FINAL REPORT

MORGAN STATE UNIVERSEITY
9-XG9-H4078-1

FOR ARMED FORCES CAREER EXPLORATION FOR HIGH SCHOOL STUDENTS IN THE FIELDS OF ENGINEERING AND SCIENCE

Submitted To:

U. S. ARMY LABORATORY COMMAND

and

U. S. DEPARTMENT OF ENERGY
(LOS ALAMOS NATIONAL LABORATORY)

By:

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ARMED FORCES CAREER EXPLORATION FOR HIGH SCHOOL STUDENTS IN THE FIELDS OF ENGINEERING AND SCIENCE

INTRODUCTION

Morgan State University's School of Engineering conducted its third annual Armed Forces Career Exploration program for high school students in the fields of engineering and science. The four week program was jointly sponsored by the U. S. Army Laboratory Command (Ballistics Research Laboratory and Human Engineering Laboratory) and U. S. Department of Energy (Los Alamos National Laboratory). Thirty-four high school students (18 females and 16 males) participated in the rigorous residential program that ran from 8:00 am to 10:00 pm daily.

The environment in a predominantly urban school system is such that a significant number of very capable students reach the eleventh grade without plans for the future. These students as a result of teacher influence have taken lower level math and science courses and we feel by participating in this program will see reasons for pursuing higher level math and science courses their last two years in high school. Inasmuch as intervention programs have not yet significantly affected the profile of these schools this pool of students represents an opportunity to make an early impact on the number of students that enter college intending to major in math, science or engineering.

This report presents the program that provided selected students with pre-engineering and science enrichment experiences designed to enhance their understanding of engineering, increase their awareness of career opportunities in science and engineering, advance their readiness to enter temporary job situation, and foster the development of self-confidence in their individual capabilities.

PROGRAM GOALS

The major goal of this program is to motivate a selected group of tenth grade students who are prepared academically and have demonstrated interest and potential for a high level of achievement in science and mathematics to pursue careers in engineering or related fields. The specific goals of the program and the efforts performed to achieve these goals are:

1. **To enhance the students' awareness of the academic requirements for becoming an engineer or scientist.**

   The academic requirements for becoming an engineer or scientist include not only certain courses but good study skills and discipline. The students are exposed to a typical freshman engineering curriculum. The courses in Chemistry, Physics and Calculus or Trigonometry are taught at paces that require the students to constantly work and study. For example- the Calculus course starts at limit theory and goes through using integrals to calculate volumes. The students are not expected to learn the material in four weeks, but the constant demand and the structured study sessions (Problem Solving Workshop see schedule), disciplines the student, helps them manage their time and develop better study skills.

2. **To enhance the students' awareness of the career options available in various engineering disciplines.**

   The exposure to various career option was carried out in three forms, guest lectures, field trips and the career planning workshop. All the guest lectures were Afro American engineers and scientist with various backgrounds including the Dean of Morgan's School of Engineering, a female product manager from Noxell with a B.S. in metallurgical engineer and a MBA, and a female civil engineer from the State Highway Administration. The fieldtrips really enhance their awareness of career options. The field trip to the Backwater Treatment Plant help many students decide to avoid careers in waste water treatment. In the career planning workshop, students were required to pick a discipline and write a research paper on a planning a career in their chosen discipline.

3. **To afford students the opportunity to observe the practice of engineering in industry.**

   The students observed the practice of engineering on all the industrial fieldtrips. On a few of the fieldtrips small groups participated in laboratory demonstrations. The State Highway Administration field trip included four modules of civil engineering: 1. Rerouting a major highway; 2. Building bridges; 3. Designing drainage systems; and 4. Using Computer Aided Design system.

4. To increase the students' awareness of their own potential and aptitudes.

The students' awareness of their own potential and aptitudes were increased through the Intro to Engineering course and the engineering competition. The Intro to Engineering course included several small projects and puzzles. The projects and puzzles were used to teach different types of problem solving skills. The engineering competition (Eggdrop Contest discussed later) was used to stimulate creativity and show the iterative process of engineering design.

5. To motivate students to continue to study.

The majority of the students had not taken advance level math and science courses. Therefor, emphasis was placed on the application of these courses. And through the applications we tried to stimulate the eagerness to learn more about the foundations. In each class we emphasized the importance of trying to take these classes before entering college.

6. To strengthen students' skills in mathematics, science and communication.

In each class the students were taught problem solving skills that would be useful in future courses. For example, in the Chemistry course students learned to set up equations using a chain of conversion factors, the same technique was also used in the Physics course to change miles per hour to feet per second and kilometers per hour. The students truly enjoyed the Communications Skills Workshop where they learned to prepare and make presentations. The students enthusiasm for this event is reflected in the Program evaluation summary. The Communications Skills Workshop received a 100% approval rating.(See Program Evaluation Summary)

7. To increase students' motivation and enthusiasm to attend college and particularly to consider careers in engineering.

The engineering college students play an important role in increasing the highschool students motivation and enthusiasm. At ages that highschool students can readily relate and openly talk to, the engineering students serve as junior role models. In informal discussions with engineering students, participants find out about the rigor and challenge of engineering education and the joys of college life. The participants are able to see first hand the necessary discipline to succeed in engineering and science. Three engineering students (junior and senior level) were employed as instructors (Physics, trigonometry and computer science) and tutors. They were responsible for course development and testing of the students. They conducted help sessions for classes and brainstorming sessions for projects.

Recruitment and Selection of Students

Announcements were sent to all the high schools in the state of Maryland. Each school received a letter explaining the program and three brochure/applications (included in appendix). The program was also announced in Montgomery County's Summer Search Magazine. We were particularly interested in serving the minority groups that are underrepresented in the mathematics, science, and engineering fields. Students were selected based on the following criteria:

1. Demonstrated interest in science and engineering.
2. Completion of algebra and geometry or algebra II and science courses
3. Recommendation by high school science and mathematics teachers
4. Scholastic ability
5. An essay explaining the students interest in engineering and science .

More than sixty students applied. Upon receipt of application materials the Program Director, along with staff personnel, screened the applications for eligibility, then ranked each applicant and selected thirty-four to attend and three alternates.

PROGRAM DESIGN

The program was designed as a four week summer residence session which engaged the participants in activities in mathematics, engineering and science that challenged and provided opportunities to promote development of the skills needed to pursue careers in mathematics, engineering and science. The theme that permeated all the activities is enhancement of each participant's understanding of the requirements, privileges, and responsibilities of mathematics science, and engineering careers. The Program consisted of three major components: laboratory experiences, career planning as a process and classroom instructions. Motivational activities were also included. The design of each component emphasized active involvement by each participant. The activities of each component are described below.

ENGINEERING COMPETITION

The engineering competition took the eggdrop contest a step further. In the previous contest teams were given material from which they designed an apparatus to prevent the egg from breaking when dropped from a second story balcony. This year students teams of 4 or 5 were given a budget of $4 to $5 dollars (one dollar per member) to purchase any desired material to build their apparatus. Teams were responsible for budgeting, designing, testing, marketing and presenting their product in an oral presentation during the final week.

CAREER PLANNING AND COMMUNICATION SKILLS WORKSHOPS

Eight two-hour workshops were held. The first two workshops were devoted to discussions and audio-visuals of the many options available to the individual pursuing a career in engineering or science. The second two of the workshops were with smaller groups and dealt with personal interests of members of the groups. The third set covered career planning as a process and mock interviews, while the last set were reserved for marketing and presenting final projects.

CLASSROOM COURSES

Classroom courses that reinforce and extend mathematics and science concepts learned in high school were covered. The objective of these courses is to expose students to advance levels of mathematics, science and highlight problem solving techniques and analytical thinking. Students were placed in proficiency level groups for classes based on their high school backgrounds and math aptitude test. Twenty students with good algebra skills were place in a calculus course, while the remaining students were placed in a Trigonometry course. By exposing the students to these two courses, they had an opportunity to see how each is applied in the real world.

Appendix

AFCE 1990 SCHEDULE

	SUNDAY 8-Jul	MON 9-Jul	TUES 10-Jul	WED 11-Jul	THUR 12-Jul	FRI 13-Jul	SAT 14-Jul
700	BREAKFAST			BREAKFAST			
800		TESTING	CHEM	CHEM	NASA	CHEM	
900		TESTING	PHYS	PHYS	GODDARD	PHYS	
1000		TESTING	MATH	MATH	SPACE	MATH	
1100		TOUR	GL	GL	CENTER	LUNCH	BRUNCH
1200	ARRIVAL	LUNCH	LUNCH	LUNCH	LUNCH	"	"
1300	OF	"	"	"		CPW	SCAVENGER
1400	STUDENTS	ENGR	ENGR	ENGR	SMITH-	CPW	HUNT
1500		COMP	COMP	COMP	SONIAN	CSW	"
1600	OPENING	LAB	LAB	LAB		CSW	
1700	RECEPT.	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER
1800						F T	F T
1900	ORIEN-	PROBLEM SOLVING				R I	R I
2000	TATION	WORKSHOP				E M	E M
2100						E E	E E
2200	GROUP COUNSELING SESSIONS						
2300	LIGHTS OUT			LIGHTS OUT			

	SUNDAY 22-Jul	MON 23-Jul	TUES 24-Jul	WED 25-Jul	THUR 26-Jul	FRI 27-Jul	SAT 28-Jul
700	BREAKFAST			BREAKFAST			
800		CHEM	CPW	CHEM	BACK-	CHEM	
900		PHYS	CSW	PHYS	WATER	PHYS	
1000		MATH	CSW	MATH	TREAT-	MATH	
1100		LUNCH	GL	LUNCH	MENT	LUNCH	JOINT
1200	LUNCH		LUNCH	"	PLANT	"	NASA
1300	"	WESTING	"	GL	LUNCH	GL	AND
1400			EGG	ENGR	CPW	ENGR	AFCE
1500		HOUSE	DROP	COMP	CSW	COMP	PICNIC
1600			TESTING	LAB	CSW	LAB	
1700	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER
1800						F T	F T
1900	PROBLEM					R I	R I
2000	SOLVING					E M	E M
2100	WORKSHOP					E E	E E
2200	GROUP COUNSELING SESSIONS						
2300	LIGHTS OUT			LIGHTS OUT			

	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul
700	BREAKFAST			BREAKFAST			
800		CHEM	GENERAL	CHEM	STATE	CHEM	
900		PHYS	MOTORS	PHYS	HIGHWAY	PHYS	
1000		MATH	PLANT	MATH	SYSTEM	MATH	WILD
1100		GL		LUNCH	"	GL	WORLD
1200	LUNCH	LUNCH	LUNCH	"	LUNCH	LUNCH	
1300	"	"	CPW	GL	"	CPW	WATER
1400		ENGR	CPW	ENGR	ENGR	CPW	PARK
1500		COMP	CSW	COMP	COMP	CSW	
1600		LAB	CSW	LAB	LAB	CSW	
1700	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER
1800						F T	F T
1900	PROBLEM SOLVING WORKSHOP					R I	R I
2000						E M	E M
2100						E E	E E
2200	GROUP COUNSELING SESSIONS						
2300	LIGHTS OUT			LIGHTS OUT			

	29-Jul	30-Jul	31-Jul	1-Aug	2-Aug	3-Aug	4-Aug
700	BREAKFAST			BREAKFAST			
800		CHEM	A P	CHEM		TESTING	
900		PHYS	B R	PHYS	KINGS	TESTING	
1000		MATH	E O	MATH	D	TESTING	CHECK
1100		GL	R V	LUNCH	O		OUT
1200	LUNCH	LUNCH	D I	"	M	LUNCH	CLOSING
1300	"	"	E N	GL	I	"	CEREMONY
1400		EGG	E G	ENGR	N	EGGDROP	
1500		DROP	N	COMP	I	CONTEST	
1600		TESTING	GROUNDS	LAB	O	"	
1700	DINNER	DINNER	DINNER	DINNER	N	DINNER	
1800							
1900							
2000	PROBLEM SOLVING WORKSHOP					PIZZA	
2100						PARTY	
2200	GROUP COUNSELING SESSIONS						
2300	LIGHTS OUT			LIGHTS OUT			

CSW - COMM. SKILLS WORKSHOP CPW - CAREER PLANNING WORKSHOP GL - GUEST LECTURE

.990 AFCE PROGRAM EVALUATION

Area	4 Point Scale	Success Rate
The program announcement established clear, accurate expectations concerning program activities and workload.	2.78	69.5%
The program content and materials were designed to address students' needs.	3.34	83.5%
Adequate transportation was provided.	3.40	85.0%
Adequate housing was provided.	2.90	62.5%
Adequate meals were provided.	3.13	78.3%
The scheduled field trips helped further students' understanding of science applications in technology.	3.54	88.5%
Sufficient time was provided to meet all of the instructional/learning objectives.	3.00	75.0%
The instructors/counselors allowed ample opportunity for questions.	3.60	90.0%
The instructors/counselors provided opportunities for individual attention.	3.40	85.0%
The instructors/counselors provided satisfactory and adequately detailed answers to questions.	3.04	76.0%
The instructors/counselors closely monitored students' performance to quickly address any problems.	3.12	78.0%
The instructors/counselors worked to ensure that all participants understood and could implement the concepts and demonstrations presented during the program.	3.49	87.3%
The group sessions provided an opportunity to share experiences and brainstorm solutions with other participants.	2.46	61.5%
The program provided opportunities for peer help and support.	3.40	85.0%
The program provided instructors and guest lecturers that improved students' knowledge of math, science and engineering professions.	3.58	89.5%

Area		Percent Favorable
The Problem Solving Workshop was helpful.		70.6%
The Communications Workshop was of interest among the students.		100.0%
The Career Planning Workshop was of interest among the students.		87.5%
The guest lecturers provided interesting topics.		78.0%
Field Trips & Activities	3 Point Scale	Success Rate
NASA Goddard Space Flight Center	2.25	75.0%
Westinghouse	2.40	80.0%
Smithsonian Air and Space Museum	2.70	90.0%
General Motors Dundalk	2.50	83.3%
State Highway Administration	2.57	85.5%
Backwater Treatment Plant	1.53	51.0%
Aberdeen Proving Grounds	2.50	83.3%
Ballistic Research Laboratory	2.14	71.3%
Human Engineering Laboratory	2.73	91.0%
Wild World	2.76	92.0%
Kings Dominion	2.60	86.7%
Eggdrop Contest	2.67	89.1%
Trial of Gay Vs Kenlaw	2.33	77.7%
Overall Opinion of Program	2 Point Scale	Success Rate
The students would recommend this program for their fellow classmates.	1.78	89.0%
The program increased the students' interest in engineering.	1.81	97.1%
Overall success rate		**81.%**

1. What are the units of the following :

   Distance_____

   Velocity_____

   Acceleration _____

   Time _____

2. Complete the conversions (K = 1000):

   1 minute = _____ seconds

   50Km/hour = _____ m/sec

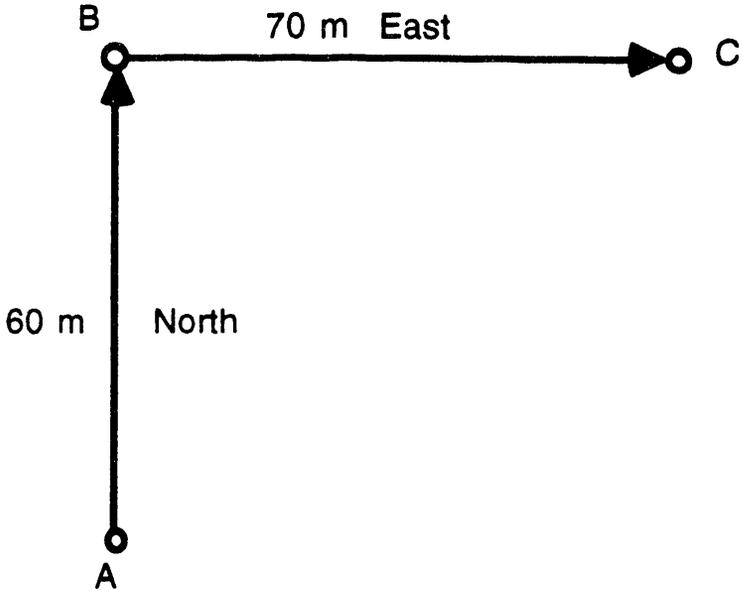
   10Km = _____ m

3. In the figure below, if Tracy starts at point A, walks 60 meters North to point B and then 70 meters East to point C, determine the following for Tracy's trip.

   a. The total distance traveled.

   b. The displacement between the initial and final points.

   c. What is the resulting direction Tracy traveled.

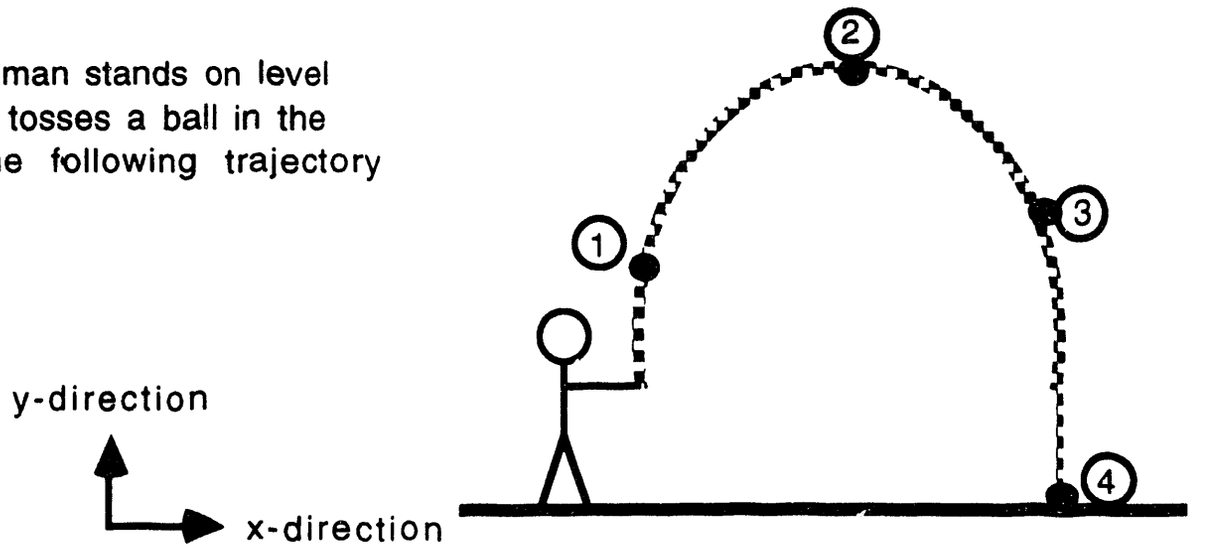


4. What are the Units for 1 Newton?

5. What is the acceleration due to gravity? In what direction is the acceleration?

6.

A big head man stands on level ground and tosses a ball in the air with the following trajectory



a. At what point(s) will the ball experience 0 velocity in the y-direction?

b. At what point(s) will the ball experience maximum velocity in the y-direction?

c. At what point(s) will the ball experience maximum velocity in the x-direction?

b. At what point(s) will the ball experience 0 velocity in the x-direction?

1 Simplify:

$(4x^3y^2z^4)^2\ (8x^4y^6z)^{-1}$

2. Multiply:

$(x + a)(x^2 + ax + a^2)$

3. Factor Completely:

$3b^2 + 22b + 35$

4. Expand:

$(y + 2)^3$

5 Factor Completely

$81 - W^4$

6 Solve y in terms of x:

$6y + 4x + 12 = 0$

7. Use the quadratic formula to solve:

$x^2 + 8 = 4x$

9 Find u: 0C < u < 180C and

sin(u)= cos(u)

8. Dick and James are refinishing an antique table. Working alone, Dick would need 8 hours to finish the table, while James would require 10. If they work together, how long will it take them to finish the project.

10 Given a rectangular lot, 30 feet wide and 40 feet long. Calculate the following quantities:

a. the length of the fence needed to enclose the lot;
b. the square footage of the lot and
c. the length of a rope needed to stretch between two corners diagonally across the lot.

INTRO TO CALCULUS

Instructor:	Eric A. Cheek, Ph. D.	Office: CGW 318
Phone Number:	444-3231	
Office Hours:	Appointments Only	
Class Time:	SEE SCHEDULE	Room: JB 404
Prerequisite:	Good Algebraic Skills	
Objective:	Exposure to the basics of differential, integral calculus and applications of each.	
Required Text:	"Calculus The Easy Way" Author: Douglas Downing Publisher: Barron's Educational Series Inc.	
References:	"Calculus and Analytical Geometry" Alternate edition Authors: George B. Thomas Jr. Publisher: Addison-Wesley Company	

Grading:		
	Homework* (8 Assignments)	40%
	2 Take-Home Exams	30%
	Final Exam (Fri. July. 28, 10:00-11:00)	30%
		100%

*** All Homework Assignments are due in class upon arrival. Late Assignments (after 10:50 pm) will receive Zero Credit!!!**

LECTURE SCHEDULE

CHAPTERS	SUBJECT	DATE
1	The Slope of the Tangent Line	Tue. Jul. 11
2	Calculating the Derivative	Tue. Jul. 11
3	Drawing Curves with Derivatives	Fri. Jul. 15
4	Derivatives of Complicated Functions	Mon. Jul. 17
6	Optimum Values and Related Rates	Tue. Jul. 18
7	The Integral: Backwards Derivative	Wed. Jul. 19
8	Finding Areas With Integrals	Mon. Jul. 24
13	Finding Volumes with Integrals	Wed. Jul. 26

1 Find the equation of the tangent line to the curve $y = x^2$ at the point (3,9).

2. Find the derivative with respect to x and evaluate this derivative at x = -2.

$y = x^3 - 6x^2 - 36x + 20$

3 Use first and second derivatives to sketch $y = x^3 - 27x$.

4 Find dy/dx for:

$y = (3x-4)(6x-7)^{1/3}$

5. Find the area between the parabola $y = x^2 + 3x + 5$, the line $x = 0$, the line $x=1$ and the x axis.

6. Evaluate:

$$\int_{-2}^{2} \left(2x^2 - 8 \right) dx$$

END

DATE
FILMED
9/29/93