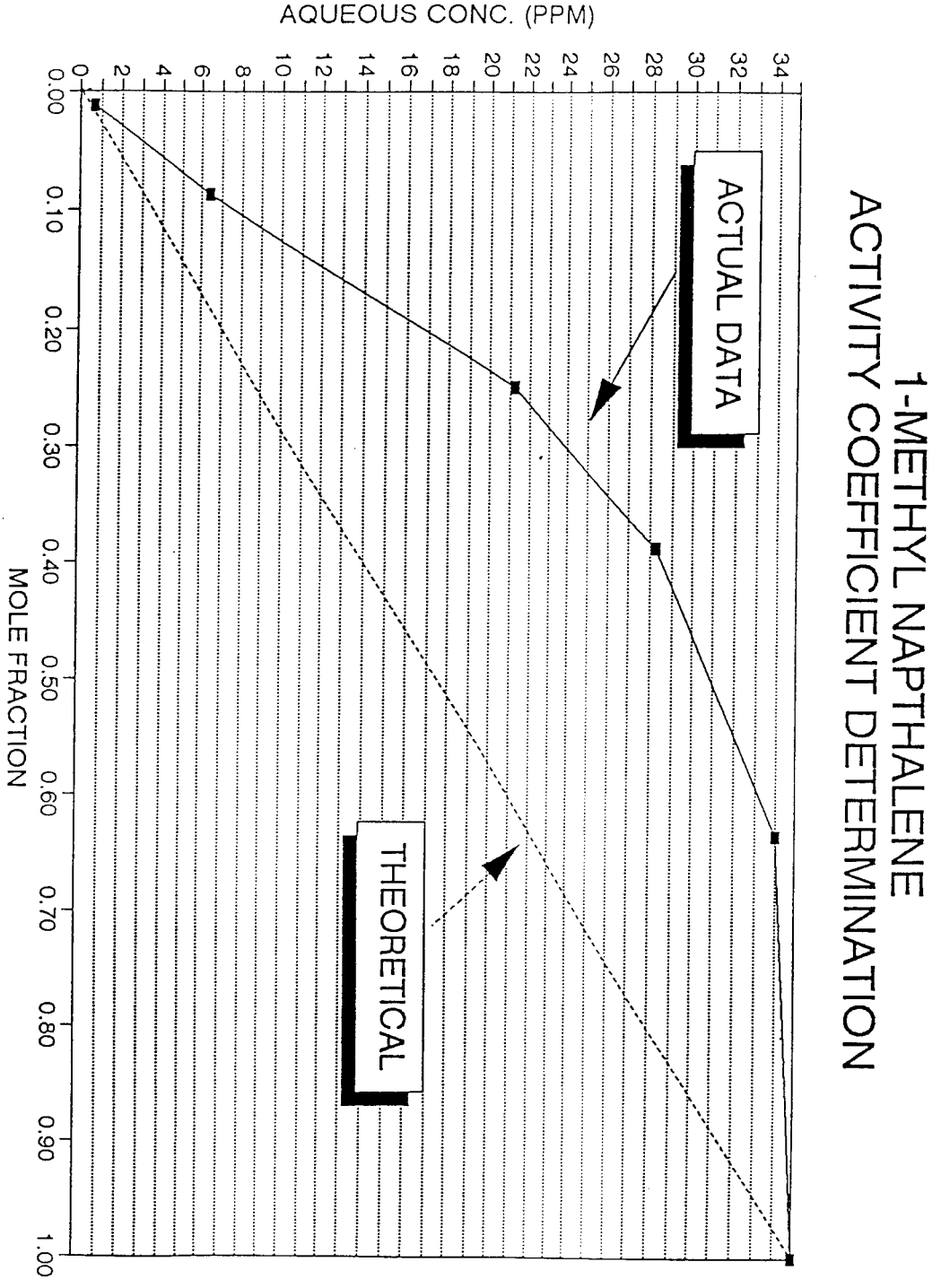
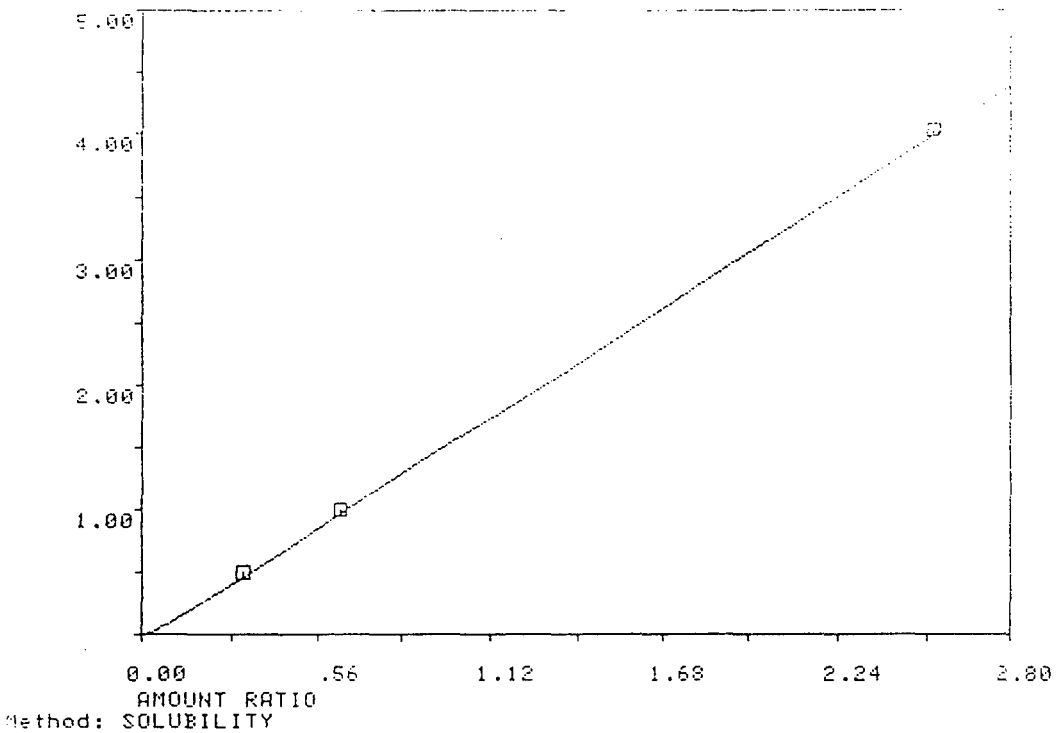
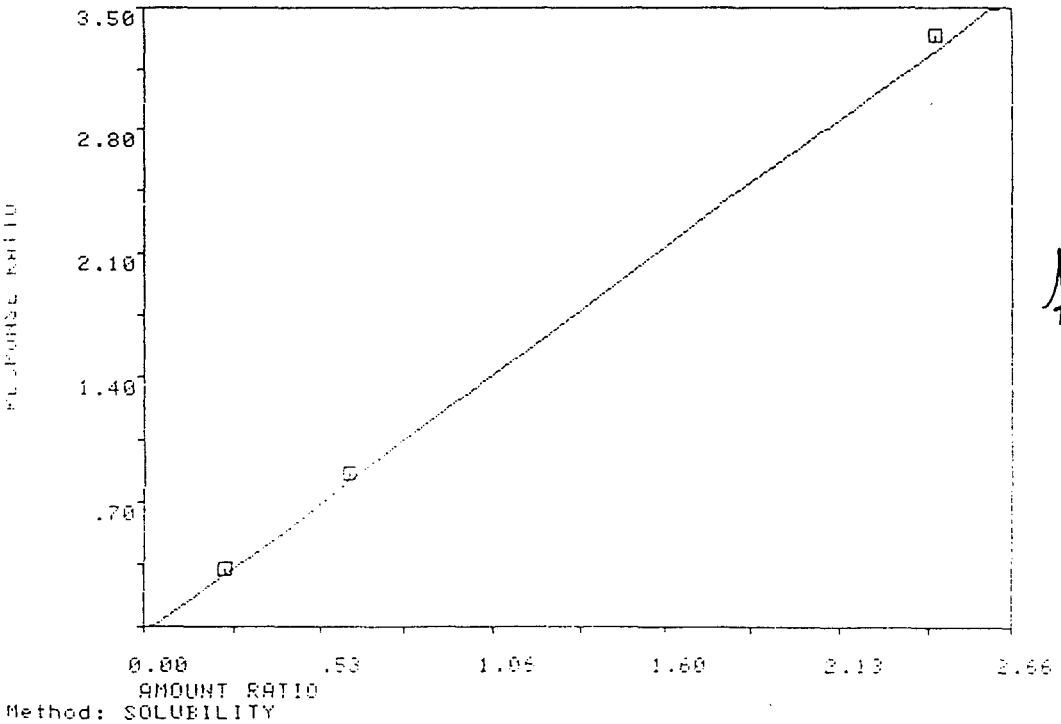

1-METHYL NAPTHALENE
ACTIVITY COEFFICIENT DETERMINATION
ACTUAL DATA
THEORETICAL
AQUEOUS CONC. (PPM)
MOLE FRACTION
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

Figure 7



1-Methyl Naphthalene

Method: SOLUBILITY
Pk # : 5 Type:Linear Zero:Include Corr: .998810E+00
B0:-.248871E-01 B1: .157103E+01 B2: .000000E+00 B3: .000000E+00



Hexadecane

Method: SOLUBILITY
Pk # : 6 Type:Linear Zero:Include Corr: .996248E+00
B0:-.315796E-01 B1: .136200E+01 B2: .000000E+00 B3: .000000E+00

References

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TEST AND EVALUATION OF THE ESTIMATES CREATED BY THE TRACES (TRI-SERVICE AUTOMATED COST ENGINEERING SYSTEM) PARAMETRIC MODELING SYSTEM

Final Report for:

AFOSR Summer Research Program

Sponsored by:

AFCESA (Air Force Civil Engineering Support Agency)

Tyndall Air Force Base, Florida

August 1993

TEST AND EVALUATION OF THE ESTIMATES CREATED BY THE TRACES (TRI-SERVICE AUTOMATED COST ENGINEERING SYSTEM) PARAMETRIC MODELING SYSTEM

Abstract

The accuracy of the TRACES (Tri-Service Automated Cost Engineering System) was evaluated. This software was developed by AFCESA/DC (Air Force Civil Engineering Support Agency/Directorate of Construction Cost Management). Evaluation was accomplished by comparing estimates of forty buildings produced by the TRACES system to the estimates created by two other systems, PDC (Programming, Design, Construction) and Air Force form 1178 reports. Data was gained from the 1178's and inputted into TRACES for evaluation. It was shown that the TRACES estimates were coming out high. The problem was isolated to the Division 99 data (Contractor Overhead and Profit), and can be easily fixed after data is acquired on the average percentage for this division of the program.

TEST AND EVALUATION OF THE ESTIMATES CREATED BY THE TRACES (TRI-SERVICE AUTOMATED COST ENGINEERING SYSTEM) PARAMETRIC MODELING SYSTEM

Introduction

There has long been a need for a simpler way of doing estimates than by sending a person out to a site and having that person look at blueprints to reach a final number. The TRACES system is a computer based system that produces accurate estimates at a fraction of the cost and in less time than the old method. The TRACES system will also estimate the number of specific materials needed for a project, such as light switches and screws. This Summer project evaluated TRACES estimates relative to actual cost and historical cost of each of forty projects.

Methodology

Forty buildings were selected at random for use in the test. These buildings ranged from dormitories to hospitals. All of the test buildings were previously built at Military installations, so the final cost as approved by Congress was known. These final appropriations by Congress for these buildings were acquired from the Form 1178 reports which were submitted to Congress and later approved. The forty buildings were also estimated using the PDC (Programming, Design, Construction) system. It is a large database of

military buildings. Rough estimates for each building are created by this system by compiling data from previous buildings thus creating a historical estimate. The buildings were then run in the TRACES system. The TRACES system lets the user input the building to his/her specifications. Everything from square footage to the type of roof can be changed. The system performs each assembly and multiplies it by a location factor relative to Atlanta, Georgia. All of the assemblies are compiled to form the final estimate, then contractor overhead and profit is added. Each estimate was compared to find the problem area.

Results

After the projects were estimated, it was found that about fifty percent of the PDC estimates were off the actual cost by greater than twenty percent. Most of the TRACES models were too high. It was found that in Division 99 (Contractor Overhead and Profit), the default settings were too high. Attachment. 1-1, block 20 shows the most important number in the Form 1178 report. It is the total for the main building (Primary Facility). This particular building cost $5,976,000. This number includes contractor overhead and profit. The PDC system estimated it at $5,312,000 (Attachment 2, Dormitories, Total Cost) which is 12.5 percent lower than the actual cost. The TRACES system, using default values, estimated it at $5,232,948 (Attachment 3, Facility Dorm, Facility Total, Total). Then the default

Div. 99 of 28.5 percent is added. This brings the total to 6,728,193, 12.9 percent higher than actual cost. The supporting facilities in the PDC and TRACES systems are low, because default values were used. The defaults were used, because the main focus of this project was on the primary facilities. Attachment 1-1, block 27 shows the actual cost of the supporting facilities to be $1,149,000 with O & P (Overhead and Profit). This is added to the $6,728,193 to get 7,872,193, 10.4 percent high compared to attachment 1-1, block 28. The O & P was manually adjusted to 24.5 percent which was established by Carl Giadrosich, who has been in construction for over 15 years. This is shown in attachment 4. $5,232,948 with the O & P is $6,513,840, 9 percent high. With the supporting facilities, the total is $7,663,945, 7.6 percent high. This number is considerably closer than that created using the default value.

Conclusions

After completing the forty estimates, it was shown that the TRACES system defaults in Division 99 need to be adjusted. The Contractor Overhead and Profit is too high. As the size of a building goes up, O & P goes down. It apparently is not going down enough in the TRACES system.

FY 1990 PROJECT COST ESTIMATE SUMMARY (Computer-Generated)

1. PDC NUMBER	2. PROJECT TITLE	3. DATE
AWUB885601	DORMITORIES	880913

4. MAJCOM	5. BASE/STATE/INST CODE	6. ACF
ACC	BARKSDALE AFB LA	.88

7. CONST START	8. MTHS OF CONST	9. PG DATE	10. CURRENT PA	11. EXCHANGE RATE
900400	12	9010		.0000

12. PRIMARY FACILITIES	13. CAT CODE	14.SAF	15.CGF	16. U/M	17. SCOPE 83,000	18. UNIT COST	19. COST (000)
AMN PERMANENT PARTY/PCS DORM	721-312	1.00	1.13	SF	83,000	72.00	5,976
20. PRIMARY FACILITY SUBTOTAL							5,976

21. SUPPORTING FACILITIES	22.CGF	23. U/M	24. SCOPE	25. UNIT COST	26. Cost (000)
THIS IS BASED UPON THE 35% EST	1.13		1		
DEMOLITION BUILDING (3 STORY)	1.13	CF	600,000	.50	300
DEMOLITION PAVEMENT (6")	1.13	SF	4,500	2.00	9
COMM SUPPORT	1.13	LF	2,450	8.00	20
OVERHEAD LINES BELOW 15KV 3P4W	1.13	LF	300	40.00	12
UNDERGROUND DUCT 6-WAY-6"	1.13	LF	310	100.00	31
TRANSFMR 3P PAD MOUNT 300 KVA	1.13	KW	300	53.00	16
A/C SURFACE 2" (PARKING)	1.13	SY	8,700	5.00	44
CONE CURB/GUTTER 6"X18" SIDEWA	1.13	LF	3,050	16.00	49
SIDEWALKS 4" CONCRETE	1.13	SY	950	19.00	18
BLACK STEEL 2" (GAS)	1.13	LF	800	5.00	4
BLACK STEEL 6" (WATER)	1.13	LF	700	32.00	22
CAST IRON 6" (SANITARY SEWER)	1.13	LF	250	36.00	9
CONC REINF 36"& 18"(STORM DRN)	1.13	LF	950	76.00	72
CONCRETE PILING	1.13	LF	15,400	26.00	400
HEATING	1.13	LF	1,300	35.00	46
EXTERIOR LIGHTING	1.18	EA	12	3,000.00	36
EMCS CONNECTIONS	1.18	LS			3
SITE IMPROVEMENTS	1.13	LS			16
QUALITY CONTROL	1.13	LS			42

27. SUPPORTING FACILITY SUBTOTAL	1,149
28. PRIMARY + SUPPORT SUBTOTAL (20 + 27)	7,125
29. CONTINGENCY (5.0%)	356
30. TOTAL CONTRACT COST (28 + 29)	7,481
31. SIOH (5.5%)	411
32. TOTAL REQUEST (30 + 31)	7,892
33. TOTAL REQUEST ROUNDED	7,900
34. EQUIPMENT FROM OTHER APPROPRIATIONS	

AF Form 1178, NOV 88.

Attachment 1-1

FY 1990 PROJECT COST ESTIMATE WORKSHEET - DETAIL COST ESTIMATE				
1. PDC NUMBER AWUB885601		2. PROJECT TITLE DORMITORIES		3. DATE 880913
4. MAJCOM ACC	5. BASE/STATE/INST CODE BARKSDALE AFB LA			6. ACF .88
7. CONST START 900400	8. MTHS OF CONST 12	9. PG DATE 9010	10. CURRENT PA	11. EXCHANGE RATE .0000
12. PRIMARY FACILITIES AMN PERMANENT PARTY/PCS DORM		13. CAT CODE 721-312	14. SCOPE 83,000	15. EQUIP DOLLAR, OTHER APPN

16. BUILDING UNIFORMAT SYSTEM	($000)	17. SUPPORTING FACILITIES	($000)
SUBSTRUCTURE		THIS IS BASED UPON THE 35% EST	
SUPERSTRUCTURE		DEMOLITION BUILDING (3 STORY)	300
ROOFING		DEMOLITION PAVEMENT (6")	9
EXTERIOR CLOSURE		COMM SUPPORT	20
INTERIOR CONSTRUCTION		OVERHEAD LINES BELOW 15KV 3P4W	12
INTERIOR FINISHES		UNDERGROUND DUCT 6-WAY-6"	31
SPECIALTIES		TRANSFMR 3P PAD MOUNT 300 KVA	16
PLUMBING		A/C SURFACE 2" (PARKING)	44
H.V.A.C.		CONE CURB/GUTTER 6"X18" SIDEWA	49
SPECIAL MECHANICAL		SIDEWALKS 4" CONCRETE	18
ELECTRICAL		BLACK STEEL 2" (GAS)	4
SPECIAL ELECTRICAL		BLACK STEEL 6" (WATER)	22
EQUIPMENT		CAST IRON 6" (SANITARY SEWER)	9
CONVEYING SYSTEMS		CONC REINF 36"& 18"(STORM DRN)	72
		CONCRETE PILING	400
UNIFORMAT SUBTOTAL		HEATING	46
		EXTERIOR LIGHTING	36
OTHERS SUBTOTAL	5,976	EMCS CONNECTIONS	3
		SITE IMPROVEMENTS	16
		QUALITY CONTROL	42

18. BUILDING TOTAL	5,976
19. SUPPORTING FACILITY SUBTOTAL	1,149
20. PRIMARY + SUPPORT TOTAL	7,125
21. CONTINGENCY (5.0%)	356
22. TOTAL CONTRACT COST	7,481
23. SIOH (5.5%)	411
24. TOTAL REQUEST	7,892
25. TOTAL REQUEST ROUNDED	7,900

AF Form 1178B, NOV 88.

Attachment 1-2

PDC #: AWUB885601 E Block 9 of DD Form 1391 BASE: BARKSDAL RM: ACC PG24

Item	UM	Quantity	$/Qty	Tot Cost
DORMITORIES	SF	83,000	64	5,312
SUPPORTING FACILITIES				1,035
UTILITIES	LS			(345)
SITE IMPROVEMENTS	LS			(345)
PAVEMENTS	LS			(345)
SUBTOTAL				6,347
CONTINGENCY (5%)				317
TOTAL CONTRACT COST				6,664
SUPERVISION, INSPECTION AND OVERHEAD (6.0%)				400
TOTAL REQUEST				7,064
TOTAL REQUEST (ROUNDED)				7,100

PF 1 - Redo Support Categories PF15 - Print Screen PF16 - EXIT

PRINTED BY: DCG ON 93/07/30 AT 12:44:45

Attachment 2

PROJECT: TEST01
PROJECT DESCRIPTION: Barksdale Dormitories

PROJECT COMMENT:

BUILDING TOTAL GROSS FLOOR AREA: 82,999 SF
GEOLOCATION: BARKSDALE AFB
ESTIMATED BY: CHRIS PROTZ
ESTIMATE DATE: 07/16/1993
REPORT FILE: 93203113.md2
COST DATABASE: NAT92R

ESCALATION MODIFIER: Mid-Point of Construction

DATE: 07/22/1993 PARAMETRIC MODELS SYSTEM CONSTRUCTION COST REPORT

SYSTEM DESCRIPTION	MATERIAL	LABOR	EQUIPMENT	TOTAL	% TOTAL
FACILITY: DORM					
01 SUBSTRUCTURE	467,106	104,952	32,687	604,745	11.6%
02 SUPERSTRUCTURE	445,939	137,374	14,225	597,539	11.4%
03 ROOFING	246,652	61,344	5,254	313,251	6.0%
04 EXTERIOR CLOSURE	196,697	176,733	3,224	376,655	7.2%
05 INTERIOR CONSTRUCTION	321,615	247,167	4,991	573,773	11.0%
06 INTERIOR FINISHES	200,657	214,528	3,807	418,992	8.0%
07 SPECIALTIES	97,278	47,287	1,159	145,725	2.8%
08 PLUMBING	285,075	254,418	5,694	545,187	10.4%
09 H.V.A.C	204,688	178,236	3,794	386,719	7.4%
10 SPECIAL MECHANICAL SYSTEMS	97,663	2,194	46	99,903	1.9%
11 ELECTRICAL	324,452	498,495	3,377	826,325	15.8%
12 SPECIAL ELECTRICAL SYSTEMS	45,890	76,090	442	122,423	2.3%
13 EQUIPMENT	8,386	999	26	9,413	0.2%
14 CONVEYING SYSTEMS	198,003	13,300	986	212,291	4.1%
FACILITY TOTAL	$3,140,106	$2,013,123	$79,718	$5,232,948	100.0%
FACILITY: SUPP					
17 SITE PREPARATION	2,722	35,602	50,472	88,797	25.5%
18 SITE IMPROVEMENTS	46,430	27,050	6,788	80,268	23.0%
19 SITE CIVIL/MECHANICAL UTILITIES	74,151	10,604	6,819	91,575	26.3%
20 SITE ELECTRICAL UTILITIES	50,047	36,174	1,797	88,020	25.2%
FACILITY TOTAL	$173,352	$109,431	$65,878	$348,662	100.0%
FACILITY: Project					
99 CONTRACTOR OVERHEAD AND PROFIT	1,239,002	355,297	1,920	1,596,220	100.0%
FACILITY TOTAL	$1,239,002	$355,297	$1,920	$1,596,220	100.0%
TOTAL CONSTRUCTION COST	$4,552,461	$2,477,851	$147,517	$7,177,830	100.0%
PERCENT OF TOTAL	61.6%	33.5%	2.0%		

Attachment 3

DATE: 07/22/1993

PARAMETRIC MODELS
SYSTEM CONSTRUCTION COST REPORT

TIME: 05:03:15

PROJECT: TEST01
PROJECT DESCRIPTION: Barksdale Dormitories

PROJECT COMMENT:

BUILDING TOTAL GROSS FLOOR AREA: 82,999 SF
GEOLOCATION: BARKSDALE AFB
ESTIMATED BY: CHRIS PROTZ
ESTIMATE DATE: 07/16/1993
REPORT FILE: 93203050.md2
COST DATABASE: NAT92R

ESCALATION MODIFIER: Mid-Point of Construction

DATE: 07/22/1993

PARAMETRIC MODELS
SYSTEM CONSTRUCTION COST REPORT

TIME: 05:03:15

SYSTEM DESCRIPTION	MATERIAL	LABOR	EQUIPMENT	TOTAL	% TOTAL
FACILITY: DORM					
01 SUBSTRUCTURE	467,106	104,952	32,687	604,745	11.6%
02 SUPERSTRUCTURE	445,939	137,374	14,225	597,539	11.4%
03 ROOFING	246,652	61,344	5,254	313,251	6.0%
04 EXTERIOR CLOSURE	196,697	176,733	3,224	376,655	7.2%
05 INTERIOR CONSTRUCTION	321,615	247,167	4,991	573,773	11.0%
06 INTERIOR FINISHES	200,657	214,528	3,807	418,992	8.0%
07 SPECIALTIES	97,278	47,287	1,159	145,725	2.8%
08 PLUMBING	285,075	254,418	5,694	545,187	10.4%
09 H.V.A.C	204,688	178,236	3,794	386,719	7.4%
10 SPECIAL MECHANICAL SYSTEMS	97,663	2,194	46	99,903	1.9%
11 ELECTRICAL	324,452	498,495	3,377	826,325	15.8%
12 SPECIAL ELECTRICAL SYSTEMS	45,890	76,090	442	122,423	2.3%
13 EQUIPMENT	8,386	999	26	9,413	0.2%
14 CONVEYING SYSTEMS	198,003	13,300	986	212,291	4.1%
FACILITY TOTAL	$3,140,106	$2,013,123	$79,718	$5,232,948	100.0%
FACILITY: SUPP					
17 SITE PREPARATION	2,722	35,602	50,472	88,797	25.5%
18 SITE IMPROVEMENTS	46,430	27,050	6,788	80,268	23.0%
19 SITE CIVIL/MECHANICAL UTILITIES	74,151	10,604	6,819	91,575	26.3%
20 SITE ELECTRICAL UTILITIES	50,047	36,174	1,797	88,020	25.2%
FACILITY TOTAL	$173,352	$109,431	$65,878	$348,662	100.0%
FACILITY: Project					
99 CONTRACTOR OVERHEAD AND PROFIT	1,139,068	223,452	1,920	1,364,441	100.0%
FACILITY TOTAL	$1,139,068	$223,452	$1,920	$1,364,441	100.0%
TOTAL CONSTRUCTION COST	$4,452,527	$2,346,007	$147,517	$6,946,052	100.0%
PERCENT OF TOTAL	62.2%	32.8%	2.1%		

Attachment 4

READING AND WRITING IN A SUPPORTIVE ENVIRONMENT (R-WISE)

Sarah Alexanderson
Summer Research Program
High School Student

East Central High School
7173 Farm Road 1628
San Antonio, TX 78263

Final Report for:
Summer Apprentice Program
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Brooks Air Force Base, San Antonio, TX

August 1993

READING AND WRITING IN A SUPPORTIVE ENVIRONMENT (R-WISE)

Sarah Alexanderson
Summer Apprentice
Armstrong Laboratory
East Central High School

ABSTRACT

This report is based on the Reading and Writing in a Supportive Environment (R-WISE) computer program. This program was designed to help tutor ninth graders on their reading and writing skills. This report is going to give you ideas about how the R-WISE program works and looks. R-WISE has eight tools: Freewriting (Dinosaur Drag), Sticky Notes, Writing Pad, Thought Log, Crossword Puzzle, Cubing, Revision, and Idea Board. In addition to describing this software, I will tell you how I helped with the R-WISE program.

Reading and Writing in a Supportive Environment
(R-WISE)

Sarah Alexanderson

INTRODUCTION

My report is on R-WISE, a computer program designed to help tutor ninth graders in reading and writing by using different tools designed to build up their verbal skills. R-WISE stands for Reading and Writing in a Supportive Environment. This tutor was designed at the Armstrong Laboratory at Brooks Air Force Base in San Antonio, Texas.

R-WISE has eight tools that are used to help tutor ninth graders. These tools are like little lessons that teach the students better verbal skills. These tools should enable students to write more clearly and with greater understanding. The R-WISE tools are (1) Freewriting (Dinosaur Drag), (2) Sticky Notes, (3) Cubing, (4) Idea Board, (5) Revision, (6) Crossword Puzzle, (7) Thought Log, and (8) Writing Pad. In the upcoming paragraphs I am going to tell you about each tool, how it is used, and what it looks like.

FREEWRITING

The first tool is Freewriting (also known as Dinosaur Drag). This is a warm-up exercise that allows the student to write about anything the teacher wants him to write about. Entries do not have to be in complete sentences; they can be in phrases. This tool could be used at the very beginning of the class to

get the student's mind going and thinking of ideas. The screen is divided into three main areas: the scoreboard, the dinosaur track, and the writing pad. The writing pad is where the student types. The dinosaur track is a path with a dinosaur on it. As the student types, he moves the dinosaur down the track. It takes about three typed lines for the dinosaur to get to the finish line. Each time the student reaches the finish line he gets one point or lap. When the student reaches the finish line, he will hear a beep and then a box comes up and says, "WOW! you have completed one lap." To get rid of this box and go back to typing, the student will have to click on the continue button. The box comes up every time the dinosaur reaches the finish line. If the student needs HELP, he can go to the menu bar under HELP. If the student is writing about a story and needs to see the reading, he can go up to ACTIONS and go to SEE READING. If the student needs to start over, then he can go to ACTIONS and select START OVER. Freewriting provides a "gaming" environment that helps motivate the student to write longer, more fluent passages.

STICKY NOTES

Sticky Notes is a tool that electronically duplicates using small yellow note pads with sticky stuff on the back to help a person remember little things. With this tool, the students makes little notes that remind him about things in the reading . To be able to make a Sticky Note the student highlights the word or phrase in the reading and then goes to the ACTIONS

menu and chooses NEW NOTE. A small yellow "sticky note" will appears with the term the student has highlighted. At this point, the student can type interpretations or explanations of the highlighted word or phrase. Going to ACTION and selecting HIDE NOTE stores the information. If the student wants to see what he has typed, he goes to the bottom of the screen and clicks on STICKY NOTEBOOK. This brings up another screen that displays all the notes made so far in alphabetical order. If the student wants to add more to a note that is already in the STICKY NOTEBOOK, he goes to ACTION menu and selects SHOW NOTE, and the appropriate yellow note appears. If the student decides that he no longer wants a sticky note he has written, then he can go to ACTION and choose THROW AWAY NOTE. If the student wants to see the reading, he can click on RETURN TO READING at the bottom of the screen.

THOUGHT LOG AND WRITING PAD

Thought Log and Writing Pad are very much the same. They are both computer interfaces that look like pieces of spiral notebook paper. They are designed like a journal, and they keep the date for each entry. Each day the student just adds pages. The system never deletes pages unless the student deletes them. If the student has been typing everyday for two weeks he could go back to the first week on any day and look at what he entered on a particular day. The only difference between the Thought Log and the Writing Pad is their purpose. Thought Log's purpose is for the teachers to display questions about

how the student viewed the lesson he was currently doing. When printed, the questions and answer will be on the same page. The Writing Pad's purpose is the same as a journal or a word processor. It is basically the same as the Thought Log. Next to the page there are four buttons: (1) First, (2) Previous, (3) Next, and (4) Last. The buttons refer to the pages the student has typed. To start a new page, the student goes up to ACTIONS, and then goes to NEW PAGE. The only limitation is that the student is allowed only three new pages per day.

CROSSWORD PUZZLE

The Crossword Puzzle is a tool to test comprehension skills. The student is given a reading assignment and a puzzle that goes with the assignment. First, the student has to choose a reading assignment and then read it. Second, the student has to go to ACTIONS and choose CROSSWORD PUZZLE. Then the computer will build a puzzle for that reading. When a student clicks on an empty square, he gets the first clue. The system will only give three clues at a time for a word. It will tell the student to go back to the reading if the student uses all these clues and still does not get the correct answer.

CUBING

Cubing is a tool designed to focus the student's ideas. Cubing has two main parts: (1) the Pre-writing stage and (2) the Writing stage. The Pre-writing

stage has a couple of steps to it. The student has to pick a Topic, then a Reader, a Scenario, and a Plan. The computer usually picks the Reader and Scenario randomly. There are nine choices for the Reader: (1) Alicia the Willing Listener, (2) Edward the Nodder, (3) Mary Ellen the Expert, (4) Melaine the Fence Sitter, (5) Jullian the Antagonist, (6) Juan the Evaluator, (7) Andy the Outsider, (8) Veronica the Insider, and (9) Frank the General Reader. Additionally, there are nine Scenarios to choose from: #1 Cause and Effect, #2 Explain, #3 Compare, #4 Entertain, #5 Persuade/Argue, #6 Inform, #7 Tell a Story, #8 Feeling, and #9 Opinion. There are six choices for the Plan; (1) Describe, (2) Compare, (3) Associate, (4) Analyze, (5) Apply, and (6) Argue.

Now once the student finishes picking all of this, he goes to the Writing Stage, where there are two parts. Part one, Composing, has a box with lines where the student can enter the text. On the side of the box there are six buttons: (1) See Profiles, (2) Change Cube, (3) Think About It, (4) Get A Hint, (5) Get Advice, and (6) Final Edit. When the student clicks on See Profiles, he can review the Reader and the Scenario picked for the writing. If the student clicks on Change Cube, he can pick a new Plan. If the student clicks on Think About It, two more button will pop up: Transitional Words and Leading Prompts. If the student clicks on Transitional Words, he will have three levels to choose from: more general, same level, and more specific. If the student clicks on Leading Prompts, he has the same level of words as Transitional Words, but he has to click on one of the levels to see any list of words. If the student clicks on Get A Hint, R-WISE will give him some hints about how to continue writing.

If the student clicks on Get Advice, he gets suggestions from an expert that knows all about the topic. The system is designed to look like a prescription from a doctor. If the student clicks on Final Edit, the system will take the student to the final stage of this tool. The display looks like paper on the bottom half of the screen, and the top part has two buttons: (1) Return To Composing and (2) Click To Choose Paragraph. When the student finishes with the Final Edit, he is done with the Cubing Tool.

IDEA BOARD

Idea Board is a tool designed to take a student through all the steps from planning to revising by using proven principles of idea mapping. is technique may also be known as "clustering" or "webbing." In Idea Board the student has four stages: Planning Stage, Idea Mapping, Paragraph Stage, and Organize Stage. In the Planning Stage the student develops a specific purpose, assesses his audience, selects an effective form, and identifies possible difficulties he may have with his topic. To choose a Planning Stage, the student clicks on the number of the choice he wants to select. The computer then takes the student to another screen where he clicks on the sentence that best describes his knowledge and attitude about the topic and reader.

The next stage is Idea Mapping, which involves writing only key words and small phrases to support the key words. In this stage the student is brainstorming ideas. Here the student uses a thesis statement and phrases

or words that support the thesis statement. On the Idea Map screen, the student has a big box with his thesis statement with six boxes connected to the thesis box. When the student clicks on one of the six boxes, he can type in a supporting idea. Then nine little boxes pop up to contain the other ideas that develop the supporting idea of the thesis statement. There are eight buttons on the side, but in this stage the student is only allowed to use four of them: P-Planning, IM-Idea Map, PL-Paragraph Level, O-Organize. The next stage is Paragraph Level where the student develops each supporting idea for a paragraph. On this interface, the student also links the sentences together into a paragraph.

Also at this stage, the student has buttons that access expert advice: Think About It, Get A Hint, and Get Advice. (The buttons are the same for Cubing). Additionally, the student has four buttons which help in writing: (1) S-Sentences, (2) T-Topic sentence, (3) L-Linking sentences, and (4) V-Viewing. The last and final stage is the Organize Stage, from which the student goes to Final Paragraph. A big box displays the typed paragraphs. On the left side of that, the student has four buttons: P-Planning, IM-Idea Map, PL-Paragraph Level, O-Organize. As an additional feature, a box above both of them has the numbers of paragraphs. When the student is satisfied with his paper, he is finished with Idea Board.

REVISION

The Revision Tool helps revise the paper in stages. There are two main stages: Specifying the Goal and Editing the Paper. In the first stage, the student has to pick from six answers to six questions. The questions involve: The Reader's Age, Reader's Knowledge, Reader's Attitude, Writer's Distance, Writer's Tone, and Writer's Purpose. To get to the next stage, the student clicks on Go On. This takes the student to Editing the Paper. On the screen there are basically three long boxes. On the left side are eight paragraph number buttons. Under that is the Advice button and the Hint button. Under those buttons there are Edit 3, Edit 1, and Edit 2. The last button on the left is the Goals button. The middle box is the biggest. This box displays the text. The box on the right gives advice on how to diagnose problems and how to improve the organization and development of the paper.

CONCLUSION

The eight tools described above are integrated into a single, seamless environment. I think R-WISE will be very valuable to our society. This tutor is really going to help ninth grade students improve their reading and writing skills. I think it has helped me a little, too. I think the R-WISE will succeed in the world.

ADDITIONAL EXPERIENCES

In my eight weeks as a High School Apprentice, I have learned quite a bit. I was a very busy person. I always had plenty to do. I learned how to use Micro Soft Word, and I think that is the best experience. I learned much about the R-WISE program because I have used it and tested all of the tools. I typed almost all the lessons for the Teacher Training. So I know almost all there is about the R-WISE program. This was a great experience for me. I am so glad I had the opportunity to get in this program.

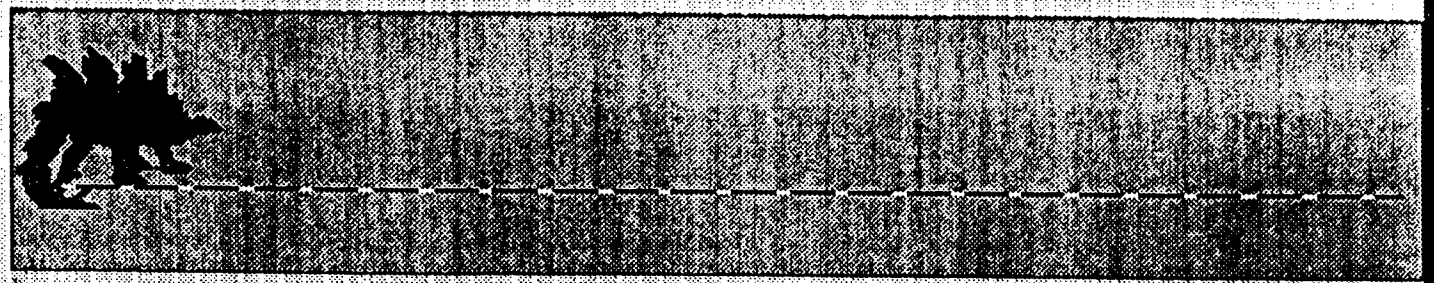
REFERENCE

Patricia M. Harn, R-WISE User's Manual.

FREEWRITING

File Edit Text Actions Tools Help

SCOREBOARD :



VERN's STICKY NOTES

File Tools Actions Edit Text Help

STICKY NOTEBOOK

evolved -

Return to Reading

THOUGHT LOG

File Edit Text Actions Tools Help

4/9/93 THOUGHT LOG PAGE 1

TEACHER: PERIOD:

STUDENT NAME:

FIRST

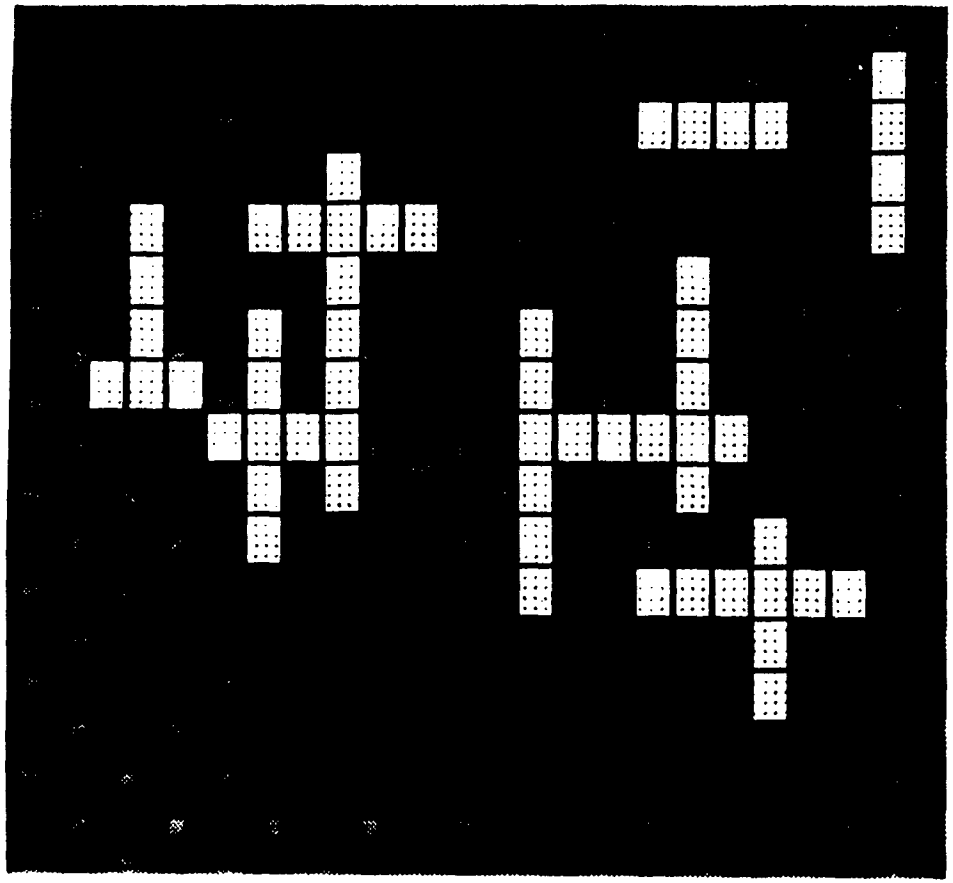
PREVIOUS

NEXT

LAST

CROSSWORD PUZZLE

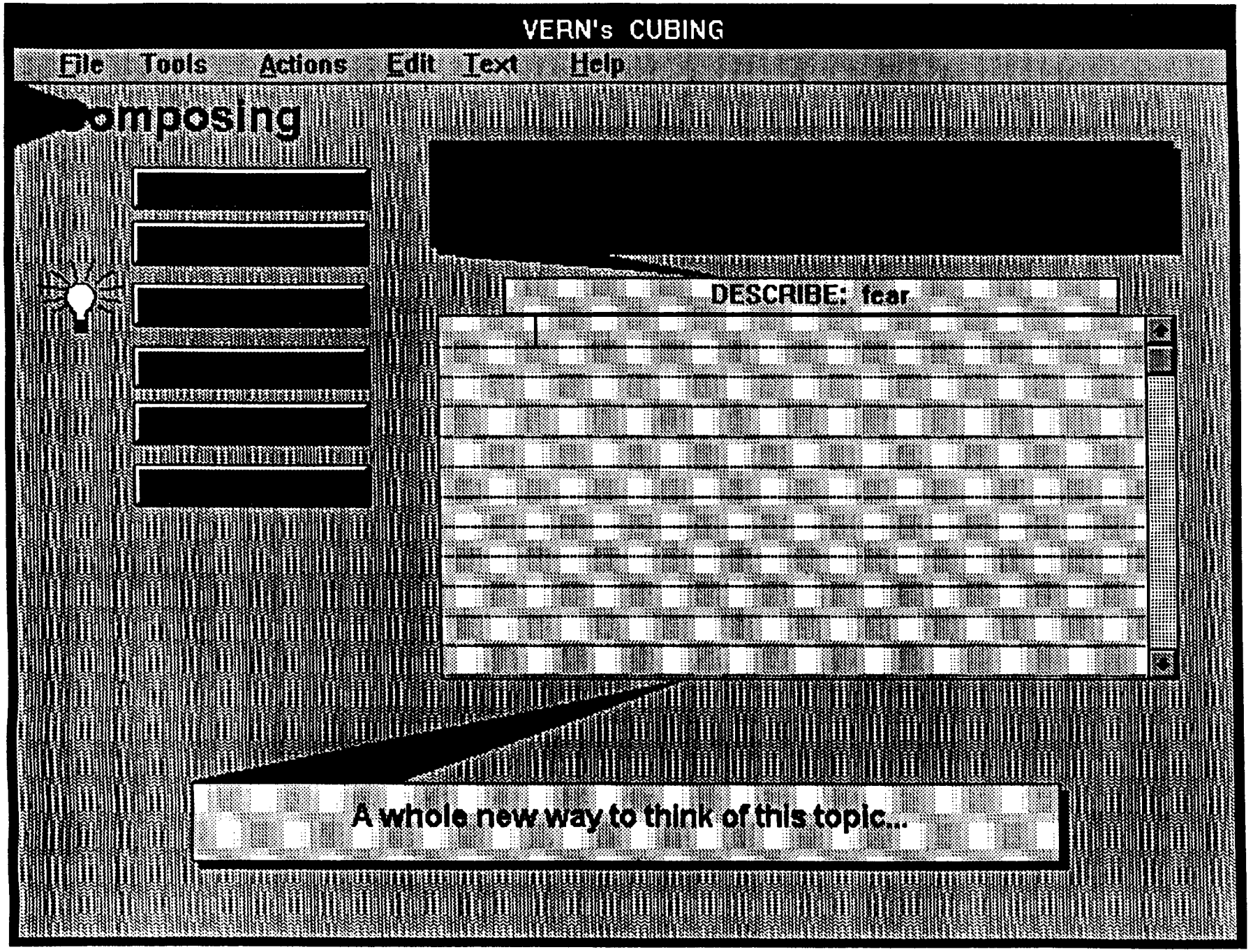
File Edit Text Actions Tools Help



INSTRUCTIONS

Click to Remove

To fill in the blanks on the crossword, click on an empty square of the puzzle. You'll be given a clue: a sentence from the reading containing the word to be filled in. Type in the word you think should go in the sentence and press ENTER. If you're right, R-WISE will enter the word in the puzzle. If not, you'll be given another clue. After the third clue, you can go back to review the reading if you wish.


VERN's CUBING
File Tools Actions Edit Text Help
omposing
DESCRIBE: fear
A whole new way to think of this topic...

VERN's CUBING

File Tools Actions Edit Text Help

Profiles

READER PROFILE

MARY ELLEN, THE GENERAL READER: Many times, your reader may only be a face in a crowd. In other words, you may not know much about your audience, other than he is of average intelligence and has diverse interests. A similar situation would be when you meet someone for the first time. You wouldn't take a chance of making a bad impression by acting like an obnoxious know-it-all nor would you risk seeming to be too shallow to have a serious thought.

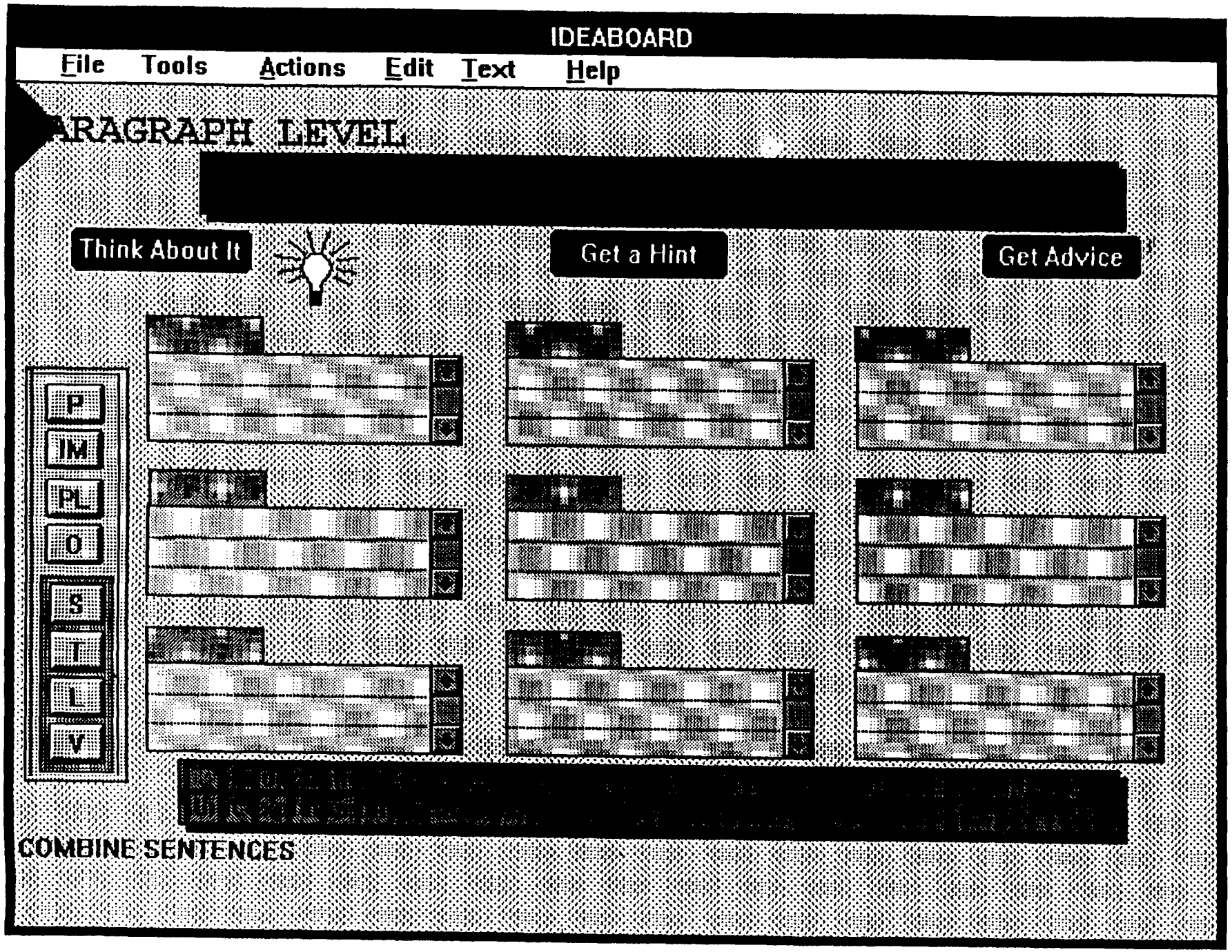
When writing for the GENERAL READER, present yourself as a thoughtful and

SCENARIO PROFILE

EXPLAIN: Your teacher has assigned each member of the class a writing partner. You have been paired with Mary Ellen the general reader. As you discuss plans for your writing assignment, Mary Ellen the general reader says she has only a vague idea of what "fear" means, so she wants you to explain "fear" to her.

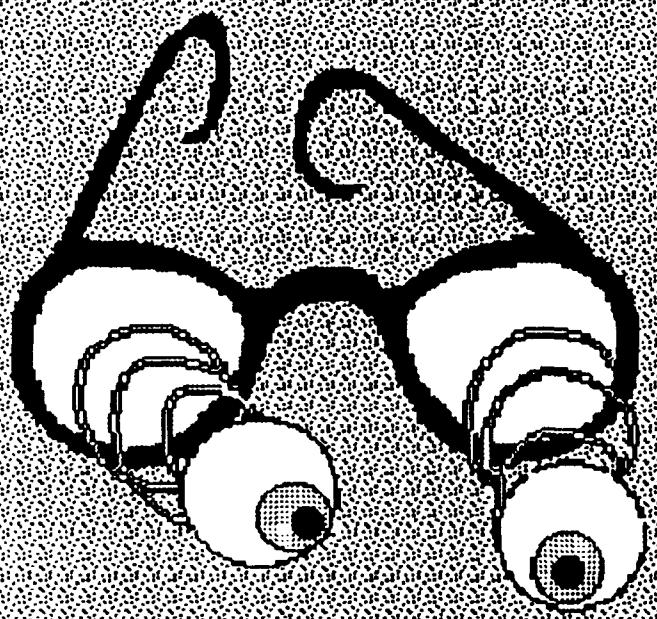
Explain "fear" to Mary Ellen the general reader.

Return


IDEABOARD
File
Tools
Actions
Edit
Text
Help
ARAGRAPH LEVEL
Think About It
Get a Hint
Get Advice
P
IM
PL
O
S
T
L
V
COMBINE SENTENCES

REVISION

File Tools Actions Edit Text Help



Welcome to RE-vision

Go On

This tool will help you to review your writing. By stepping back and "re-seeing" your paper as your reader will see it, you can improve both the content and the structure.

REVISION

File Tools Actions Edit Text Help

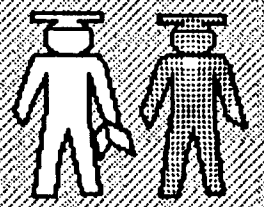
Goal Specifications

Reader's Age

Go On

How we "sound" when we write depends a great deal on the age of the reader. For example, you would not write the same way for your high school principal as you would for your seven-year-old brother.

Using the mouse, move the slider to the position that best represents your reader's age in relation to your own.



Younger Same Older

MY EXPERIENCE AS AN RDL SUMMER EMPLOYEE

David J. Danelo

High School Student

San Antonio Christian School

25 Burwood

San Antonio, TX 78216

Final Report for:

High School Apprenticeship Program

Armstrong Laboratory

Sponsored by:

Air Force Office of Scientific Research

Brooks Air Force Base, San Antonio, TX

MY EXPERIENCE AS AN RDL SUMMER EMPLOYEE

This report, as the title suggests, will detail my experiences as an RDL summer employee. My participation in the High School Apprenticeship Program (HSAP) took a somewhat different turn then I had initially anticipated. When I received the notice that I was chosen to be a summer employee, my impression was that I would be participating in some kind of technical research. In actuality, I have been exposed to various kinds of work -- everything from library tasks to computer maintenance.

I was able to work in this capacity for two main reasons. First, the division I was assigned to, Human Resources Plans & Programs (HRP), is not a research oriented division, so I had little opportunity to participate in any kind of research. Second, my mentor took some time to show me standard office procedures when I first arrived. This was beneficial from the beginning, as it gave me the familiarity with a general worksetting, whereas my peers had to take more time to adjust.

As I have previously mentioned, having "nothing to do" was a problem I rarely experienced. One of my main responsibilities was to administer the AFOSR Summer Research Program among high school students, graduate students, and college faculty. That task took up a fair amount of time the first couple of weeks, since I was just learning basic office skills.

My afternoons were taken up with working as a library aide. The Human Resources technical library had been understaffed all summer, so my mentor asked me if I would mind helping them. Each

working day, I spent the afternoon doing various inventory projects, and other basic library tasks. Working in the library gave me a good appreciation for the work it takes to maintain a proper level of organization.

Another interesting situation I encountered during my tenure at the Armstrong Lab occurred about three weeks after I started. The computer I was doing most of my work on developed a major problem. I spent about a week with the resident computer experts learning how to debug a computer, install programs, and configure systems.

Another responsibility I had was to aid my mentor in tracking the progress of the Small Business Innovation Research (SBIR) Program. My mentor is currently responsible for monitoring several current efforts in the SBIR Program, so I was able to assist her in her work. Working in this capacity gave me new knowledge of government funded research, and gave me a greater understanding of the various nuances of government related work.

In conclusion, my experience with the Summer Research Program administered by RDL has been a very positive one. I hope that future students will benefit from this program as much as I have. I encourage both RDL and Armstrong Laboratory to continue making this program available to as many high school students as possible.

LITERATURE SEARCHES AT HRTC

Janette Dominguez
High School Student

Harlandale High School
114 E. Gerald
San Antonio, TX 78214

Final Report For:
High School Apprenticeship Program
Armstrong Laboratory

Sponsored By:
Armstrong Laboratory
Human Resource Directorate
Technical Training Research Division
Brooks Air Force Base, San Antonio, Texas

August 1993

LITERATURE SEARCHES AT HRTC

Janette Dominguez
High School Apprentice School
Harlandale High School

While working in the Instructional Design Branch at the Human Resources Laboratory, I did not only have the opportunity to experience what a scientist work environment is like, but I had the task of providing the scientists with information by conducting literature searches. A small research study was done, which involved how I would construct a mental model and guidelines for doing literature searches. After being exposed to both the GAIDA and PLS-ID Advisor programs provided by my branch, I revised my steps on doing literature searches. The main objective was to see which set of instructions in the programs did I apply to develop my procedure on literature searches for learners.

MY TASKS AT HRTC

Janette Dominguez

My main task while working in this program was to gather the topics that were given by the scientists to conduct literature searches. Some topics I researched were on teaching, mentoring, behavior, EEG and complex decision making, neurophysiology of complex decision making, gender differences and high school achievement, and sexual abuse and dreams. I searched for the topics using the SPIRS program on the computer. I would either download or print the abstracts. After the information was reviewed, then I would provide the scientists with more information on the topic by finding the journals or books selected. I also developed the steps on conducting literature searches for a small research project.

The main objective on this literature project was to demonstrate if the events on the GAIDA and PLS-ID Advisor programs would improve my skills on writing steps on how to conduct literature searches and if the information provided would help other learners. My first draft of steps on "Steps to Doing A Literature Search," (27-8) was development by my own experience on how I have been doing literature searches on the computer using SPIRS. When I wrote the first draft, I was not exposed to any type of training or programs. The next step was to use the nine events of instructional events on the GAIDA program (27-9) and write a summary and revise my steps (27-10/13) on doing literature searches. The third step was to make any adjustments,

after using the PLS-ID advisor.

I also had the experience of doing some office administration work such as make copies, answer phones, fill order forms, and organize tech reports. I found working with the computers to be very interesting. I had the opportunity to learn about the Microsoftware program. I also enjoyed making slides for the scientists' presentations by using Powerpoint. I think working at Human Resources Directorate has been a rewarding learning experience.

Literature Search: Which is the most essential tool?

People learn additional information or have new ideas, when they conduct a research to gain knowledge. After a problem and hypothesis has been stated, then a literature search can be developed as the third step in developing a paper for a project. Doing a search for a project or research paper can be easily done if the proper tools are used. Using the proper tools and being well-organized can save people time. It may help to state some reasons, develop research questions, determine methods, and analysis the procedure in preparation to make the project run smoothly. Sources such as bibliographies, statistical references, and directories/newspapers can be beneficial when conducting a search. Books can provide complete information on a subject, but it may not contain recent information. To do a literature search, I have had the opportunity to experiment with CD-ROM databases.

The CD-ROM databases have a variety of selections and are equipped to provide essential information on the topics entered. For example, I have found that the ERIC database has given me the output needed in conducting literature searches. If there is not enough adequate information considering the topic I have entered, then finding other terms may be helpful; if there is an excess amount of abstracts on a certain topic, then the topic can be narrowed down to get the specific information necessary. The abstracts on the ERIC database can be selected

and printed or downloaded on a disk for convenience. Some other databases provide journals. The journals have been helpful because it gives current information. The CD-ROM databases have many options to help make a literature search effective.

First Draft: Steps To Doing A Literature Search

1. Select which CD-ROM database to use.
   -Citation Index, ERIC, GPO, MathSci, Sociofil, Social Sciences, Ulrich's Plus, Wilsondic Library Literature, or Wilsondic Applied Sciences and Index.

2. The Main Menu will appear.
   -Select Silver Platter if using EconLit, ERIC, GPO, NTIS, PSYCLIT, or Sociofile.

3. The system will start and ask if the user would like to find, use thesaurus (F9), database (F3), or retrieval system (F1).

4. Type in word or phrase, then press enter to search.

5. The screen will list the number of records on the topic given.

6. If needed, narrow search.
   -Operator words: and, with, near, not
   -By year use: py with =,<, >, _>, <_, or -.

7. Press (F4), to see records.

8. Scroll through abstract by using page down or up.
   -Mark the selected abstracts by pressing enter.

9. When finished marking abstracts there will be several options on the menu.

10. To print press "p."
    -A list of print options will appear.
    -If needed, make changes.
     Fields to print: All
     Records to print: Marked
    -Start print when ready.

11. To download press "d."
    -Similar procedure and options apply to print.

12. When finished printing or downloading press "Esc."

13. A list of commands will appear.
    -Press enter, to type more searches.
    -Press "Q" to quit.

14. Don't forget to remove disc.

TABLE 1

GAIDA: EVENTS OF INSTRUCTION AND THEIR RELATION TO PROCESSES OF LEARNING

INSTRUCTIONAL EVENT	RELATION TO LEARNING PROCESS
1. Gaining attention	1. Reception of patterns of neural impulses
2. Informing learner of the objective	2. Activating a process of executive control
3. Stimulating recall of prerequisite learning	3. Retrieval of prior learning to working memory
4. Presenting the stimulus material	4. Emphasizing features for selective perception
5. Providing learning guidance	5. Semantic encoding; cues for retrieval
6. Eliciting the performance	6. Activating response organization
7. Providing feedback about performance correctness	7. Establishing reinforcement
8. Assessing the performance	8. Activating retrieval; making reinforcement possible
9. Enhancing retention and transfer	9. Providing cues and strategies for retrieval

GAIDA: Steps To Doing A Literature Search

First, select which CD-ROM database disc will provide the most accurate information.
There is a selection of discs such as: Citation Index, ERIC, GPO, MathSci, Sociofil, Social Sciences, Ulrich's Plus, Wilsondic Library Literature, or Wilsondic Applied Sciences and Index.

Watch the Main Menu appear by pressing any key to start.
On the Main Menu select Silver Platter. (If using EconLit, ERIC, GPO, NTIS, PSYCLIT, or Sociofile.)

The system will begin and the options- to find, use the thesaurus (F9), the database (F3), or the retrieval system (F1) will appear.

Next, type in the word or phrase that will be used to conduct the research and then press "enter" to search.

Look the screen has listed the number of records on the topic given.

Use the following terms to narrow the search:
Operator words: and, with, near, not
By year use: py with =, <, >, _>, _<, or -.

The records can be seen by pressing (F4).

Scroll through the abstracts by using "page down or up." Then mark your selected abstracts by pressing "enter." Watch the asterisks appear on the left side of the abstracts, when being marked.

When the abstracts have been marked then several options will be listed on the bottom of the screen.

To print the abstracts, press "p." Look for the list of print options to appear. If needed press "c" to make changes such as:
Fields to print: All
Records to print: Marked
When ready press "enter" to start the printing.

Downloading is another option which can be obtained by pressing "d." Downloading has a similar procedure and options that apply to printing.

When the printing or downloading has been completed, press "Esc."

Watch for a list of commands to appear. To type in more search words or phrases, press "Enter." To quit, simply press "Q."

Don't forget to remove the disc and place it in the proper slot of the shelf.

GAIDA is a set of instructions that helps support the process of learning. In reviewing the nine events of instructional design in GAIDA, I have found several GAIDA events to have been helpful. The first instructional event was gaining attention. I think gaining the learner's attention is the most important event. If the learner does not gain attention, then there will be a lack of interest and participation. Informing the learner of the lesson objective can be used as a guideline. With given information, the learner will be able to know if the procedure he is following is correct. If incorrect, the learner can correct it before going on any further and hopefully, it can be improved. I think getting the learner to recall information from prior learning will not always be necessary. The three events of presenting stimuli with distinctive features, guiding learning, and eliciting performance all demonstrate the action that has occurred in following the procedure. Providing informative feedback is important to the tester because he needs to be informed on how and what things are affective to the learner. Asking questions as instructions can give the learner different ideas to explore. The ninth event of enhancing retention and learning transfer was not very clear.

I learned that the nine events were not used in my first set of steps. I have made changes to get the learner's attention and used words such as "next," to inform the learner that he is following the procedure correctly. The learner was also informed what kind of results should occur in doing the steps. My method

of writing steps has normally been by using numbers and fragments, but I have learned that by using more complete sentences can make the steps clearer to the learner.

TABLE 2

COMPONENTS OF THE PLS-ID ADVISOR PROCESS

Phase I: Analysis

Phase II: Design

Phase III: Development

Phase IV: Implementation

Phase V: Maintenance

PLS ID Advisor: Steps To Doing A Literature Search

First, select which CD-ROM database disc will be the most helpful in finding the information needed.
There is a selection of discs such as: Citation Index, ERIC, GPO, MathSci, Sociofil, Social Sciences, Ulrich's Plus, Wilsondic Library Literature, or Wilsondic Applied Sciences and Index.

Watch for the Main Menu to appear by pressing any key to start. When the Main Menu appears select Silver Platter. (If using EconLit, ERIC, GPO, NTIS, PSYCLIT, or Sociofile.)

The system will begin and the options such as: to find, use the thesaurus (F9), the database (F3), or the retrieval system (F1) will appear.

Next, type in the word or phrase that will be needed to do research on and then press "enter" to search.

Look the screen has listed the number of records on the topic given.

Is there too many records on the topic entered?
Use the following terms to narrow the search:
Operator words: and, with, near, not
By year use: py with =, <, >, _>, _<, or -.

The records can be seen by pressing (F4).

Scroll through the abstracts by using "page down or up." Then mark the selected abstracts by pressing "enter." Watch the asterisks appear on the left side of the abstracts marked.

When the abstracts have been marked then several options will be listed on the bottom of the screen.

To print the abstracts, press "P." Look for the list of print options to appear. If needed press "C" to make changes such as:
Fields to print: All
Records to print: Marked
When ready press "enter" to start the printing.

Downloading is another option which can be obtained by pressing "D." Downloading has a similar procedure and options that apply to printing.

When the printing or downloading has been completed, press "Esc."

Watch for a list of commands to appear. To type in more search words or phrases, press "Enter." To quit, simply press "Q."

Don't forget to remove the disc and place it in the proper slot of the shelf.

I think the PLS-ID Advisor can be useful for only certain scientific projects. The PLS ID Advisor was not as specific as the GAIDA program. The context of the PLS ID Advisor contained five phases. By using Phase I: Analysis, I could not relate it to the steps I had listed. I think key words that show what will occur next had to be used to complete Phase II: Design. The phase of development, simply modifies to use specific buttons to enter. Implementation was not very clear or to the point. This program contained phase five, maintenance that can be used to explain how to do a literature search for scientists at Armstrong Human Resources Laboratory.

Examinee Selection of Recycling Instruction or Practice Items for Computer Administered Tests

Rebecca C. Mortis
Student
Incarnate Word High School

727 E. Hildebrand
San Antonio, Tx. 78238

Final Report For:
Summer Research Program
Armstrong Laboratory

Sponsored By:
Air Force Office of Scientific Research
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Examinee Selection of Recycling Instructions or Practice Items for Computer Administered Tests

Rebecca C. Mortis
Student
Incarnate Word High School

Abstract

Computers have revolutionized the testing world. Providing practice items along with the instructions for a test and then giving the examinees the chance to recycle the instructions and/or practice items are just a few of the options that are now made available through computerized testing. An analyses of examinees' performance on sixteen subtests, measuring cognitive processes, was conducted to determine whether the option to recycle the instructions and/or practice items affected the examinees' subtest performance. It was concluded that the option to recycle did not have a profound effect on the examinees' overall subtest performance.

Since 1945, multiple aptitude testing batteries have been given using paper and pencil tests (Anastasi, 1976). These tests, however were limited in the abilities that they could measure. Most batteries given by pencil and paper methods could only assess a limited range of a person's abilities.

Computers have opened a whole new world of testing methods not available to the traditional paper and pencil tests. Computers have changed our ideas of what tests can and should be. Memory tests, processing speed tests, and learning tests are several domains that computerized testing unveiled. Non-lock-step group battery administration is possible. Timed items as well as item response times are available. Computerized testing can give on-line item, test and composite performance feedback.

Providing practice items along with the instructions for a test and then giving the examinees the chance to recycle the practice items and/or the instructions are just a few of the options now accessible to computerized tests. When the subjects are given the chance to recycle the instructions before beginning the test, they have the opportunity to begin the test when they feel sure that they fully comprehend the task that is required. This, in turn, increases the reliability of the test as a true measure of a person's aptitude in a specific content area rather than how well that person could comprehend the instructions. The question therefore arises as to what factors prompt a person's choice to recycle the instructions and/or the practice items.

It is believed that two factors influence a person's decision to review. These two factors are that person's basic ability and

how well that person performed on the first taking of the practice items. It is hypothesized that the lower ability examinees would choose to review the instructions and/or practice items more often than the higher ability examinees. It is also hypothesized that the examinees who performed poorly on the practice items would choose to review the instructions and /or practice items more often than the examinees who performed better on the practice items. Further, it is contended that after recycling the instructions and/or practice items, the subtest performance would be about equal for examinees regardless of the option selected.

Method

Subjects

The subjects were 1,288 Airmen tested on their 18th day of basic training. The sample was predominantly male (n=1,145) and white (n=1,005).

Instruments

Advanced Personnel Test Battery (APT). The APT battery is a computer administered cognitive ability test battery containing 16 subtests. The subtests are based on a consensus information processing model. The cognitive processes measured are processing speed, working memory, skill learning, induction, general knowledge, and fact learning. These processes are measured using three knowledge domains: verbal, quantitative, and spatial. The responses are entered using a keyboard.

Armed Services Vocational Aptitude Battery (ASVAB). The ASVAB is a paper and pencil, multiple choice battery. It contains ten

subtests that measure verbal, quantitative, spatial, perceptual speed, and technical abilities. The Air Force forms five composites from the ten subtests: a measure of general learning ability, the Armed Forces Qualifying Test (AFQT); and four job classification measures, Mechanical (M), Administrative (A), General (G), and Electronics (E). All of the Armed Services use the AFQT to select enlisted personnel. M, A, G, and E are used by the Air Force to classify the selectees into jobs.

Procedure

The APT battery was given to airmen on their 18th day of basic training during a 3 1/2 hour testing session. The examinees were tested in same sex groups of 40 at individual testing stations. Instructions, testing, and feedback were all computer administered with proctors available to answer questions. The tests were administered on Unisys 386, 25 MHz desktop microcomputers with standard keyboards.

Half of the subjects received the APT battery in an established order. The other half of the examinees received the subtests in the reverse order. Detailed computer administered instructions proceeded the items in each of the subtests. All subtests, except for the three that measured fact learning ability, contained practice items at the conclusion of their instruction set. Following the practice items the examinees were given one of three recycle options: to recycle the subtest instructions and take additional practice items; to take only additional practice items; or to immediately begin the subtest. One subtest (PSV4) had two parts and another test (GKS2) had three parts. Because each of

these parts had individual instructions and the three options applied the parts are treated as individual subtests. Thus, there were 16 subtests each with complete instruction sets.

The ASVAB was administered prior to the examinee's admission into basic training. The ASVAB scores were obtained from master files maintained by the Air Force Human Resources Directorate.

Results

Samples. Comparisons first were conducted between the AFQT scores of individuals in the two samples using a t-test. Two sets of analyses were accomplished. In the first, the AFQT scores of Sample 11 were compared with those in Sample 12. In the second, the scores of the subsamples who completed 16, 15, 14, and 13 subtests were tested. Results of all analyses revealed no significant differences for any of the comparisons. The two samples were merged for further analyses.

Recycle Option. The percent of examinees choosing each of the three recycle options are provided in Table 1. In general, the subtests that are intuitively harder, such as the spatial subtests, have instruction sets that the examinees were more likely to recycle. For every subtest, more than fifty percent of the examinees chose to begin the subtest (Option 3) without further review of the instructions or practice items. For seven of the subtests (i.e., PSQ2, WMQ4, SLV2, INQ3, GKSa, GKSb, and GKSc) over eighty percent of the subjects chose Option 3. Further, only three of the subtests (i.e., WMS3, SLQ3, and INS2) have ten percent or more of the examinees recycling the entire instruction set (Option

1), and in fact, six of the subtests have less than one percent of the examinees choosing this option. A comparison of Option 1 versus Option 2 shows that having more practice is the overwhelming choice for examinees who decided to recycle back instead of beginning the test.

Table 1

Percent of Examinees Who Chose Each Recycle Option for Each of the 16 Subtests

SUBTEST	RECYCLE OPTION		
	1	2	3
PSV4a (n=1123)	01.07 (n=12)	23.78 (n=267)	75.16 (n=844)
PSV4b (n=1090)	03.49 (n=38)	31.78 (n=341)	65.23 (n=711)
PSQ2 (n=1156)	00.52 (n=6)	17.56 (n=203)	81.92 (n=947)
PSS1 (n=1190)	02.77 (n=33)	26.81 (n=319)	70.42 (n=838)
WMV1 (n=1252)	04.55 (n=57)	39.86 (n=499)	55.59 (n=696)
WMQ4 (n=1283)	00.78 (n=10)	09.90 (n=127)	89.32 (n=1146)
WMS3 (n=1288)	10.79 (n=139)	32.53 (n=419)	56.68 (n=730)
SLV2 (n=1288)	03.11 (n=40)	16.54 (n=213)	80.36 (n=1035)
SLQ3 (n=1283)	16.84 (n=216)	26.97 (n=346)	56.20 (n=721)
INV1 (n=1268)	7.33 (n=93)	39.59 (n=502)	53.08 (n=673)
INS2 (n=1255)	14.42 (n=181)	27.01 (n=339)	58.57 (n=735)
INQ3 (n=1253)	02.23 (n=28)	10.85 (n=136)	86.91 (n=1089)
GKQ0 (n=1217)	00.66 (n=8)	36.07 (n=439)	63.27 (n=770)
GKSa (n=1164)	00.69 (n=8)	10.65 (n=124)	88.66 (n=1032)
GKSb (n=1152)	00.52 (n=6)	17.80 (n=205)	81.68 (n=941)
GKSc (n=1131)	00.18 (n=2)	10.34 (n=117)	89.48 (n=1012)

Note. OPTION 1 = Review the Instructions and the Practice Items; OPTION 2 = Review the Practice Items; OPTION 3 = Begin the Subtest. Standard deviations are in parentheses.

AFQT and Option Selection. Inspection of Table 2 shows that as anticipated, the examinees who chose to begin the subtest (Option 3) had higher mean AFQT scores than those examinees who chose to review the practice items (Option 2) who , in turn, had higher mean AFQT scores than those who chose to review the entire instruction set (Option 1). There are two subtests in which the mean score for the examinees who chose Option 2 was higher than those who chose Option 3, PSV4a and WMV1. However, for PSV4a the difference in AFQT scores was two tenths of a point. Examinees who chose Option 1 had a higher mean score than those who chose Option 2 for the subtests PSQ2, GKSa, and SLV2. Two of these subtests (PSQ2 and GKSa) had a low count of examinees (n=6 and n=8, respectively, choosing Option 1).

The results in Table 2 confirm the hypothesis contending that a person's basic ability influences his/her choice to recycle the instructions and/or practice items. The lower ability examinees, as reflected by their lower AFQT scores, did indeed choose to review the instructions and/or practice items more often than the higher ability examinees.

Table 2

Mean and Standard Deviation of AFQT Scores of Examinees Who Chose Each Recycle Option for Each of the 16 Subtests

SUBTEST	RECYCLE OPTION		
	1	2	3
PSV4a	59.33 (15.28)	65.87 (15.33)	65.66 (16.54)
PSV4b	63.83 (15.70)	64.30 (15.65)	66.69 (16.47)
PSQ2	76.67 (13.14)	64.54 (16.10)	65.60 (16.27)
PSS1	60.31 (12.93)	64.77 (15.89)	65.59 (16.43)
WMV1	60.46 (12.47)	65.87 (16.14)	64.70 (16.44)
WMQ4	60.00 (12.95)	62.45 (15.79)	65.09 (16.19)
WMS3	56.81 (14.36)	64.52 (15.55)	66.34 (16.37)
SLV2	63.00 (16.31)	60.18 (14.70)	65.82 (16.26)
SLQ3	61.89 (15.08)	62.24 (14.86)	66.91 (16.75)
INV1	58.09 (14.70)	64.68 (16.17)	65.98 (16.10)
INS2	57.59 (13.58)	61.40 (14.90)	68.30 (16.37)
INQ3	59.74 (17.72)	61.81 (15.49)	65.41 (16.13)
GKQ0	60.00 (13.28)	64.88 (15.93)	65.10 (16.41)
GKSa	74.00 (08.04)	64.19 (15.73)	65.32 (16.37)
GKSb	60.00 (11.28)	66.12 (15.62)	66.31 (16.32)
GKSc	61.00 (07.07)	61.04 (13.69)	65.89 (16.51)

Note. OPTION 1 = Review the Instructions and the Practice Items; OPTION 2 = Review the Practice Items; OPTION 3 = Begin the Subtest. Standard deviations are in parentheses.

Practice Score and Option Selection. The relationship between performance on the practice items and the recycle option selected is shown in Table 3. In all instances, examinees who chose to begin the subtest (Option 3) had a higher mean practice score than the examinees who chose to recycle only the practice items (Option 2); who, in turn, had a higher practice score than the examinees who chose to recycle the entire instruction set (Option 1). The one exception was a general knowledge spatial test (GKSa) in which the mean score for the examinees who chose Option 1 was higher than that of Option 2. On four of the tests the examinees scored high (more than two out of three correct) regardless of the option selected. These tests were PSV4a, PSQ2, WMQ4, and GKSa. Conversely, the mean scores for the subtest WMV1 averaged less than one correct out of three, regardless of the option chosen.

The results displayed in Table 3 substantiates the hypothesis stating that the examinees who received lower practice scores would choose to recycle more often than examinees who received higher practice scores.

Table 3

Mean and Standard Deviation of Practice Scores of Examinees Who Chose Each Recycle Option for Each of the 16 Subtests

SUBTEST	RECYCLE OPTION		
	1	2	3
PSV4a	2.50 (1.00)	2.61 (0.65)	2.83 (0.42)
PSV4b	1.58 (0.83)	2.11 (0.74)	2.61 (0.60)
PSQ2	2.17 (0.75)	2.55 (0.65)	2.79 (0.48)
PSS1	1.55 (0.87)	2.09 (0.76)	2.49 (0.67)
WMV1	0.23 (0.50)	0.59 (0.65)	0.93 (0.79)
WMQ4	2.20 (1.03)	2.49 (0.63)	2.81 (0.46)
WMS3	0.18 (0.49)	0.94 (0.99)	1.83 (1.20)
SLV2	3.13 (1.56)	3.61 (1.32)	4.74 (1.28)
SLQ3	2.29 (1.14)	2.51 (1.03)	3.21 (0.95)
INV1	0.63 (0.76)	1.26 (0.79)	1.95 (0.83)
INS2	0.50 (0.76)	1.18 (0.94)	2.39 (0.82)
INQ3	0.54 (0.96)	2.00 (0.82)	2.72 (0.60)
GKQ0	0.88 (0.64)	0.98 (0.67)	1.40 (0.75)
GKSa	2.75 (0.46)	2.65 (0.63)	2.89 (0.36)
GKSb	1.5 (1.38)	1.76 (0.72)	2.51 (0.65)
GKSc	1.00 (0.00)	2.09 (0.73)	2.68 (0.56)

Note. OPTION 1 = Review the Instructions and the Practice Items; OPTION 2 = Review the Practice Items; OPTION 3 = Begin the Subtest. Standard deviations are in parentheses.

Subtest Performance and Option Selection. The hypothesis asserting that subtest performance for examinees would be about equal, regardless of the option chosen, after recycling the instructions and/or practice items, was not confirmed. There does not appear to be any strong trends existing in the relationship between subtest performance and option selection. However, it can be noted that in only three instances did the examinees who chose to recycle the entire instruction set (Option 1) score higher than the examinees who chose to begin the test (Option 3). Similarly, there were only three instances in which those examinees who chose Option 1 scored higher than those who chose to recycle only the practice items (Option 2). Only four instances existed where those who chose Option 2 had a better score than those who chose Option 3. Thus, Table 4 shows a slight tendency that examinees who chose either Option 1 or Option 2 performed slightly lower than those examinees who chose Option 3.

Table 4

Mean and Standard Deviation of Subtest Percent Correct Scores of Examinees Who Chose Each Recycle Option for Each of the 16 Subtests

TEST	RECYCLE OPTION		
	1	2	3
PSV4a	90.00 (05.27)	90.32 (10.53)	89.17 (09.76)
PSV4b	89.18 (10.75)	90.87 (06.84)	89.87 (07.81)
PSQ2	84.33 (10.26)	87.93 (08.75)	89.42 (09.17)
PSS1	76.10 (20.22)	86.33 (14.99)	84.85 (15.51)
WMV1	66.87 (24.46)	76.83 (18.48)	70.94 (22.70)
WMQ4	77.00 (08.97)	74.67 (16.42)	77.24 (14.04)
WMS3	49.25 (26.71)	63.31 (23.52)	64.96 (26.21)
SLV2	83.85 (17.27)	83.96 (18.40)	88.10 (15.75)
SLQ3	87.23 (13.93)	84.22 (14.35)	86.18 (15.31)
INV1	54.84 (19.14)	59.02 (18.20)	62.08 (18.00)
INS2	75.53 (14.33)	76.95 (13.91)	81.22 (11.65)
INQ3	69.64 (27.92)	83.27 (20.03)	85.40 (18.27)
GKQ0	37.13 (10.79)	32.21 (09.35)	33.07 (09.69)
GKSa	81.25 (13.24)	83.50 (08.61)	85.04 (09.82)
GKSb	80.83 (09.70)	83.88 (07.85)	85.50 (08.82)
GKSc	57.00 (21.21)	83.56 (08.39)	85.72 (07.86)

Note. OPTION 1 = Review the Instructions and the Practice Items; OPTION 2 = Review the Practice Items; OPTION 3 = Begin the Subtest. Standard deviations are in parentheses.

Discussion

One of the reasons for providing recycle options on the instruction sets of computerized tests is to allow examinees to dispel any confusion that they might have regarding the instructions. The reason for this is to guarantee that the examinee's score on the test is a true measure of that person's ability and not just a measure of how well that person understood the instructions. However, in this particular study, it did not appear that the examinees used the recycle options for this purpose, as very few chose to recycle the entire instruction set and more opted to recycle only the practice items. Examinees who did choose to recycle apparently did so not because they did not understand what they were supposed to do, but rather because they wanted more practice before beginning the test.

A factor that may have influenced examinees' selection of additional practice was the scores that they received on the practice items. In almost all instances, the examinees who chose to begin the subtest had a higher mean score than those examinees who chose to recycle the instructions and/or practice items. However, the mean practice score differences between those who recycled and those who immediately began the test were often small (half of the differences were under one half of a point). Nonetheless, there does appear to be a small relationship between greater differences and the percentage of examinees who recycled. Thus the hypothesis that the examinees who performed poorly on the practice items would choose to recycle more often than those examinees who received higher practice scores was essentially

proven to be true.

Learning ability, as measured by the AFQT, appears to explain at best a trivial amount of the decision to recycle the practice items. It does, though, offer a bit more of an explanation for the few examinees who chose to repeat the entire instruction set. Those who repeated the instructions often had about a five point lower mean AFQT (around a one-third of a standard deviation). The hypothesis that lower ability examinees would choose to recycle appears to be weakly supported.

Finally, allowing the examinees to recycle the instructions and/or practice items did not equalize subtest performance for the examinees represented by all three of the option groups. Only about five subtests have more-or-less level performance across the three options. These simple analyses cannot address the issue of whether the use of recycle options effect the examinee's subtest scores, given the slight difference in AFQT and practice score performance of the examinees represented by the three option groups.

Conclusion

In conclusion, it was evident that a person's basic ability and how well that person performed on the first taking of the practice items did influence his/her decision to review. In general, lower ability examinees, as well as examinees who performed poorly on the practice items, chose to review the instructions and/or practice items more often than the higher ability examinees, as well as the examinees who obtained a higher

practice score. However, to what extent a person's ability and his/her practice score affects his/her decision to review can not be determined until more sophisticated analyses have been performed

References

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CONDUCTING LITERATURE SEARCHES: MY SUMMER EXPERIENCE

Kimberly Ondrusek
High School Student

East Central High School
7173 Farm Road 1628
San Antonio, TX 78263

Final Report for:
High School Apprenticeship Program
Armstrong Laboratory

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CONDUCTING LITERATURE SEARCHES: MY SUMMER EXPERIENCE

Kimberly Ondrusek
High School Apprenticeship Student
Brooks Air Force Base

Abstract

The summer research I conducted, consisted mostly of using the literature search machines. I used them to help assist in some of the research needed for the scientists in my department. Once I learned how to use the literature search machines, my mentor gave me a project. I wrote a step-by-step procedure on how to use the literature search machines. The next phase of my project, was to revise it using the nine events of GAIDA, which were previously developed by my branch. The third phase of my project was to again revise my first draft, using the program PLS ID Advisor.

CONDUCTING LITERATURE SEARCHES: MY SUMMER EXPERIENCE

Kimberly Ondrusek

Literature searches make research much easier. They have a large variety of information on a large range of topics. Instead of using a card catalog or journal list, you simply type in a keyword. It gives abstracts from journals or books. Then the user is able to go look up the information. The literature search machines are very easy and uncomplicated to use, and are a good source of research information.

My summer project, was to write individual summaries and step-by-step outlines, using the GAIDA and PLS ID Advisor programs. To begin the project, the first step was to pretend to be the branch expert on conducting literature searches. I was to be called away from my job for a while; a temporary replacement would take my place. I wrote a precise explanation on how to use the literature search machine; (pages 29-7--29-8). Next, I wrote a two page summary on conducting literature searches; (pages 29-5--29-6). Then I wrote a step-by-step outline of the correct way to use the literature search machines; (pages 29-7--29-8). After the first part of the project was complete, I was given part two.

Part two of my project, contains mostly the same components as part one. For part two of my project, I revised part one, by using the GAIDA system. I made a summary page of what I thought

of the GAIDA system, based on the information from my first step-by-step outline; (page 29-9). After completing the summary, I used the GAIDA system to revise my step-by-step outline; (pages 29-10--29-12).

Part three of my project, was to write a summary stating how I liked the PLS ID Advisor system. Like GAIDA, this system was also developed by the department I had the opportunity to work in. The PLS ID Advisor summary page is found on page 29-13 of my report. For part three, I also revised my step-by-step procedure page, using the PLS ID Advisor computer program; (pages 29-14--29-15). Part three is the final phase of my "Conducting a Literature Search" project.

I really enjoyed my summer, and found it to be very productive and enlightening. I had many opportunities to learn new concepts. I learned to use "Word Perfect", "Microsoft Windows", "Microsoft Power Point", and most of all, to perform literature searches. I enjoyed my eight week stay at Brooks Air Force Base and in the Instructional Design Branch. Everyone I met or had the opportunity to work with was very nice and helpful. I am glad that I had the opportunity to be a part of this program.

CONDUCTING LITERATURE SEARCHES

Although literature searches may be used for a variety of projects, they are most commonly used for scientific research. The literature search machines used at the Human Resources Directorate are located in Building 578. If anyone is not sure about how to use the program, the librarians will be glad to help them.

Once the user has been given or has selected the key words, they are ready to begin their literature search. To begin using the literature search machine, the user should first select the disc that will give the most material on their particular subject. For example, if the key word is associated with psychology, they should not choose the EconLit disc, because it deals with Economics. They would need to choose a disc such as Eric, PsychLit, or Social Sciences. After successfully finding the correct disc, it is time to enter the key words. Some examples of key words include: Mentoring, Behavior Modeling, Intelligent Design, and Courseware Automation. After the first key word is entered, lists of journal titles will appear on the screen along with abstracts from those journals. The search program will allow the user to scan through and read the abstracts and titles. A particular abstract may be marked and then printed out, or the abstracts can be downloaded onto a diskette.

The CD Rom's have different characteristics that allow the

user to perform many different types of searches. One feature of the program is to allow the operator to only look up the information that was published in or after a certain year.

I find the literature searches to be very easy and uncomplicated to operate. The program seems to be very straight forward and user friendly.

HOW TO CONDUCT A LITERATURE SEARCH: First Draft

Here is a step-by-step list of the correct way to conduct a literature search:

1. Select the key words.

2. Select the CD disc.

3. Place the disc in the bottom drive of the CD Rom.

4. Move the cursor arrow down, until you find the name of the disc, then press Enter.

5. Some programs will ask if journals or books are wanted. Press the spacebar to check the entry, then press Enter. If the disc only contains journals, then the FIND cursor will automatically appear at the bottom of the screen.

6. Next, the cursor will be blinking, with the word FIND in front of it.

7. Type in the first key word, and push Enter; a list will come up on the screen, telling how many abstract entries there are on that particular topic.

8. If there are any listed press F4 and it will show the abstracts and titles. If there is a 0 beside the key word, then type in another key word at the cursor and press Enter.

9. After pressing F4, and getting the list of abstracts, use the Page Down key or the arrow keys to scroll through them.

10. Now, read the abstracts to preview the articles, if you like the abstract, then you can mark it and save it to print out or download at a later time. To mark the abstract, press Enter and *'s will line the left side of the abstract.

11. Continue to scroll through until reaching the very end. When ready to print out press "P". A screen will then appear. If you wish to print the abstracts and titles, press "C", to change the options. Change the" Fields to Print:" from CITN, to ALL. Then, Change " Field Labels", to (Long). Press Enter and make sure the printer is on and ready to print. Press Enter again, and it will print out only the abstracts that were marked.
    If you wish to Download instead of print, press "D".

Before downloading, press "C" to change the options to All and Long. Also change the filename before downloading. Insert a formatted disk into Drive A, and press Enter to begin the download process. It will then download the marked abstracts onto the disk.

12. After the computer is finished either downloading or printing the information, press "F" for FIND, then enter the next key word.

13. For each other key word from that same disc, follow steps 6-12.

14. When the literature search is complete, press "Esc", then press "Q" for Quit. This will take you back to the main menu. Once this point is reached, press the eject button on the CD Rom, this will remove the disk.

15. If you want to use another disc for further research, follow steps 1-15.

*** If the field needs to be narrowed by year, at
*** the FIND cursor, type in the key word then py >= year. For
*** example, if they only want journals or books published in or
*** after 1989, on the key word coaching, then type in:
*** "Coaching and py >= 1989" and press Enter. It will
*** then give a number of terms for that topic. Repeat
*** steps 8-12.

SUMMARY: REVISING USING GAIDA

The nine events of Instructional Design include:

1. Gaining attention
2. Informing learner of lesson objective
3. Stimulating recall of prior learning
4. Presenting stimuli with distinctive features
5. Guiding learning
6. Eliciting performance
7. Providing informative feedback
8. Assessing performance
9. Enhancing retention and learning transfer

These events are listed along with examples in the GAIDA computer program and also in the book, Principles of Instructional Design. Gagné, Briggs, and Wager, 1992.

My first Draft, found on page 29-4, of my final report, was written prior to learning these nine events; it already contained most of them. However, it did not contain "gaining attention", because I did not use any words such as "look" or "watch". It also did not contain "presenting stimuli with distinctive features", however I have corrected the paper, and it now contains it. My original draft also did not talk about "eliciting performance" in any great depth. The other terms my paper did not include were, "assessing performance" and "enhancing retention and learning transfer." It did not contain "assessing performance," because I did not ask questions throughout the course of the paper, however that has been changed. My revised instructions now contain all of the nine GAIDA terms.

Dear Temporary Hire,

Literature searches may be used for a variety of projects, however they are mostly used for scientific research. As already known, I have been called away form the Branch. I am leaving a step-by-step list of the correct way to conduct a literature search. The machines are very easy to use, and I am sure there will be no problems. To begin, first go up to the library and follow this paper very carefully. After following this step-by-step explanation, you should completely understand the correct way to perform a literature search. You should be able to show everyone how well you understand by the information that is found. I hope you enjoy doing literature searches, and find these directions to be very easy to follow. The step-by-step directions for literature searches are on the next two pages.

GOOD LUCK!!
Kim

HOW TO CONDUCT A LITERATURE SEARCH: 1st Revision

USING GAIDA SYSTEM

Here is a step-by-step list of the correct way to conduct a literature search:

1. Select key words.

2. Select the CD disc. (Did you select the disc with the most information about your topic?).

3. Place the disc in the bottom drive of the CD Rom.

4. Move the cursor arrow down, until you find the name of the disc you are using, then press Enter.

5. Some programs will ask if books or journals are wanted. Look to see if the program gives a choice. Press the spacebar to check the entry, then press Enter. If the disc only contains journals, then the FIND cursor will automatically appear.

6. Next, look for the cursor blinking, with the word FIND in front of it.

7. Type in the first key word, and push Enter; watch the screen, a list will soon come up on the screen, telling how many abstract entries there are on that particular topic.

8. If there are any listed press F4, and it will show the abstracts and titles. If there is a 0 beside the key word, then type in another key word at the cursor and press Enter.

9. After pressing F4, and getting the list of abstracts, use the Page Down key, or the arrow keys to scroll through them.

10. Now, read the abstracts to preview the articles, if you like the abstract, then you can mark it and save it to print out or download at a later time. To mark the abstract, press Enter and *'s will line the left side of the abstract.

11. Continue to scroll through until reaching the very end. When ready to print out press "P". A screen will then appear. If you wish to print the abstracts and titles, press "C", to change the options. Change the "Fields to Print:" from CITN, to ALL. Then change "Field Labels" to (Long). Press Enter. The corrected screen will then appear. Press Enter and it will print out the abstracts that were marked. Then, if the key word contains a lot of information, downloading may be the best solution. Press "D", to make the download screen appear.

Press "C", to change the options to All and Long. Also change the Filename before beginning the download process. Then press Enter to confirm the information. Insert a formatted disk into Drive A and press Enter to begin the download process. The computer will then download onto the disk.

12. After finishing the download or print process, press "F" for FIND, to enter the next key word.

13. For each other key word form that same disc, follow steps 6-12.

14. After completing the literature search, press "Esc", then press "Q" for Quit. This will take the cursor back to the main menu. Once it appears here, press the eject button on the CD Rom, this will remove the disc.

15. If more information is needed from another disk, repeat steps 1-15.

****

If you need to narrow the field of research by year, at the FIND cursor, type in the key word then py>= year. For example, if the researcher only wants journals or books published in or after 1989, on the key word coaching, they would type in: "Coaching and py >=1989" and press Enter. It will then give a number of terms for that topic. Repeat steps 8-12.

SUMMARY: REVISING USING PLS ID ADVISOR

The program PLS ID Advisor, used on the Macintosh computer, is another type of Instructional Design program. It gives steps on how to write an informative, or step-by-step paper, on a large range of topics.

The five main phases of this program include:

1. Analysis
2. Design
3. Development
4. Implementation
5. Maintenance

The program lists these five steps, then expounds on each step. It gives a very good understanding of the way to write an informative paper. The paper that follows is revised by using the Advisor, and the GAIDA program. I found that my paper contained most of the essential items, even before I revised it using the Advisor.

I have now corrected my step-by-step list of conducting a literature search, so that it contains all the phases used by the Macintosh computer.

HOW TO CONDUCT A LITERATURE SEARCH: 2nd Revision
USING PLS ID ADVISOR

Here is a step-by-step list of the correct way to conduct a literature search:

1. Select key words.

2. Select the CD disc.

3. Place the disc in the bottom drive of the CD Rom.

4. Move the cursor arrow down, until you find the name of the disc you are using, then press Enter.

5. Some programs will ask if journals or books are wanted. Look to see if the program gives a choice. Press the spacebar to check the choice, then press Enter. If the disc only contains journals, then the FIND cursor will automatically appear at the bottom of the screen.

6. Next, the cursor will be blinking, with the word FIND in front of it.

7. Type in the first key word, and push Enter. Watch the screen, a list will soon come up, telling how many abstract entries there are on that particular topic.

8. If there are any listed press F4, and it will show the abstracts and titles. If there is a 0 beside the key word, then type in another key word at the cursor and press Enter.

9. After pressing F4, and getting the list of abstracts, use the Page Down key, or the arrow keys to scroll through them.

10. Read the abstracts to preview the articles, if you like the abstract, mark it and save it to print out or download at a later time. To mark the abstracts, press Enter and asterisk's (*'s) will line the left side of the abstract.

11. Continue to scroll through until reaching the very end. When ready to print out press "P". A screen will then appear. If you wish to print the abstracts and titles, press "C" to change the options. Change the "Fields to Print:" from CITN, to ALL. Then change "Field Labels" to (Long). Press Enter. The corrected screen will then appear. Make sure the printer is on and ready to print.

Press Enter, and it will print out only the wanted abstracts.

12. To download instead of print, press "D". Before downloading, press "C", to change the options. Change "Fields to Print", from CITN to ALL. Then change "Field Labels" to (Long). Before downloading, also change the filename. Once finished changing the options, press Enter, to confirm your choices. Insert a formatted disk into Drive A, and press Enter to begin the download process. The computer will then download the abstracts onto the disk.

13. After finishing downloading or printing the information, press "F" for Find, to enter the next key word.

14. For each other key word from that same disc, follow steps 6-12.

15. After completing the literature search, press "ESC", then press "Q" for Quit. This will take you back to the main menu. Once there, press the eject button on the CD Rom, this will remove the disc.

16. If another disc is wanted for more research, follow steps 1-15.

****

If the field of research needs to be narrowed by year, at the FIND cursor, type in the key word, then py>=year. For example, if you only want journals or books published in or after 1989, on the key word coaching, type in: "Coaching and py >=1989" and press Enter. It will then give a number of terms for that topic. Repeat steps 8-12.

THE BUILDING OF THE USAF PANASONIC UD-809AS ALGORITHM

Katherine M. Arnold
Research Associate
Radiation Dosimetry Branch

Brooks Air Force Base
San Antonio, Texas 78235

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Armstrong Laboratory

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THE BUILDING OF THE USAF PANASONIC UD-809AS ALGORITHM

Katherine M. Arnold
Research Associate
Radiation Dosimetry Branch
Armstrong Laboratory

Abstract

In an attempt to improve personnel monitoring for neutron emissions, Panasonic has developed the UD-809AS, a thermoluminescent dosimeter (TLD). The UD-809 contains $^{7}Li_2{}^{11}B_4O_7$ as its first element to measure background gamma radiation. The other three elements are composed of $^{6}Li_2{}^{10}B_4O_7$, which is more sensitive to neutron emissions and is relatively gamma insensitive. Elements 1 and 3 are shielded by cadmium on both sides. Elements 2 and 4 are shielded by cadmium and tin. The goal is to develop an algorithm which will utilize the data gathered from the UD-809 to measure exposure to neutron radiation and thereby be able to calculate the dose to the individual wearing the badge. This report is the primary step in developing this algorithm. Three different existing UD-809 neutron algorithms were analyzed. Suggestions are then offered for future action in building a UD-809 algorithm.

THE BUILDING OF THE USAF PANASONIC UD-809AS ALGORITHM

Katherine M. Arnold

Introduction

Radiation dosimetry is a program which monitors the radiation exposure to individuals working with radiation generating devices or radioactive materials. With advances in radiotherapy, nuclear power, weapons systems, and other nuclear technology, there is an equal need to advance methods of assessing risk of death from cancer to the individuals employed in those occupations that deal with ionizing radiation, which ranges from soft x-rays to fast neutrons. The Panasonic UD-809 was created to better assess exposures to personnel who operate around neutron emitting sources. The UD-809 is specifically designed to measure fast neutron radiation. It is used in conjunction with the UD-802AT. Before the UD-809AS can be put into use, however, an algorithm must be developed to calculate the dose results from the dosimeter readings. To help accomplish this, three UD-809 algorithms were analyzed using data collected at Armstrong Laboratory, Brooks Air Force Base, Texas for the purpose of finding the best components of each algorithm.

Technical Information

The devices used to monitor an individual's exposure to radiation are called thermoluminescent dosimeters, or TLD's.

When exposed to gamma or neutron radiation from 10 keV to 20 MeV and up, the electrons of the thermoluminescent elements inside the TLD move from a stable state to a higher metastable energy level. To measure the exposure, the TLD's are read by a TLD reader. The reader exposes the TLD's to a controlled amount of heat. This causes the electrons to return to their ground states. In the process, the elements release energy in the form of photons (visible light). A mechanism called the photomultiplier tube (PMT) contains devices designed to count the individual pulses of light emitted by each element. Then, by using an algorithm to analyze the results attained from each of the elements, the radiation dose to the individual wearing the badge can be assessed.

The current monitoring method utilizes the UD-802AT TLD. The first two elements of the UD-802AT are lithium borate ($^{7}Li_2{}^{11}B_4O_7$). The last two elements are calcium sulfate ($CaSO_4$).(4) This type of badge is designed to monitor many radiation fields, including beta, gamma, neutron, and x-ray radiation.

The UD-809AS contains $^{7}Li_2{}^{11}B_4O_7$ as its first element to measure background gamma radiation, as it cannot detect neutron radiation. The difference from this element and the lithium borate in the UD-802 is that the UD-809 has cadmium shielding on both sides of Element 1. Cadmium absorbs thermal neutrons and causes the fast neutrons to be transformed to thermal neutrons so the latter can be measured by more sensitive elements. The other three elements are composed of $^{6}Li_2{}^{10}B_4O_7$, which are more sensitive

to neutron emissions. The shielding of the UD-809 makes the individual elements sensitive to particular types of neutron emission energies. Element two has cadmium shielding on the back and tin shielding on the front. Fast neutrons are not easily detected by unshielded $^{6}Li_2{}^{10}B_4O_7$ because of their small cross section, and the unlikely probability of interaction. Element four is the only element that can detect preexisting thermal neutrons, but does not count fast neutrons.(4)

Procedure

Several UD-809's were irradiated to a known dose equivalent, 250 mrem, using both a D_2O and cadmium moderated and an unmoderated 252-Californium source. The badges were then read. The algorithms were then separately applied to this data to trace algorithm development, differences in each set of data, and a percentage of accuracy for each algorithm.

The first algorithm tested was developed by Frederic J. Mis, a Health Physicist at Rochester Gas and Electric's Ginna Station. (3) The algorithm for mixed neutron fields is as follows:

If:

$$(0.8) \leq \frac{(E2-E1)}{(E3-E1)} < 1.2 \quad \text{AND} \quad (E4-E1) \geq 1.5(E3-E1), \quad \text{then}$$

the field of exposure is dominated by neutrons or approximately equal values, and the dose is calculated by the following equation:

$$H_{Cf\text{-}Mod} = .322(E4-E1).$$

UD-809AS Algorithm Study: Results from Mis Algorithm

MOD 252Cf									
badge #									
	E1	E2	E3	E4	E2-E1	E3-E1	E4-E1	E2-E1/E3-E1	DOSE
900011	90.2	370.1	376.44	777.9	279.9	286.24	687.7	0.97785075	221.4
900012	96.6	288.9	298.9	657.2	192.3	202.3	560.6	0.95056846	180.5
900013	78.2	320	279.3	637.8	241.8	201.1	559.6	1.20238687	179.9
900014	73.1	296.9	309.9	728.5	223.8	236.8	655.4	0.94510135	211
900015	95.6	339.7	331.9	617.7	244.1	236.3	522.1	1.03300889	168.1
900022	90.4	320.7	388.7	862.9	230.3	298.3	772.5	0.77204157	248.7
900023	74.4	346.6	389.9	792.3	272.2	315.5	717.9	0.86275753	231.2
900024	79.1	382.7	395	769.2	303.6	315.9	690.1	0.96106363	222.2
900028	86.5	370.9	333.9	674.1	284.4	247.4	587.6	1.14955538	189.2
900030	86.3	316.3	361.7	604.5	230	275.4	518.2	0.83514887	166.9
								AVG:	201.91
UNMOD 252Cf								% ERROR:	19.24%
900016	33.4	50.2	57.6	103.9	16.8	24.2	70.5	0.69421488	UNKNOWN
900017	38.9	55.6	45.9	98.1	16.7	7	59.2	2.38571429	18.3
900018	36.9	71.9	53.9	109.9	35	17	73	2.05882353	22.1
900019	44.3	55.1	67.1	120.3	10.8	22.8	76	0.47368421	UNKNOWN
900020	32.2	57.9	59.4	106.2	25.7	27.2	74	0.94485294	23.8
900025	35.4	52.9	48.7	95.5	17.5	13.3	60.1	1.31578947	18.7
900029	36	54.5	69	132.4	18.5	33	96.4	0.56060606	UNKNOWN
900037	33.6	53.5	55.7	105.6	19.9	22.1	72	0.90045249	23.2
900038	34.4	64.1	59.7	110.3	29.7	25.3	75.9	1.17391304	24.4
900040	41.3	53.3	53.6	112.13	12	12.3	70.83	0.97560976	22.8
								AVG:	21.9
								% ERROR:	91.24%

Table 1

If:

$\frac{(E2-E1)}{(E3-E1)} > 1.5$ AND $\frac{(E2-E1)}{(E4-E1)} < 3$, then

the neutron field has contribution from both thermal neutrons and a higher energy neutron flux. So by calculating a thermal and higher energy number and adding them together, the total dose can be calculated. The equations are as follows:

$H_{thermal} = (E2-E1)(0.02)$

$H_{Cf} = \{E4-[(E2-E1)/6]\} * 0.322$

$H_{Total} = H_{thermal} + H_{Cf}$

If: $\frac{(E2-E1)}{(E4-E1)} > 3$, then the exposure is a non-reactor field.

Using this algorithm, the data in Table 1 was collected. As the data in the table indicates, the dose was calculated to within 20% accuracy for the TLD's exposed to moderated Californium. The results for the unmoderated Californium were not uniform. The "unknowns" are for results where the E2/E3 ratio did not fit into any aspect of the algorithm; therefore, a dose could not be calculated. For the TLD's where results could be calculated, the calculated dose came out to be significantly lower than the delivered dose. In an interview with the author of the algorithm, Mis suggested that an error may have occurred in the exposure of the UD-809's to the unmoderated Californium. This conclusion was reached because the expected response of Element 2 to this source was fifty times higher than the actual

delivered dose. This would indicate that some error did actually occur; however, the results calculated from the moderated Californium are within the tolerance level set forth by the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP is one of two organizations that provides certification for dosimetry laboratories. The tolerance level for neutron radiation is 50% accuracy, so the results from this algorithm are accurate for moderated Californium.

The next algorithm was developed by Ronald M. Thurlow as a master's thesis at the University of Lowell.(5) This algorithm follows the following steps:

1. Subtract the gamma component from elements 2, 3, and 4.

$$E2' = E2-E1$$
$$E3' = E3-E1$$
$$E4' = E4-E1$$

2. Calculate the following ratios:

$$A = E3'/E2'$$
$$B = E4'/E2'$$
$$C = E3'/E4'$$

3. From the above ratios, the C value is compared to J, a constant factor designed to determine the field of exposure. If C is less than J (J = .37) the exposure is assumed to have been to an Americium/Beryllium source. The dose is then calculated by dividing the E4' value by a neutron correction factor (.286) to get the dose equivalent.

4. If the answer to step three was no, then the value of C is compared to I, which is another calculated constant. If C is less than I (I = 2.0), the exposure is assumed to be to a moderated Cf-252 source. The dose for this is calculated by

UD-809AS Algorithm Study: Results from Thurlow Algorithm

MOD 252Cf											
badge #											
	E1	E2	E3	E4	E2-E1	E3-E1	E4-E1	E3'/E2' (A)	E4'/E2' (B)	E3'/E4' (C)	DOSE
900011	90.2	370.1	376.44	777.9	279.9	286.24	687.7	1.022651	2.456949	0.416228	263.4866
900012	96.6	288.9	298.9	657.2	192.3	202.3	560.6	1.052002	2.915237	0.360863	214.7893
900013	78.2	320	279.3	637.8	241.8	201.1	559.6	0.831679	2.314309	0.359364	214.4061
900014	73.1	296.9	309.9	728.5	223.8	236.8	655.4	1.058088	2.928508	0.361306	251.1111
900015	95.6	339.7	331.9	617.7	244.1	236.3	522.1	0.968046	2.138878	0.452595	200.0383
900022	90.4	320.7	388.7	862.9	230.3	298.3	772.5	1.295267	3.35432	0.386149	295.977
900023	74.4	346.6	389.9	792.3	272.2	315.5	717.9	1.159074	2.637399	0.439476	275.0575
900024	79.1	382.7	395	769.2	303.6	315.9	690.1	1.040514	2.273057	0.45776	264.4061
900028	86.5	370.9	333.9	674.1	284.4	247.4	587.6	0.869902	2.066104	0.421035	225.1341
900030	86.3	316.3	361.7	604.5	230	275.4	518.2	1.197391	2.253043	0.531455	198.5441
										AVG:	240.295
UNMOD 252Cf										% ERROR:	3.88%
900016	33.4	50.2	57.6	103.9	16.8	24.2	70.5	1.440476	4.196429	0.343262	246.5035
900017	38.9	55.6	45.9	98.1	16.7	7	59.2	0.419162	3.54491	0.118243	206.993
900018	36.9	71.9	53.9	109.9	35	17	73	0.485714	2.085714	0.232877	255.2448
900019	44.3	55.1	67.1	120.3	10.8	22.8	76	2.111111	7.037037	0.3	265.7343
900020	32.2	57.9	59.4	106.2	25.7	27.2	74	1.058366	2.879377	0.367568	258.7413
900025	35.4	52.9	48.7	95.5	17.5	13.3	60.1	0.76	3.434286	0.221298	210.1399
900029	36	54.5	69	132.4	18.5	33	96.4	1.783784	5.210811	0.342324	337.0629
900037	33.6	53.5	55.7	105.6	19.9	22.1	72	1.110553	3.61809	0.306944	251.7483
900038	34.4	64.1	59.7	110.3	29.7	25.3	75.9	0.851852	2.555556	0.333333	265.3846
900040	41.3	53.3	53.6	112.13	12	12.3	70.83	1.025	5.9025	0.173655	247.6573
										AVG:	254.521
										% ERROR:	-1.81%

Table 2

dividing E4′ by another neutron correction factor (2.61).

5. If C was not less than 2.0, the dose is calculated by applying a thermal neutron correction factor (TNCF) to the thermal component and a fast neutron correction factor (FNCF) is applied to the fast neutron component to determine the neutron dose equivalent. The TNCF and FNCF are found with the following equations:

$$TNCF = 152.26427A^2 - 297.35545 + 157.57566$$
$$FNCF = 4.00252B^2 + 14.12005B - 4.89347$$

The dose is then calculated with the following equation:

$$Dose = (E4-E3) * FNCF + (E2-E3) * TNCF$$

The data calculated using this algorithm is found in Table 2. This algorithm produced very accurate results. The average dose result for the moderated Californium was 240.3 mrem, which is 96.1 percent accurate. The results for the unmoderated Californium were 98.2 percent accurate, with an average dose result of 254.5 mrem. This algorithm procured the best results.

The last algorithm tested was extrapolated from a report written by Hideharu Ishiguro and Shinso Takeda.(2) This algorithm requires pre-identification of the exposure to determine which set of equations to use. The coefficients in each set of equations differs because the neutron energy differs with each type of exposure. For a PuO_2 source the equations are as follows:

$$H_{Nth} = 0.033\ (E2-E3)$$
$$H_{Nep} = 0.012\ ((E3-E1) + 0.37\ (E2-E3) - 0.47\ (E4-E3))$$
$$H_{Nf} = 2.5\ ((E4-E3) - 0.80\ (E2-E3) - 0.19\ (E3-E1))$$

UD-809AS Algorithm Study: Results from Ishiguro Algorithm

MOD 252Cf								
badge #								
	E1	E2	E3	E4	H(th)	H(ep)	H(f)	H(T)
900011	90.2	370.1	376.44	777.9	-0.20922	2.25427	845.1514	847.1964
900012	96.6	288.9	298.9	657.2	-0.33	1.41944	786.8712	787.9606
900013	78.2	320	279.3	637.8	1.3431	1.495032	690.5544	693.3925
900014	73.1	296.9	309.9	728.5	-0.429	1.661	921.6192	922.8512
900015	95.6	339.7	331.9	617.7	0.2574	1.984268	563.1912	565.4329
900022	90.4	320.7	388.7	862.9	-2.244	2.11838	1132.615	1132.49
900023	74.4	346.6	389.9	792.3	-1.4289	2.509012	905.028	906.1081
900024	79.1	382.7	395	769.2	-0.4059	2.630012	777.6456	779.8697
900028	86.5	370.9	333.9	674.1	1.221	2.03808	632.6256	635.8847
900030	86.3	316.3	361.7	604.5	-1.4982	2.415336	544.3056	545.2227
							AVG:	781.6408
UNMOD 252Cf							% ERROR:	-212.66%
900016	33.4	50.2	57.6	103.9	-0.2442	0.151316	114.2928	114.1999
900017	38.9	55.6	45.9	98.1	0.3201	-0.02077	103.464	103.7633
900018	36.9	71.9	53.9	109.9	0.594	0.09548	92.088	92.77748
900019	44.3	55.1	67.1	120.3	-0.396	0.11264	140.3232	140.0398
900020	32.2	57.9	59.4	106.2	-0.0495	0.1936	102.7968	102.9409
900025	35.4	52.9	48.7	95.5	0.1386	0.050732	98.1912	98.38053
900029	36	54.5	69	132.4	-0.4785	0.198	164.952	164.6715
900037	33.6	53.5	55.7	105.6	-0.0726	0.129448	113.9064	113.9632
900038	34.4	64.1	59.7	110.3	0.1452	0.174724	101.4552	101.7751
900040	41.3	53.3	53.6	112.13	-0.0099	0.006006	135.4392	135.4353
							AVG:	116.7947
							% ERROR:	53.28%

Table 3

For ^{241}Am-Be:

$$H_{Nth} = 0.033\ (E2-E3)$$
$$H_{Nep} = 0.011\ ((E3-E1) + 0.22\ (E2-E3) - 0.28\ (E4-E3))$$
$$H_{Nf} = 3.3\ ((E4-E3) - 0.80\ (E2-E3) - 0.19\ (E3-E1))$$

And for ^{252}Cf:

$$H_{Nth} = 0.033\ (E2-E3)$$
$$H_{Nep} = 0.011\ ((E3-E1) + 0.16\ (E2-E3) - 0.20\ (E4-E3))$$
$$H_{Nf} = 2.4\ ((E4-E3) - 0.80\ (E2-E3) - 0.19\ (E3-E1))$$

The results from these equations are shown in Table 3. The calculated dose from these equations was radically inaccurate. Upon further analysis of the development of the equations it was discovered that the conditions for test irradiations and correction factor development were not in compliance with NVLAP standards, so the equations prima facie would be invalid regardless of results.

Conclusions and Recommendations

The algorithm proposed by Ronald Thurlow (5) procured the best results for this set of data. The algorithm proposed by Frederic J. Mis (3) was accurate for moderated Californium; however the discrepancy in the results for unmoderated Californium suggest that perhaps irradiation conditions differed or the neutron energy differed. Further study in this area is needed. The results of Ishiguro's equations (2) emphasize the importance of standardization and continuing research in albedo dosimetry.

The Air Force Dosimetry Program has not yet developed an algorithm for the UD-809/UD-802 badge pack. One standard procedure for developing an algorithm is as follows:

> Algorithm development is begun by mounting dosimeters on a tissue equivalent phantom and irradiating the dosimeters to a known dose from a known type of radiation. . . . The dosimeters are allowed to fade for approximately 24 hours post irradiation, and then they are read in a TLD reader that has been properly calibrated. Element correction factors are applied. . . . The responses of the various elements are divided in order to determine unique ratios that will identify a given type of radiation in the future. This process is repeated for every type of radiation of concern for a given personnel monitoring situation.
>
> Therefore, the algorithm has two major functions which must be completed in sequential order to determine the correct dose equivalent when the radiation type and delivered dose are unknown. First, the algorithm must identify the type of radiation to which a dosimeter was exposed. This is accomplished by comparing element ratios to those observed when the type of radiation was known. Second, the algorithm must determine the proper dose equivalents at the specified depths in tissue. (6)

In order to follow Panasonic's standard procedure for algorithm development, several UD-809AS/UD-802AT TLD's in dual badge holders must be irradiated to determine the unique ratios. From this information, and from the data gathered in the previous algorithm studies, an adequate algorithm can be developed and put into use for the United States Air Force's Dosimetry program.

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Dermal Absorption Rate of Dibromomethane

Sara Berty
Carroll High School

Final Report for:
AFOSR Summer Research Program
Armstrong Laboratory

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

August 1993

Dermal Absorption Rate of Dibromomethane

Sara Berty
Carroll High School

Abstract

In order to determine the absorption rate of dibromomethane, a physiologically based pharmacokinetic model was developed. Cannulas were inserted in the external jugular vein of anesthesized, male Fischer-344 rats, and after each animals' back had been shaved, a glass exposure cell was affixed with adhesive. The following day, the cells were filled with three milliliters of a dibromomethane in mineral oil dosing solution. Blood samples were drawn through the cannula immediately after dosage and again after ½, 1, 2, 4, 8, 12, and 24 hours. The blood was injected into vials containing one milliliter of hexane; and after the samples had been shaken on a vortex evaporator for 15 minutes, the hexane was drawn off the blood and analyzed on the gas chromatograph. The concentration of dibromomethane in the samples was determined from the area counts provided by the gas chromatograph. These values were then used in the physiologically based pharmacokinetic model to estimate the dermal penetration rate of dibromomethane.

Dermal Absorption Rate of Dibromomethane

Sara Berty

Introduction

In order to assess the hazards involved in exposure to potentially dangerous chemicals, their rate of absorption must be measured. Chemicals enter the body through three primary routes: dermal penetration, oral ingestion, and inhalation. In this study, a physiologically based pharmacokinetic model was used to estimate the rate of chemical absorption through rat skin. In the future, these numbers will be used to predict the rate of human dermal absorption, allowing exposure limits and safety standards to be established.

Methodology

Twenty, male Fischer-344 rats in the weight range of 200-250 g, were anesthesized using a ketamine/xylazine solution. While under the anesthesia, a cannula was inserted into the right external jugular vein of each animal. After each rats' back had been shaved, a glass exposure cell was affixed with adhesive, 100 mm from the middle of the head, in the center of the back.

The following day, three milliliters of a dibromomethane in mineral oil dosing solution were injected into each exposure cell. Immediately prior to dosage and again after ½, 1, 2, 4, 8, 12, and 24; 0.1 mL of blood was drawn through the cannula. The blood was then injected into vials

containing one milliliter of hexane. The vials were shaken on a vortex evaporator for 15 minutes. The hexane was then drawn off the blood and analyzed on a gas chromatograph. The concentration of dibromomethane in the sample was determined using the following equation.

$$(((X-960.06)/63{,}933.3)/E*D)$$

X=area count

E=89%; extraction efficiency: the percentage of dibromomethane removed from the blood by the hexane after 15 minutes on the vortex evaporator

D=50; dilution factor

63,933.3=slope of the standard curve

960.06=y-intercept of the standard curve

Using the following equation, the permeability constant K (cm/hr) was determined.

$$K = \frac{(ABS/A/t)}{C}$$

ABS=amount of chemical absorbed

A=area of skin exposed

t=time of exposure

C=chemical concentration

Results

In this study, the penetration rate of dibromomethane and bromochloromethane, in the vehicles corn oil, mineral oil, and water, was determined. For the purposes of this paper, only the data for the permeability constant for dibromomethane in mineral oil will be presented.

Chemical	Vehicle	K_p	$P_{S/V}$	$K_{p,n}$
DBM	min oil	0.02	0.64	0.03

Where K_p is the permeability constant, $P_{S/V}$ is the skin to vehicle partition coefficient, and $K_{p,n}$ is $K_p/P_{S/V}$ (the normalized permeability constant.) The permeability constant indicates the rate at which dibromomethane is absorbed through the skin.

Conclusions

Dibromomethane is a member of the dihalomethane family. Chemicals from this family were chosen because they penetrate skin easily and their metabolites are easily measured in blood and other biological materials (Gargas and Andersen, 1982, 1984.) The penetration rate of dibromomethane in mineral oil, through rat skin, can be determined using a physiologically based pharmacokinetic model. In the future, this data will be used to estimate the permeability constant for dibromomethane through human skin. The determination of this value will allow for the establishment of exposure limits and safety standards.

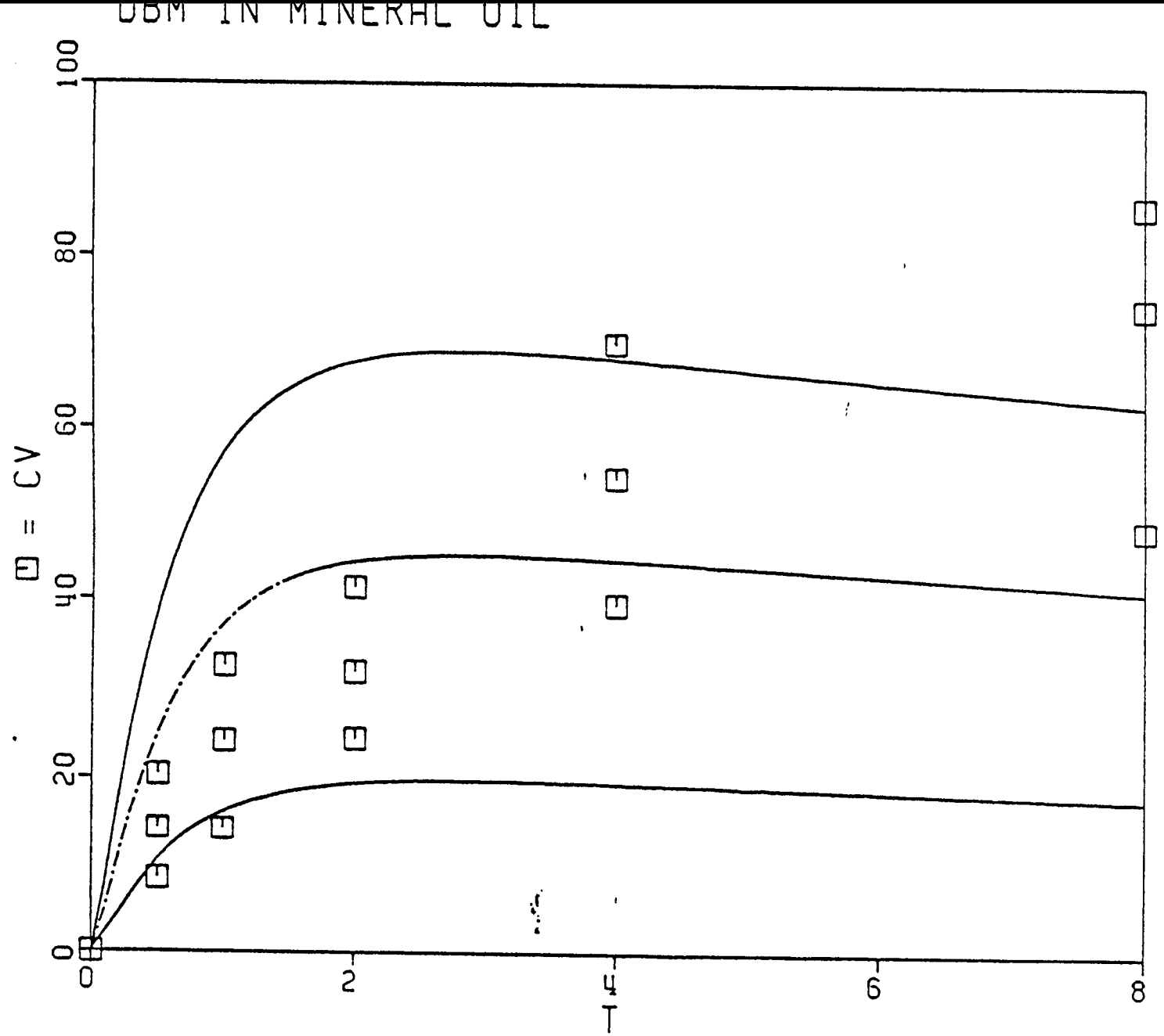

Figure 3. Data (squares) and model simulation (lines) of the DBM rat venous blood concentration (CV,mg/L) vs T (time in hrs) following dermal exposure to 25%, 50%, and 75% DBM solutions in mineral oil.

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ANALYSES OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik

High School Student

12th Grade

East Central High School

7173 FM 1628

San Antonio, Texas 78263

Final Report for:

Air Force Office of Scientific Research

Armstrong Laboratory

Sponsored by:

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ANALYSES OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik
High School Student
12th Grade
East Central High School

ABSTRACT

The main function of the Metals Section of the Armstrong Laboratory is to provide support for bases worldwide in the analysis of environmental and occupational samples for metal content. These samples include, but are not limited to, drinking water, wastewater, soils, sludges, biologicals, and air samples. The section analyzes an average of 10,000 samples per year with the average of four or five different analyses. The sample load is almost evenly split between occupational and environmental samples. Analysis of the sample is accomplished by using several varieties of spectroscopic instruments including Inductively Coupled Plasma (ICP), Flame Atomic Absorption (FAA), Graphite Furnace Atomic Absorption (GFAA), and hydride generator for the analysis of mercury. This section also manually prepares samples for mercury analysis.

ANALYSES OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik

INTRODUCTION

The Armstrong Laboratory Metals Section is an EPA compliance laboratory. The section must maintain certification through several national programs including EPA, NIOSH, OSHA, and the College of American Pathologists (CAP), as well as environmental certification from a number of states who run their own programs. The section does EPA compliance analyses which means that it helps bases comply with EPA guidelines by identifying problem areas through the analysis of drinking water, wastewater, soils, sludges, and biologicals. It also does air analysis that is monitored by NIOSH and OSHA. The program is quality controlled by both EPA and NIOSH as the section performs analysis of samples from both of these agencies. Also, the CAP monitors the analysis of the biological samples being tested for lead. In addition the section is also monitored by individual state agencies, some of which have stricter guidelines than EPA.

The Metals Section has also been involved in many special projects. One such project was the analysis of the blood of children at a day-care for possible lead-poisoning. The blood samples are run as zinc protoporphryins as a screen. These samples are then analyzed for Pb content on a Zeeman Furnace.

The Metals Section was also the main contributor to the Lead Assessment Program. This program identifies and monitors drinking water for lead contamination at bases worldwide. Soap samples are also analyzed for boron. The most recent project done was an analysis for lead in paint. The metals section also completed 120 priority samples. Each sample was completed within a week.

METHODOLOGY

In order to be EPA certified the Metals Section must use EPA methods to perform these analyses. NIOSH also requires appointed methods. Some examples of EPA methods that the section uses are: (1) 200 series methods for both potable and non-potable water, (1a) a specific method, 239.2 which is used for lead analysis through a Perkin Elmer Zeeman Furnace Atomic Absorption Spectrophotometer, (2) SW846 methods for wastewater and solid materials including paint, wipes, soil, etc., (2a) also a specific method, SW846 method 6010 is used for analysis on an Inductively Coupled Plasma Emission Spectrophotometer. Prior to analysis, samples must be digested using appropriate Sample Preparation Methods (e.g. Method 3005-3050), (3) NIOSH methods are used for air and biological analysis, (3a) one specific method, NIOSH 8003, is used on the analysis of lead in blood.

APPARATUS

All of the analyses are processed using advanced electronic equipment. This equipment is operated by the principle of detection of light absorption of light emission. The range of equipment consists of three general categories of spectrophotometers: (1) Flame Atomic Absorption, (2) Graphite Furnace Atomic Absorption, and (3) Inductively Coupled Plasma.

The Flame Atomic Absorption Spectrophotometer (FAA) introduces a liquid sample into an air-acetylene flame. A hollow cathode lamp containing the metal of interest is lit and gives off light at a wavelength characteristic of that metal. If the sample contains that metal, it absorbs the light at that wavelength, and is compared to a set of standards to obtain a concentration in micrograms per liter. The FAA can detect common metals, including the alkali and alkaline earths, as well as several transition metals such as Fe, Mn, Cu, and Mn. The Graphite Furnace Atomic Absorption Spectrophotometer (GFAA) is the same principle, but only microliter amounts of the sample are used, and the sample is subjected to programmed heating and is much more sensitive than the FAA. There are several advantages to using the GFAA rather than the FAA. One is that the GFAA has a higher sensitivity than the FAA. Another is the ability of the GFAA

to handle small sample volumes of liquids. Also, the GFAA has the ability to analyze solid samples directly without pretreatment. Finally, the GFAA has a lower noise level than the FAA. The GFAA is capable of detecting a wide variety of metals such as As, Sb, Se, Sn, and Tl.

The Inductively Coupled Plasma Emission Spectrophotometer (ICP) measures element-emitted light by optical spectrometry. The sample absorbs energy in the form of heat and the resulting aerosol is transported to the plasma torch. The light emitted is at a wavelength characteristic of that metal. The amount of light emitted is compared to the standards.

ESTABLISHMENT OF PARTITION COEFFICIENTS FOR THE HALON REPLACEMENT CANDIDATE BROMOTRIFLUOROMETHANE

D. Joshua Finch

Final Report for:

High School Apprenticeship Program

Armstrong Laboratory

Sponsored by:

Armstrong Laboratory

Wright Patterson Air Force Base, Ohio

August 1993

ESTABLISHMENT OF PARTITION COEFFICIENTS FOR THE HALON REPLACEMENT CANDIDATE BROMOTRIFLUOROMETHANE

D. Joshua Finch

Abstract

The amount of bromotrifluoromethane gas that was absorbed by specific rat tissues was measured over various time periods. The optimum time period for the absorption of the chemical into the tissue sample was then decided upon. Further samples were then incubated for the "optimum time" and then measured for their chemical content in order to establish partition coefficients for the stated chemical. The data obtained from the partition coefficient study can then be coupled with results from a gas uptake study on the same chemical and used to generate a physiologically based pharmacokinetic model to predict the human health hazards that may occur from the inhalation of bromotrifluoromethane.

ESTABLISHMENT OF PARTITION COEFFICIENTS FOR THE HALON REPLACEMENT CANDIDATE BROMOTRIFLUOROMETHANE

D. Joshua Finch

INTRODUCTION

Halons are currently being used as flight-line fire extinguishants. The ozone-depleting properties of halons have initiated the search for a less harmful replacement compound that would function similarly to the halons that are currently being used. One aspect of this search that the Air Force has focused on is to analyze the health hazards associated with each halon replacement candidate. The establishment of partition coefficients is an important step in the building of an accurate physiologically based pharmacokinetic model to assess the human health hazards of any proposed compound.

METHODOLOGY and MATERIALS

Instrumentation

Partition coefficients were calculated by analyzing the samples on a **Hewlett Packard** 19395A headspace sampler and a **Hewlett Packard** 5890 gas chromatograph with a flame ionization detector. The gas chromatograph was installed with a **Chrompak Poraplot Q** (Plot Fused Silica), 0.53 mm(internal diameter) x 25 m column. The oven temperature of the gas chromatograph was set at 70 C, the injector temperature was set at 125 C, and the detector temperature was set at 250 C. Helium was used as the carrier gas and the make up gas with a total flow of 26mL/min.

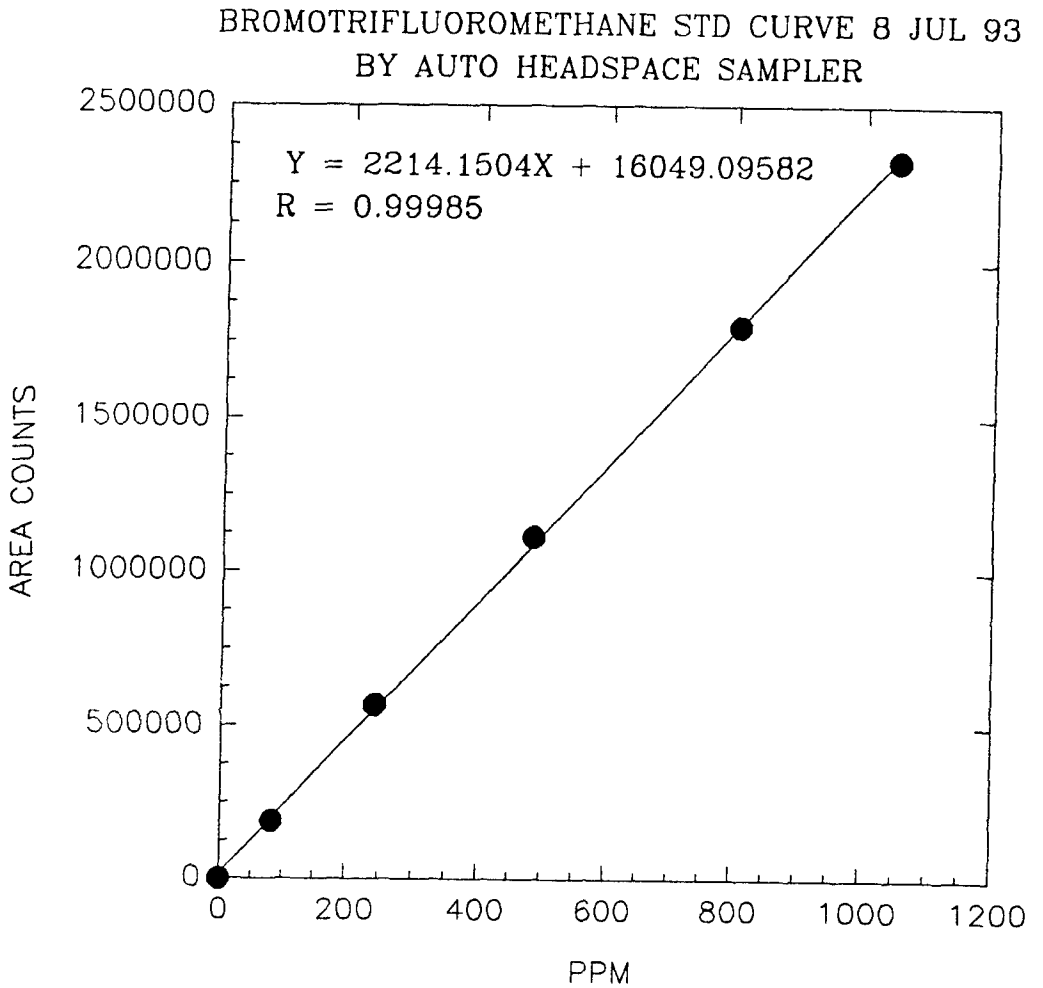
Procedure

Standard Curve

A standard curve was analyzed for the chemical using various concentrations ranging from 0 ppm to 1000 ppm. The samples were run on the instrumentation stated above and the data was analyzed on the Quattro Pro program. A standard

curve is shown in Figure 1.

Figure 1



<u>Partition Coefficients</u>

The rats were sacrificed and the following tissues were immediately harvested: blood, liver, muscle, fat, and gastro-intestinal tract. Three samples of each tissue from each rat were then measured into 10 mL glass vials. Table 1 shows the target quantity of the various tissue samples that

were dispersed into the vials.

Table 1

TISSUE TYPE	QUANTITY
Blood	500 uL
Liver	0.500 g
Muscle	0.500 g
GI Tract	0.500 g
Fat	0.100 g

The exact weight of each of the solid tissue samples was measured and recorded each day. After the samples were portioned out into the appropriate vials, the vials were capped with rubber septa. Six empty vials were also capped to be used as reference vials. One mL of air was evacuated from each vial. All vials were then injected with one mL of headspace from a 10,000 ppm bag of bromotrifluoromethane. The samples were incubated and vortex mixed for three hours at 37 degrees celsius before headspace and GC/FID analysis.

RESULTS

By viewing the data produced from various incubation times, it was found that a three hour time span between injection and analysis produced the best results. All of the data used for the computation of the partition coefficients were therefore taken from the three hour time span. Almost all of the partition coefficients, excluding fat, are less than one. An extensive summary of the partition coefficients is shown in Tables 2 through 6.

Table 2

Liver		
Lot No.	Rat No.	Mean
L89	10	0.8541
L89	12	1.4374
L89	11	0.5686
Ave. Mean		0.9534
L97	15	0.588
L97	16	1.4802
L97	17	1.1647
L97	13	0.3558
L97	14	0.9008
Ave. Mean		0.8979
M11	Spare	0.9283
M11	1	0.4003
M11	2	0.6702
Ave. Mean		0.6663
Ave. Mean(3 lots)		0.8392

Table 3

Blood		
Lot No.	Rat No.	Mean
L89	10	0.684
L89	12	0.2345
L89	16	0.3617
L89	17	0.8969
Ave. Mean		0.5443
L97	15	0.6119
L97	16	0.9115
L97	17	0.9161
L97	13	1.1801
L97	14	0.9069
Ave. Mean		0.9053
M11	Spare	0.8159
M11	1	0.6043
M11	2	0.5639
Ave. Mean		0.66137
Ave. Mean(3 lots)		0.56941

Table 4

Gastrointest		
Lot No.	Rat No.	Mean
L89	10	1.0587
L89	12,13	0.2221
L89	11	0.9443
Ave. Mean		0.7417
L97	17	0.9101
L97	15	0.9571
L97	16	1.3681
L97	12	0.2675
L97	13	0.5804
L97	14	0.1539
Ave. Mean		0.7062
M11	Spare	0.6676
M11	1	0.2323
M11	2	0.7579
Ave. Mean		0.7062
Ave. Mean(3 lots)		0.6668

Table 5

Fat		
Lot No.	Rat No.	Mean
L89	10	6.1054
L89	12	2.5711
L89	16	2.6043
L89	17	2.2489
Ave. Mean		3.38243
L97	17	2.7703
L97	15	6.0335
L97	16	3.7723
L97	13	2.7037
L97	14	3.3462
Ave. Mean		3.7252
M11	Spare	2.7243
M11	1	2.1393
M11	2	1.5411
Ave. Mean		2.1349
Ave. Mean(3 lots)		3.08084

Table 6

Muscle Lot No.	Rat No.	Mean
L89	10	0.8975
L89	12	0.2479
L89	16	0.5319
L89	17	0.3402
Ave. Mean		0.50438
L97	15	0.2004
L97	16	0.7602
L97	17	0.3663
L97	13	0.5353
L97	14	0.8503
Ave. Mean		0.5425
M11	Spare	0.8159
M11	1	0.6043
M11	2	0.5639
Ave. Mean		0.66137
Ave. Mean(3lots)		0.56941

CONCLUSION

Although a complete physiologically based pharmacokinetic model would have to be developed before a definitive conclusion about the health hazards of this compound could be made, the partition coefficients for bromotrifluoromethane are promising. The partition coefficients for this compound are relatively small. Bromotrifluoromethane would be a strong candidate for halon replacement from a health hazard assessment point of view. The fire extinguishing capabilities of this compound most also be taken into account and compared with the results from the studies of other halon replacement candidates before a final decision can be made.

Christopher Gonzalez's report not available at time of publication.

THE ROLES OF VETERINARY MEDICINE IN BIOMEDICAL RESAERCH

Laura Neitzel
RDL Apprentice
Comparative Pathology Branch

Research and Development Laboratories
5800 Uplander Way
Culver City, CA. 90230-6608

Final report for:
AFSOR Summer Research Program
Armstrong Laboratory

Sponsored by:
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and

Research and Development Laboratories

August 1993

THE ROLES OF VETERINARY MEDICINE IN BIOMEDICAL RESEARCH

Laura Neitzel
RDL Apprentice
Comparative Pathology Branch
Armstrong Laboratory

Abstract

My summer apprenticeship was spent in the veterinary Sciences Division of Armstrong Laboratories. I worked in the Comparative Pathology and the Research Support Branch. In Comparative Pathology my main job was to stain tissue placed on microscope slides, for viewing by the pathologist. I also worked in the Electron Microscopy Section where I helped in a scanning electron microscopic study of arthritic monkeys. In the Research Support Branch I helped with the transfer of information to medical records and observed physical exams performed by the laboratory animal veterinarian

THE ROLES OF VETERINARY MEDICINE IN BIOMEDICAL RESEARCH

Laura Neitzel

My summer apprenticeship was spent working in the Veterinary Sciences Division of Armstrong Laboratories, Brooks Air Force Base in San Antonio, Texas.

The Veterinary Sciences Division is made up of two branches: Research Support and Comparative Pathology. The Research Support Branch maintains animals for research. Animals that are maintained include non-human primates, goats, pigs, rabbits, and rodents. The Research Support Branch also has a breeding colony of Rhesus monkeys. The breeding colony is a select group of non-human primates picked for reproduction, ensuring the diverstiy of the animal species. Other non-human primates include baboons, and Patas monkeys.

Some of my summer research was spent in the Research Support Branch. My first experience was helping the laboratory animal veterinarian perform physical exams on the Rhesus and Patas monkeys. It was here that I learned that monkeys aren't as sweet as they look on television. During the physical exams I would write down the monkeys temperature, weight, pulse, respiration rate, and physical exam findings. All the monkeys were given a tuberculosis test at the time of their physical exams. Tuberculosis can be transmitted from humnas to monkeys. To ensure that the colony does not get infected, the monkeys are tested on a regular basis. After

the physical exams, I was asked to put all the information into the monkey's medical records. This transfer of information has given me moreknowledge of what medical records look like and their purpose. Working in this part of Armstrong Lab has strengthened my desire of becoming a Doctor of Veterinary Medicine.

The Comparative Pathology Branch consults with investigators, conducts studies to support research, and performs experimental pathology support necessary for the biomedical research program at Armstrong Laboratory. In the Comparative Pathology Branch much of my time was focused in the Anatomic Pathology Section. The Anatomic Pathology Section is the central part of Comparative Pathology. This department performs experimental pathology studies,conducts necropsies, and provides gross and histopathologic support to research.

I helped the histotechnicians porcess specimens and prepare histopathologic slides of tissues from animal models used in biomedical studies. Working in Anatomic Pathology I have seen the progression from live animal to microscope slide. This has been a great experience for me.

My job was to stain microscope slides to help the pathologists make a diagnosis. I put slides, with an extremely thin layer of tissue on them, through a series of solutions to stain the tissue cells. These solutions involved using graded dilutions of ethanol, hematoxylin which stains the

nuclei of tissue cells, and eosin which stains the cytoplasm of tissue cells. After the slides were stained, I would coverslip them to protect the tissue. Once the slides dried, I put a foot label on the bottom and a numbered label on the top of the slides for identification. I, then, stored the slides in slide filing cabinets for easy retrieval by the pathologist. I also labelled the tops of tissue embedding cassettes that contain different tissue samples for processing.

A necropsy is an examination of an animal's body after death. My first observation was the necropsy of a rat. I was not too thrilled when I was told to watch, but once I was in the necropsy room it wasn't too bad. When we got up there I mainly observed and thankfully I din't have to cut or touch anything. My next necropsy session was too watch the preparation of a monkey for necropsy. This wasn't as bad as the rat because I watched just the beginning of the necropsy.

Towards the end of my apprenticeship, I spent time in the Electron Microscopy Section of Comparative Pathology. This facility provides transmission and scanning electron microscopy support to research done at Armstrong Laboratory.

Transmission electron microscopy involves processing, plastic embedding, and cutting of tissue for study with the Hitachi Hu-12A Transmission Electron Microscope (TEM). With the TEM, all the internal structures of a cell are visible for study. You are able to "look into" the cell and record the smallest

the smallest organelles on film (electron micrographs). The sections cut for the TEM are only 600-800 Angstroms thick, and the routine magnification of the micrographs taken range from 1200x to 50,00x.

Scanning Electron microscopy (SEM) is very different from TEM. The SEM looks at the surface details of samples. We are also able to take electron micrographs of the specimen. The routine magnification used are 10x to 40,000x.

Several samples were taken of t he knee joints of Rhesus monkeys for a scanning electron microscopic investigation of arthritis. The area studied forthis paer was a0.5cm thick section of the articular surface of the femoral condyles (Figure 1).

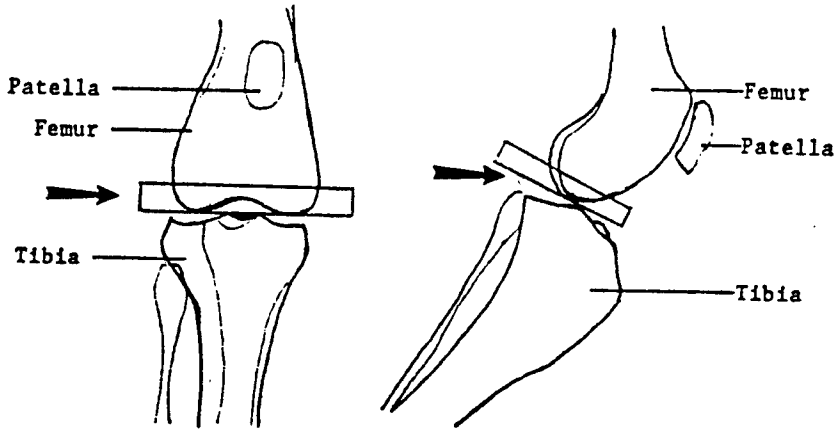

Figure 1. The arrows indicate the areas that were observed with the scanning electron microscope.

Gillette, Edward L., Thrall, Donald E., Lebel, Jack L. 1977. Carlson's Veterinary Pathology. Lea & Febiger, Philadelphia, Pennsilvania. pg. 139

The sample was dehydrated in a graded series of ethanol and critical point dried using liquid carbon dioxide in an Autosamdri Critical Point Dryer. After the specimen was dried, it was mounted on a 1" aluminum stub and sputter coated with gold-palladium. Sections of the distal femoral articular surfaces were viewed with an ETEC Autoscan Scanning Electron Microscope. Changes in the articular cartilage from the medial and lateral femoral condyles demonstrate changes consistent with acute degenerative joint disease. There is disruption of the cartilage surface characterized by fibrillation, strands of matrix, peeling of superficial cartilage surface, and erosion. The more severely affected lateral condyle exhibits an extensive focus of cartilage/bone compression. Electron micrographs were taken of each femoral condyle (Figures 2, 3, 4). Two views of the lateral condyle are attached. The first is a view taken as if one were looking at the knees towards the hip (Figure 2). The second is rotated to a not quite lateral view, demonstrating the depth of the compression (Figure 3). The third figure is of the lesser affected medial condyle (Figure 4). Note the highlighted areas on the adjacent diagrams that illustrate the areas photographed.

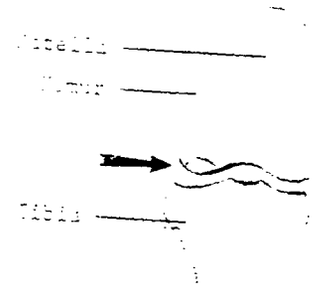

Figure 5. Lateral femoral condyle, Rhesus monkey, articular cartilage surface (10X magnification SEM). Fibrillation, matrix strands with cartilage peeling evident.

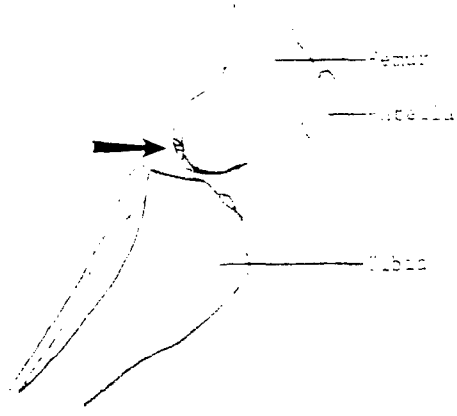

Figure 6. Lateral condyle; articular cartilage (10X magnification SEM) tangential view. Flattening of the articular suface is pronounced.

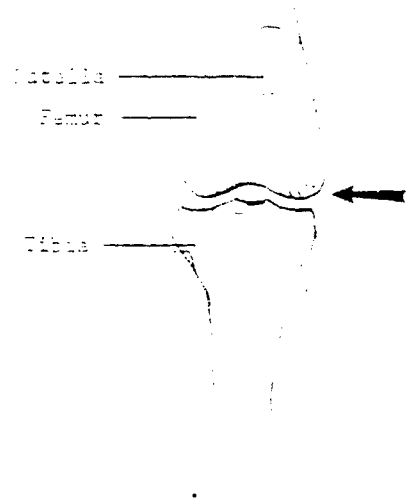

Figure 7. Medial femoral condyle. Lesions related to degenerative joint disease are present, but less severe than the lateral side. (10X magnification SEM)

I also hepled organize and update embedded tissue block storage; I organized the lectron micrograph archives by separating chronic colony micrographs (animals assigned to a 29 year old primate radiation colony) from micrographs of other protocols. I also gained experience in library research. I ofund journal articles and made copies for the doctors and researcheers here; the articles that were not available here I requested thru interlibrary loan.

My summer apprenticeship has been both a learning and hands-on experience for me. I have seen many things in one summer that most people will never see, unless they were a pathologist. I had the pleasure of meeting many wonderful and intelligent people. By working in the Veterinary Sciences Division I have seen the kind of work a veterinary pathologist and a lab animal doctor does. I had the opportunity to follow various species of animals through different satges of research studies. I participated in clinical care, histology, and electron microscopy. I also observed necropsies, and the managemetn of the breeding colony. I feel that I have gained alot of experience that will help me in my further study of Veterinary Medicine.

A STUDY OF THE EFFECTS OF LIQUID PROPELLANT 1846 ON THE FERTILITY, PREGNANCY AND LACTATION OF RATS

Ryan Quinn Simon
High School Apprentice
Air Force Toxicology Division

Final Report For:
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Armstrong Laboratories

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and

Wright-Patterson Air Force Base

June And July 1993

A STUDY OF THE EFFECTS OF LIQUID PROPELLANT 1846 ON THE FERTILITY, PREGNANCY AND LACTATION OF RATS

Ryan Quinn Simon
High School Apprentice
Air Force Toxicology Division
Wright Patterson Air Force Base

ABSTRACT

The effect of Liquid Propellant 1846 is being studied. The United States Army is considering replacing the solid propellant used in the Advanced Field Artillery System with a new liquid type of propellant. The propellant was administered to Sprague-Dawley rats through their drinking water. Later the rats were mated and observed. Behavioral tests were also being performed on the rats. Because the study is not yet completed no data concerning the fertility of male rats, or the pregnancy and lactation of female rats. It is known that the propellent is a skin and eye irritant, and in aerosol form is a respiratory irritant. Enlarged Spleens were noticed in the test animals.

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INTRODUCTION

The United States Army is considering Liquid Propellant (LP) 1846 as a replacement for the solid propellant currently being used in the Advanced Field Artillary System (AFAS). It will be used in both the Advanced Field Artillary System-cannon (AFAS-C), and the Future Armored Resupply Vehicle- ammunition (FARV-A). LP 1846 will replace the solid propellant in the regenerative injection gun system and the electrothermal gun system. The major components of LP 1846 are hydroxylammonium nitrate (HAN) and triethylammonium nitrate (TEAN).

Up to date, the major hazards of LP include dermal/ occular exposure and inhallation of LP aerosol. LP is a potential skin/eye irritant and also embodies systemic toxicity. It combines with hemoglobin in the blood to form methemoglobin, hereby reducing the supply of oxygen to the body. Inhallation of LP vapor is virtually harmless, as the vapor is almost entirely comprised of water. Inhallation of aaerosol is an entirely different matter. It may produce respiratory irratation blood dycrasia, and elevated methemoglobin.

MATERIALS

Animals

Fifty male and fifty female rats were obtained for this study. The rats were quarantined, quality controlled, and found to be in a condition acceptable for the purpose of this experiment. Rats were individually housed in clear plastic cages with wood chip bedding. The rats drank water from glass water bottles. The animals were tattooed for indentification purposes, weighed, randomized , and assigned to dose levels.

Materials

The sample of LP was obtained from the army. When mixed with distilled water it was colorless. Water solutions were prepared by the direct addition of LP 1846 to distilled water. A concentrated solution was made from which dosing solutions were prepared. There were three dose levels that received the LP; 20 mg., 100 mg., and 200 mg., for every 100 milliliters.

Before beginning the study, trial batches of the dose solution were prepared to test stability and pH of the test material.

PURPOSE

The intention of this study was to determine the effects of LP 1846 on the male fertility, female pregnancy, and lactation of Sprague-Dawley rats. The test material was administered through the rats drinking water instead of the gavage, as this would be the most probable example of exposure to humans.

The liquid propellant is being considered as a replace for the solid propellant in the Advanced Field Artillery System. It will replace solid propellants in the electrothermal gun system and the regenerative injection gun system. The results of this study will be used to help regulate the use of the regenerative gun system, which will consist of the Advanced field Artillery System- cannon and the Future Armored Resupply Vehicle-Ammunition.

Current requirements on the use of this machinery mandates that all personnel be physically separated from the machinery at all times. However, there are no requirements for the manual backup of loading and firing the gun. The manual backup of loading the LP storage tanks in both the cannon and the resupply vehicle are covered. There is the possibility of exposure, at all levels of maintennance and repair, when repairing battle damaged equipment, either in the field or at support unit facilities.

METHODOLOGY

The rats of this study had to be killed (sacrificed) in order to get the information that was desired. Before the scheduled necropsy, the last six male rats of each group were fasted for twelve hours. At the time of the necropsy, each animal will be opened and examined individually. All parental animals are subject to a gross necropsy. They will be euthanized with CO_2 and opened up at the abdomen. Histopathological evaluations will be done on these tissues that will be taken: liver, kidneys, brain, pituitary, vagina, uterus, testes, epididymides, scrotum, seminal vesicles, prostate, bone marrow (sternal and femoral) sections, ovaries, spleen, stomach, duodenum, corpora lutea, ileum, implantation sites, and any other tissues with gross lesions identified as being potentially treatment related. Sperm motility and morphology evaluations were performed on each male rat.

Two necropsies were scheduled, one was held immediately after mating and another will be held at the end of the ninety day study.

At the commencement of the study, fifty male and fifty female Sprague-Dawley, albino rats were received. These rats were Quarantined for a predetermined time of two weeks. Two rats of each sex were killed for quality control. Seeing that the rats were of satisfactory health, the study proceeded.

Forty-eight rats of each sex were weighed twice a week. They drank normal distilled water from glass water bottles. Water bottles were weighed and refilled every two days. This was done for randomization and dose purposes.

At the end of two weeks the average daily water consumption was calculated for each rat, by using the data collected from weighing the water bottles. This information was used to determine about how often water bottles would need to be changed and to get a baseline on how much each rat drank. The rats were then randomized and assigned to four dose groups of twelve rats per group, per sex. There were four dose levels; control, 20 mg./100 mL., 100 mg./ 100 mL., and 200 mg.,/100 mL.

Also at this time, rats began to receive the LP in their drinking water. Each day their water bottles were weighed empty and then at full. Their daily water consumption was also recorded. Dosing and weighing bottles continued for two weeks.

At the end of two weeks, mating began. Each female was placed in a cage with a male rat of the same dose group. They were given two weeks to mate. During these two weeks the rats continued to receive the LP at the proper dose level. The following day, and each consecutive day, during the two weeks allowed for mating, the cages were examined for copulatory plugs. The wood bedding that previously lined the cages was removed and replaced by a metal mesh that allow urine, feces, and the plugs to drop through. When a plug was found the couple were then separated and continued on the normal dosing procedure than was practiced before mating began. During this time, the water bottles of the rats that had not mated yet weren't weighed, because it is impossible to tell which rat is drinking the water. Vaginal washes were performed each day on females that did not produce a plug. The saline from the wash was examined under a microscope. If sperm was found on the slide then the couple were separated and counted as mated.

Females that were pregnant were weighed every week to monitor the pregnancy. At the end of the mating period all the rats that didn't mate were separated and placed back into individual cages.

Beginning one week before treatment, the rats began a series of behavior testing. There were three tests that were performed on the rats; the Figure Eight maze, the Opto- Varimex maze, and the Startle test. In the Figure Eight test, each maze is connected to a computer running a data collection program. One animal was placed in the maze at a time, where its movement is tracked by a series of infra-red emitters/detectors placed along the path. The computer collects information on the rat based on how many detectors it triggers. Each rat was observed for nine, sequential ten minute sessions, for a total of ninety minutes or "observational time."

In the Opto- Varimex test, each rat was placed in 30 cm. x 30 cm. chamber. A computer gathered information with the use of infra-red emitters and detectors spaced regularly around the perimeter. The program tallied: total distance traveled, time spent ambulatory, and time spent in "stereotypic movement," which includes rearing and circling. The number of clockwise and counterclockwise turns was also tabulated. Testing sessions consisted of single or successive five minute intervals, usually conducted with the room lights off.

When undergoing the Startle test, animals were placed in a clear plexiglass cylinder designed to minimize their movement. The animal was then placed in a darkened chamber on a plat form affixed to a transducer, where it was exposed to a seventy decibel, 4,000 Hz, noise impulse for 120 msec. These impulses occurred every ten seconds for fifty cycles.

The transducer measured the vibrations as the rat "flinched" at the noise. This information was tabulated and stored on a computer that controls the system.

These tests ran from one week prior to treatment every other week for five weeks. A final test was given to the remaining rats one week before the final sacrifice.

RESULTS

To date, the liquid propellant has not caused any problems in the fertility of the male test animals. The study is not yet complete at this time and more data needs to be collected. However, enlarged spleens were noticed among the test animals.

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PERMEABILITY CONSTANTS DETERMINED BY PBPK MODELS FOR VAPOR, NEAT, AND AQUEOUS FORMS OF PERC, BENZENE, DBM, AND TCE

Jill A. Solscheid

Centerville High School

Final Report for:

Summer Research Program

Armstrong Laboratory

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Jill A. Solscheid
Centerville High School

Abstract

A permeability constant is the measure of the ability of a chemical to penetrate through the skin. The constant can be mathematically computed by a Physiologically-based Pharmacokinetic (PBPK) Model. The stratum corneum, which was separated from rat skin using a trypsin method, was used to determine the stratum corneum to air partition coefficients, a parameter of PBPK models. PBPK models were developed which described each of three different in vivo dermal exposures in rats: whole body dermal exposure to vapor, exposure to neat chemical from a closed cell on the dorsal skin, and exposure to a saturated solution in water from a closed cell. The permeability constants were determined for the three forms of perchloroethylene, benzene, dibromomethane, and trichloroethylene with the exceptions of perchloroethylene saturated and trichloroethylene vapor which do not have sufficient data. Human data can easily be calculated because the PBPK model can extrapolate between species. Therefore, the permeability constants can be used to predict human skin exposure for dermal risk assessment.

PERMEABILITY CONSTANTS DETERMINED BY PBPK MODELS FOR VAPOR, NEAT, AND AQUEOUS FORMS OF PERC, BENZENE, DBM, AND TCE

Jill A. Solscheid

Introduction

The permeability constant is a measure of the ability of a chemical to penetrate through the skin. A Physiologically-based Pharmacokinetic (PBPK) Model can mathematically compute the constant, which is used to predict human skin exposure for dermal risk assessments.

If the PBPK model has the correct absorption rate then it can mathematically keep track of how much chemical each compartment of the body receives due to amount of chemical exposure and route of exposure. Tissues are grouped together in compartments according to blood flow and partition coefficients. Figure 1 demonstrates the various compartments in the PBPK model for benzene.

The dermal compartment enables dermal absorption to take place through a first order diffusion limited process. Before the model can show dermal penetration, all of the elements in the rate equation describing the uptake of chemical from skin into blood must be defined. Therefore, the stratum corneum to air

partition coefficient must be determined in order to obtain the rate at which a chemical enters the body during a dermal exposure. Now it is believed that the stratum corneum and not the dermis acts as the critical factor in dermal absorption. The dermis may be important depending on the lipophilicity of the chemical (Surber et al., 1990), but the stratum corneum as the principal barrier layer (Tayar et al., 1991) is the more critical layer to be measured for a tissue to air partition coefficient.

Once the chemical has entered the skin, it diffuses to the other compartments through the blood. Each compartment has distinct factors because of the functions of the tissues. Factors such as physiological constants, metabolic constants, and partition coefficients need to be determined in order to develop the model (see Table 1 and 2).

Methodology

PBPK models were developed which described each of three different in vivo dermal exposures in rats: whole body dermal exposure to vapor, exposure to a neat form from a closed cell on the dorsal skin, and exposure to saturated solutions in water from a closed cell. Table 3 contains the physiochemical data for each of the four chemicals used: perchloroethylene (perc), benzene, dibromomethane (DBM), and trichloroethylene (tce). The models were written and executed with experimental data using SimuSolv (Dow Chemical Co., Midland, MI). Physiological parameters for the rat in Table 1 were taken from McDougal et al

(1986). Metabolism was modeled as a saturable process based on closed chamber studies in rats (Gargas et al 1989). Partition coefficients for the rat were taken from Gargas et al (1989) (Table 2), except for stratum corneum to air partition coefficients which were determined experimentally for this study.

To establish the stratum corneum to air partition coefficient value, skin from young male rats was collected, shaved, dematomed at the 0.25 mm setting, and cut into 2x2 cm squares. Next the skin was placed dermis side down on filter paper in a petri dish saturated with a 0.5% trypsin in phosphate buffered saline solution (see appendix A). The petri dishes were placed in an incubator at 37 degrees Celsius for approximately 1 1/2 hours. The next step was to peel and lift the stratum corneum off of the dermis. The stratum corneum, after being removed from the dermis, was placed for ten minutes on the surface of a solution of 0.005% trypsin inhibitor in a phosphate buffer (see Appendix A). The stratum corneum was washed by floating for thirty minutes on distilled water. After washing, the stratum corneum was collected on screens and stored in a desiccator. Twenty-four hours before determining the stratum corneum to air partition coefficient, stratum corneum was placed into a 75% relative humidity chamber. The 75% relative humidity was achieved with a saturated solution of NaCl in distilled water.

The stratum corneum was removed from the screens, placed immediately into 12.4 mL vials, and weighed. The vials were

immediately crimped shut after weighing. For each stratum corneum vial there was a reference vial. The reference vials were crimped with just air inside. After incubating for ten minutes at 32 degrees Celcius on a vortex evaporator (Model # 4322000, Buchler Instruments, Lenexa, KS), a needle was inserted to equalize the air pressure. Next an amount of air was removed with a syringe that was equal to the amount of chemical to be injected into the vial. A known concentration of chemical vapor was then injected into the sample and reference vials. All of the samples were shaken on the vortex evaporator at 32 degrees Celsius for four hours. Finally one mL of each sample and reference vial was injected into a Hewlett Packard gas chromatograph with a flame ionization detector (Model 5890A, Hewlett Packard, San Fernando, CA) and 10% SE-30 8 foot stainless steel column (Supleco, Inc., Bellefonte, PA). The injector and oven temperatures used varied with repect to boiling temperature of the chemical.

The outcome of the samples were determined by comparing the reference area counts to the sample area counts in the following equation:

$$\text{Partition Coefficient} = \frac{(\text{reference area cts})\ (\text{vial volume}) - (\text{test area cts})\ (\text{vial volume} - \text{sample volume})}{(\text{test area cts})\ (\text{sample volume})}$$

Results

The determined stratum corneum to air partition coefficients are the PSK values defined in Table 2. Table 4 shows the permeability constants determined by a PBPK model for each exposure scenario.

Discussion

Insufficient data exists to determine the permeability constant for Perc under saturated conditions. There is no data to determine the permeability constant for TCE vapor. However, the permeability constants determined in this study are now being used to assess the dermal hazards involved with using these chemicals. With an accurate dermal risk assessment, occupational dermal exposures can be avoided in the future. The objectives of the experiment have been met since an accurate, reproducible permeability constant has been determined.

Conclusions

The PBPK models were used to estimate the permeability constants of Perc, Benzene, DBM, and TCE from blood concentrations achieved during exposure to each form of the chemical. The PBPK model can be adapted to extrapolate between species. Therefore, human data can easily be calculated. The permeability constant provides a reliable means by which dermal penetration can be assessed. In addition, exposure concentrations and routes of exposure can be adapted to any

situation that might occur. In turn, hazard assessment for dermal exposures is more accurate.

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Table 1

Model Parameters

Tissue Blood Flow as Fraction of Cardiac Output:

QLC	Flow to Liver	0.25
QFC	Flow to Fat	0.09
QSC	Flow to Slowly Perfused	0.24
QRC	Flow to Rapidly Perfused	0.76
QSKC	Flow to Skin	0.05

Tissue Volumes as Fraction of Body Weight:

VLC	Volume of Liver	0.04
VFC	Volume of Fat	0.07
VSC	Volume of Slowly Tissue Perfused	0.82
VRC	Volume of Rapidly Tissue Perfused	0.09
VSKC	Volume of Skin	0.10

Unscaled Parameters:

BW	Body Weight (kg)	
QPC	Alveolar Ventilation (L/hr/kg BW)	14.0
QCC	Cardiac Output (L/hr/kg BW)	14.0

Partition Coefficients:

PB	Blood/Air
PL	Liver/Blood
PF	Fat/Blood
PS	Slowly Perfused Tissue/Blood
PR	Rapidly Perfused Tissue/Blood
PSK	Stratum Corneum/Air
PSKB	Stratum Corneum/Blood
PSKL	Stratum Corneum/Liquid (chemical)
PSKS	Stratum Corneum/Liquid (saline)

Metabolic Parameters:

VMAXC	Maximum Velocity of Saturable Pathway (mg/hr/kg BW)
KM	Affinity of Saturable Pathway (mg/L)
KF	First Order Metabolic Rate

TABLE 2

Actual Values for Partition Coefficients and Metabolic Constants

		Perc	Benezene	DBM	TCE
PB		18.90	17.80	74.10	21.90
PL		86.70	1.00	0.919	1.20
PF		86.70	28.00	10.69	25.30
PS		1.06	0.58	0.547	0.46
PR		3.70	1.00	0.919	1.20
PSK		339.60	74.54	290.32	306.73
PSKB		17.97	4.19	3.918	14.01
VMAXC		0.0	3.30	12.50	3.78
KM		0.0	0.60	0.40	0.2
KF		0.206	0.0	0.34	0.0
BW	(NEAT)	0.257	0.262	0.284	0.276
	(VAP)	0.233	0.250	0.203	
	(SAT)	ND	0.262	0.270	0.275
PSKL	(NEAT)	0.027	0.028	0.042	0.089
PSKS	(SAT)	429.9	27.09	20.16	369.55

ND= no data available

TABLE 3

Physiochemical Data

	Perc	Benzene	DBM	TCE
Mol Weight	165.85	78.11	173.85	131.39
Density (g/ml at 20° C)	1.625	0.877	2.496	1.462
sat. concentrations:				
- air ($\times 10^5$ mg/m^3 at 20° C)	1.260	3.190	3.527	4.220
- aqueous (mg/ml)	0.102	1.823	9.859	1.255

Table 4 Stratum Corneum to Air Permeability Constant Determined by PBPK Models

	Perc	Benzene	DBM	TCE
NEAT	.0015	.0025	.00087	.000875
SAT	ND	.05	.035	.22
VAP	.668	.152	1.75	ND

ND = no data available

Appendix A Solutions

The trypsin used was from Sigma, lot number 70H0439.

The trypsin inhibitor was from Sigma, lot number 40H8205.

The phosphate buffered saline is composed of

9.00 grams NaCl

6.97 grams K_2HPO_4 (0.04 M)

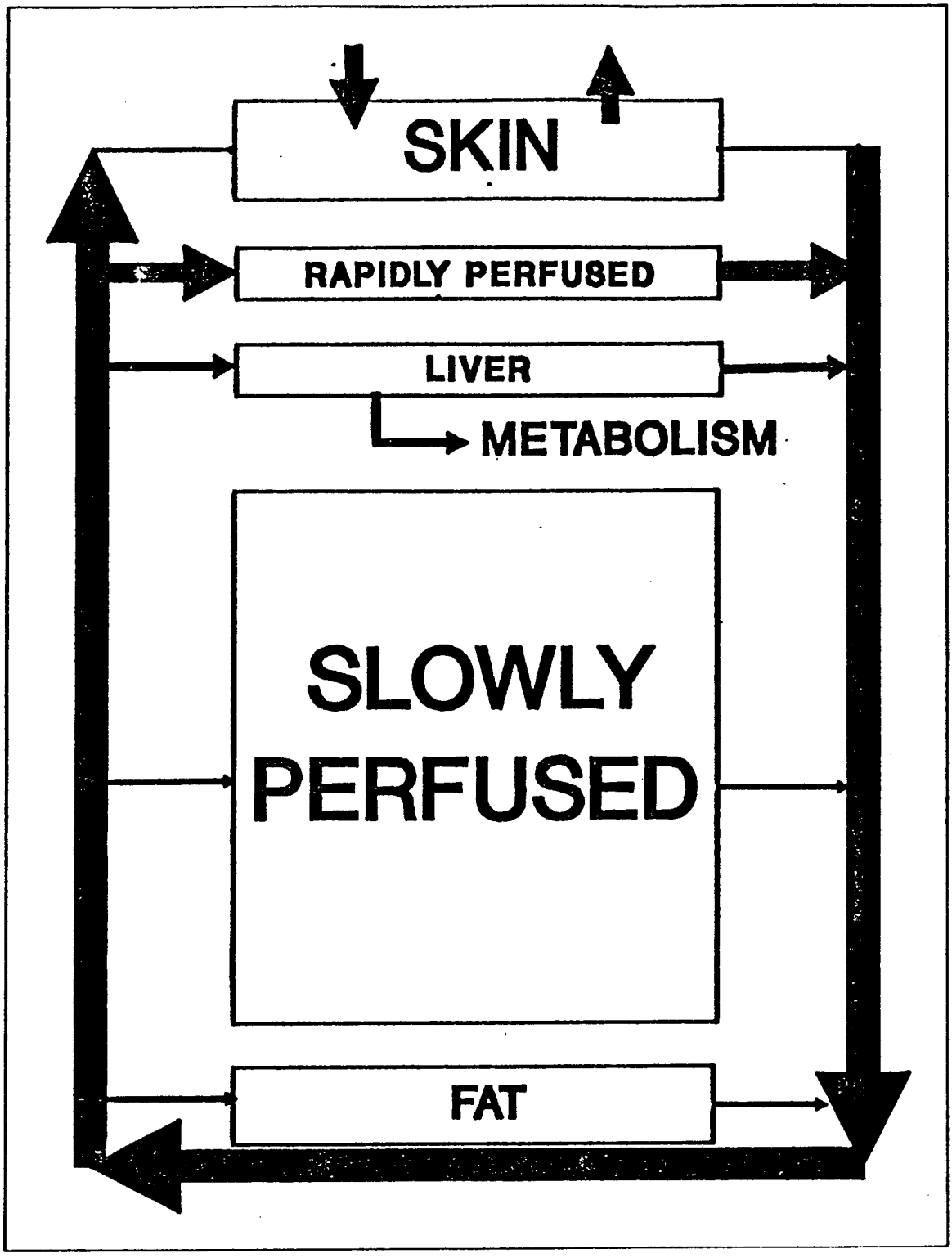
1.36 grams KH_2PO_4 (0.01 M)

dissolved into 900-950 mL distilled H_2O.

The pH must be adjusted, if necessary, to 7.4 with NaOH or HCL.

q.s. to one liter

Figure 1


SKIN
RAPIDLY PERFUSED
LIVER
METABOLISM
SLOWLY PERFUSED
FAT

THE ANAYLSIS OF INORGANIC SUBSTANCES FOUND IN WATER, AIR AND SOIL

Suzanne G. Weidner
student

East Central High School
7173 FM 1628
San Antonio, Texas 78263

Final Report for:
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Brooks Air Force Base, San Antonio, Texas

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THE ANAYLSIS OF INORGANIC SUBSTANCES FOUND IN WATER, SOIL AND AIR

Suzanne G. Weidner
student:
East Central High School
San Antonio, Texas

Abstract

This summer as a repeat participant in the HSAP summer research program for high school students, many new and different areas of an analytical laboratory were exposed. The everyday function of the lab and the many tests performed daily were presented and explained once again in an efficient manner. As an apprentice, real laboratory experience was gained which had not been learned the previous year. Hands on participation was encouraged with equipment found in the lab. While running all of the tests, safety was stressed so caution was taken. At all times a lab jacket, rubber gloves and goggles were worn. This year, accuracy was stressed once again so exactness and preciseness was taken while measuring or calculating sample results. Once the results were found, they were distributed back to the field where they originally came from. The origins of the samples came from all over the United States and world.

THE ANALYSIS OF INORGANIC SUBSTANCES FOUND IN WATER, SOIL AND AIR

Suzanne G. Weidner

In the Inorganic Analysis section of the Analytical Services Division at Brooks Air Force Base, water, soils, and air are tested for inorganic elements excluding metals from all over the world. Specific tests such as Oils and Greases (water, soils and air), Surfactants, Solids, and COD's (Chemical Oxygen Demand) were all conducted in the lab.

When samples are received at the lab, they go to Sample Control and are numbered and logged into the computer. Worksheets are generated and brought to the lab so that the results from the samples may be recorded. When the samples are waiting to be analyzed, they are kept in the freezer. Once ready, the samples are brought out and accounted for by the scientist. Afterwhich, the scientist can begin testing at anytime.

Before running each test, an explanation of the test was given by my mentor. He explained the method, how it was performed and what equipment was to be used. Helpful hints were given so that problems could be avoided and accurate reliable results could be obtained.

TESTING

OILS AND GREASE: This test determines the amount of oils and greases present in water, soil, and air samples. This is the procedure I used to perform this test:

Water: Five hundred mls of sample is poured into a separatory funnel. Five mls of H So and 20 mls of freon are added to the sample. All of which is then shook for two minutes. Number four Whatman Filter paper is then used to extract the freon layer into a clean, dry 25 ml cylinder. Caution must be taken because cells are made of NaCl, don't get them wet, freon must be water free. Extracts are then read on an infrared

spectrophotometer and scanned from 2800-3000nm.

Soils: Fifty grams of soil is extracted with 50 ml of freon. Filter into graduated cylinder and read on the infrared spectrophotometer at 2800-300nm.

Air: Take air filter and extract with 20 ml of freon. Filter like other OIL and GREASES.

SURFACTANTS: Place 100 mls of distilled water in separatory funnel labeled blank and 100 ml of standards and samples in corresponding labeled funnels. Add 1 ml of 5N H So , and 5 mls of Methylene Blue to each funnel. Mix well, while inverting gently. Add 10 mls of Chloroform to each funnel, mix for 20 seconds. Draw off Chloroform layer through a cotton filter into a 50 ml mixing cylinder. Repeat previous step 2 more times. Add 20 mls of Chloroform to each funnel and draw through cotton filter without shaking. Pour samples into cuvettes and read at 650 nm against a plain Chloroform blank. Plot standards on curve and read samples against curves.

SOLIDS: Non Filterable, Filterable, Total, Volatile

Non Filterable- Place a glass microfibre filter in the bottom of a crucible. Insert crucible into filtering apparatus and pour 100 ml of water sample into the crucible. Place in an oven at 103-105 C for 6 hours.
**To get tare weight, weigh crucible with filter before pouring in 100 ml of sample.
Take crucible out of oven and cool for 15 minutes.
**Weigh crucible to get gram weight.

(G.W. - T.W. = NON FILTERABLE)

Filterable- Take 100 ml of water sample and pour through filtering apparatus.

**Weigh 100 ml flask to get tare weight.

Take filtered 100 ml sample and pour into 250 ml flask and insert into oven at 180 C. Remove from oven after 12 hours and then cool to room temperature.

**Weigh flask to get gram weight.

(G.W. - T.W. = FILTERABLE)

Total- Remove 250 ml flask from oven. Cool and weigh (tare weight). Put 100 ml of water sample into flask and place into oven. Remove after 12 hours and cool to room temperature. Weigh to get gram weight.

(G.W. - T.W. = TOTAL)

Volatile- Take 250 ml flask out of oven and put into furnace for 15 minutes. Remove and cool to room temperature. Treat as a total. When weighing for gram weight in total, actually it is weighing for tare weight in volatile. Put back into furnance and remove after 15 minutes and cool to room temperature. Weigh to get gram weight.

G.W. (TOTAL)- G.W.(VOLATILE)= TOTAL VOLATILE

Chemical Oxygen Demand (COD)- Determines the quantity of oxygen required to oxidize the organic matter in a water sample. This is done by pipeting 2.5 mls of sample in the ready to used ampules containing 1.5 mls of digestion reagent and 3.5 mls of catalyst. The ampules are placed in an oven for three hours and allowed to digest. After digestion, the ampules are read in a spectrophotometer at 600 nm.

SAFETY

While at the lab, safety was stressed in order for the lab to be a safe working environment. Instructions were given in fire safety and all

apprentices participated in fire drills so that emergency exits could be found easily. A lab jacket was worn at all times during any type of testing. When working with strong acids, safety gloves and goggles were worn.

EXAMINATION OF THE NITRATE REDUCTASE GENE THROUGH NUCLEOTIDE SEQUENCING, GENOMIC LIBRARY PREPARATIONS, AND SOUTHERN BLOT TECHNIQUES

Matthew T. Young

Final Report for:

High School Apprenticeship Program

Armstrong Laboratory

Sponsored by:

Drs. Jill Parker and Johnathan Kiel

Occupational and Environmental Health Directorate

Brooks Air Force Base, San Antonio, Texas

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Matthew Young

High School Apprenticeship Program

Abstract

The course of research focused on the nitrate reductase gene found in barley and certain bacteria. The work mentioned herein is supplementary, contributing to a more extensive, long term research project. Although many different protocols involved in contemporary molecular bioengineering were examined, there were three primary techniques used most extensively: (1) The use of the dideoxy-mediated chain termination method to sequence the barley nitrogen reductase gene transformed into the virus, M13, (2) the isolation of DNA from P. stuzeri and B. anthrax for the creation of a genomic library wherein the nitrogen reductase gene might be located, (3) execution of the Southern hybridization technique to scan bacteria for the likely presence of a nitrogen reductase gene hybridizing with the barley gene.

EXAMINATION OF THE NITRATE REDUCTASE GENE THROUGH NUCLEOTIDE SEQUENCING, GENOMIC LIBRARY PREPARATIONS, AND SOUTHERN BLOT TECHNIQUES

Nucleotide Sequencing Component

Matthew T. Young

Introduction

The Sanger dideoxy-mediated chain termination technique for nucleotide sequencing has been in usage for quite some time and is used for determining the order of nucleotides in a given segment of DNA. It has a broad array of purposes from confirmation of transformed DNA in an organism/virus to identification and mapping of specific genes in various species. Once a nucleotide sequence is determined, it is possible to search for homologous genes from other species which are similar to a gene of interest and to confirm the presence of a gene in transformed organisms/viruses.

Barley contains a 1.1 kilobase pair gene for nitrate reduction. In this series of experiments, the gene is to be used due to its high level of effectiveness in comparison to other known nitrate reducing genes.

Discussion of Problem

In this particular research project, the Sanger method was used to sequence the nitrate reductase gene found in barley. The gene had been introduced into the virus, M13 which releases a single-stranded DNA into the medium. By extracting the DNA and processing it through the Sanger method, it is hoped that results will confirm the transformation and show the nucleotide order that produces a nitrate reducing protein.

Methodology

The experiments in sequencing originated from samples prepared by Dr. Jill Parker and consisted of DNA isolated from post-transformed M13 viruses apparently containing the 1.1 kilobase pair fragment of the barley nitrate reductase gene. Each time a sequencing sample was created (a total of 25 attempts), the United States Biochemical Corp. "Sequenase" kit was used. The protocol outlined with the commercial kit was followed as accurately as possible. The process was as follows: (For a complete explanation of times and temperatures refer to the booklet provided by Sequenase or for a similar explanation, consult any comparable company that provides equipment for dideoxy-mediated chain

termination nucleotide sequencing.) The DNA was heated to denature and linearize the molecule. A primer was added and then annealed to the DNA sample. Four separate tubes were then designated A,G,C, and T to represent the nucleotides, adenine, guanine, cytosine, and thymine. DNA was placed in each tube with the appropriate buffer mix and was then replicated using the enzyme, Sequenase 2.0. The environment in each tube consisted of normal deoxyribonucleotides and one specific nucleotide substituted with a dideoxyribonucleotide. The dideoxy-molecule terminates the extension of the DNA, so various fragments were created that terminated at a particular nucleotide along the sequence. A radioactive marker was introduced earlier into the mixture to facilitate future analysis of the sequence. The four tubes were than loaded into separate lanes of a 6% polyacrilimide gel and run for a sufficient period of time. The gel was then transferred to 3MM filter paper (complete with the radioactive markers) and placed on a gel dryer. The 3MM paper was exposed to X-ray film and left over night. It was then possible to see the order of nucleotides as the fragments in each lane separated out by size.

Results

Initial attempts were inaccurate and often produced

results that could not easily be identified. Subsequent experiments produced sequences which correlated among different DNA samples. By using the poly-A tail as a identifying point, it was easy to compare various X-rays to show commonalty. A series of 88 base pairs was confirmed through various sequencing attempts. These nucleotides are believed to be a part of the nitrate reductase gene introduced into the M13, although future verification would be recommended. The nucleotide sequence identified is as follows: CACGGGGACGGGGTACAACTCCGACAACTCGGTGCACGGTGGGTCCAG CCTATCCCACCTCGCACCGATCCGCGAGCCACCAAGGTCG.

This segment was sent to the National Institute of Health via electronic mail to search for relative sequences, but feedback did not seem to be especially beneficial.

EXAMINATION OF THE NITRATE REDUCTASE GENE THROUGH NUCLEOTIDE SEQUENCING, GENOMIC LIBRARY PREPARATION, AND SOUTHERN BLOT TECHNIQUES.

Genomic Library Component

Introduction

DNA can easily be extracted and isolated from species using equipment and chemicals common to most any laboratory. Once this DNA is separated, it can be cut into smaller molecules by a restriction enzyme or DNAase. Restriction enzymes vary in specificity and work optimally in various

conditions, but they are prolific enough so that one can be found to accommodate most any type of experiment. Once cut, DNA fragments can be "doctored" and prepared for insertion into a vector. Vectors are generally plasmids or cosmids, which are circular molecules of DNA. Vectors can be stored in bacterial or viral "libraries" indefinitely and they allow a scientist an accessible, practical way to examine specific regions of a genome.

Discussion of Problem

It is believed that Pseudomonas stuzeri and Bacillus anthrax contain a gene similar to the nitrate reducing gene discovered in barley. By growing up the two bacteria and extracting the DNA, it is possible to create libraries from which a nitrate reducing gene might be located.

Methodology

P. stuzeri and B. anthrax were grown on separate agar plates for three days at 4 C. Colonies were then scraped off and added to flasks containing 50 mL of LB broth and they were placed in a shaking incubator at 37 C to grow. There were four flasks total. Each bacterial species had two tubes, each tube designated for either method I or method II. DNA extraction was performed on the bacteria using the following methods:

Method I. Cells were spun at 8000 rpm for 10 minutes and the supernatant was poured off. Cells were resuspended in 9.5 mL of TE buffer. Half a mL of 10% SDS and .1 mL of 10mg/uL proteinase K were added at the mixture was left at 65 C for one hour. Then, 1.8 mL of 5M NaCl was added and mixed. This was followed by the addition of 1.5 mL of CTAB/NaCl. An equal volume of chloroform/isoamyl alcohol (24:1) was subsequently mixed in. The container was spun and the top layer was removed. To the top layer, 8.0 isopropanol was added to precipitate out the DNA. The DNA was spooled out and transfered to 70% ethanol. The DNA/ethanol mixture was spun for 5 minutes and then the DNA was resuspended in buffer.

Method II. Cells were centrifuged at 2500 rpm for 15 minutes at room temperature. The supernatant was discarded. A tube containing the spun pellet was filled with with 40 mL of 0.32 M sucrose, 10mM TrisHCl pH 7.5, 5mM MgCL2 and 1% Triton X - 100 that had been stored at 4 C. Ten mL of lysis buffer was added and the cells were rinsed from the tube with 50 mL of lysis buffer. Cells stayed dormant in buffer for 15 minutes
at 4 C. Then, they were spun at 2500 rpm for 10 minutes and the supernatant was discarded. Four and half mL of 0.075M NaCl and 0.024M of EDTA pH 8.0 were added to the nuclear pellet. The pellet was broken up into smaller pieces and

0.5 mL of 5% SDS and .1 mL of 10mg/uL proteinase K were added. This sample was mixed and left at 37 C overnight. The next day, 5.0 mL phenol equilibrated with 20 uM Tris HCl pH 8.0 was added and the mix was shaken vigorously. Five mL of chloroform/isoamyl alcohol(24:1) was added. The sample was shaken and then spun 10 minutes at 2500 rpm. The upper layer was removed and the chloroform extraction was repeated. One volume of sodium acetate and 2 volumes of ice cold ethanol were added. The solution was inverted back and forth until DNA precipitated out. The white, threadlike DNA was removed to a new tube with a pipette and dissolved in 0.5 mL of 10 uM Tris HCl pH 7.5 and 1 mM EDTA.

Results

The first two times the experiment was tried, results were negligible. Upon analysis with a spectrophotometer, an insufficient quantity of DNA had been isolated for any subsequent work. The third attempt produced DNA in readable amounts. Method I yielded 0.55 ug/uL of DNA for B. anthrax and 0.49 ug/uL of DNA for P. stuzeri. Method II yielded 0.46 ug/uL of DNA for B. anthrax and 0.40 ug/uL of DNA for P. stuzeri.

Due to unforeseen circumstances, this experiment could not be continued and was placed on hiatus. Time constraints and a move of labs from one building on base to another

complicated matters. A library was not made from the DNA, but could be created at a later date to search for the presence of a nitrate reducing gene.

EXAMINATION OF THE NITRATE REDUCTASE GENE THROUGH NUCLEOTIDE SEQUENCING, GENOMIC LIBRARY PREPARATION, AND SOUTHERN BLOT TECHNIQUES

Southern blot component

Introduction

Due to the complementary nature of DNA, it is possible to use radioactive fragments of DNA to search for specific pieces of DNA. By introducing the DNA in question to a radioactive probe matching a predetermined region, the region can easily be identified through examination by autoradiography. This technique developed by Dr. Southern, can be used to confirm the presence of specific DNA fragments or to search for previously unidentified genes that may show correlations with the radioactive probe in use.

Discussion of Problem

A 1.1 kilobase pair fragment of cDNA from the barley plant has been isolated. This fragment reduces nitrates.

P. stizeri, a bacteria, is thought to have a similar gene in its genome. By attempting to hybridize a radioactive version of the 1.1 piece to P. stuzeri, it is hoped that an analogous gene with slightly different properties might be identified.

Methodology

The method used was a conventional protocol as outlined in the laboratory manual, Molecular Cloning by Sambrook, Fritsch, and Maniatis. For a more extensive explanation of the Southern blot technique, please refer to this manual.

DNA was extracted and run on an agarose gel. The gel was washed, examined, and placed in the conventional S. blot set up to transfer the DNA to filter paper. The paper was then baked, treated with pre-hybridization and hybridization solutions, and the paper was left with film to be exposed.

Results

The P. stuzeri seemed to exhibit hybridization with the 1.1 piece of the barley nitrate reductase gene. This would indicate a similar gene present in the P. stuzeri which might also serve a role in nitrate reduction. Further experiments could better identify and show the exact length, makeup, and purpose of the P. stuzeri gene in question.