**CAREER INFORMATION IN THE
MATHEMATICAL SCIENCES (CIMS)**

Final Report

for Project Period 11/01/92 - 10/31/95

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1529 Eighteenth St., N.W.
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CAREER INFORMATION IN THE MATHEMATICAL SCIENCES (CIMS)

Abstract

Final Report

For Project Period 11/1/92 - 10/31/95

awarded to

The Conference Board of the Mathematical Sciences

January 29, 1996

The Conference Board of the Mathematical Sciences (CBMS) proposed four activities which would promote careers in the mathematical sciences: **A. GATHER INFORMATION ABOUT EXISTING CAREER INFORMATION AND UNFILLED NEEDS.**

CBMS distributed 70,000 copies of the first edition of its Reference Guide and 44,500 copies of its second edition containing 72 references. In addition, CBMS distributed approximately 15,000 career information kits. **B. LINK EFFORTS OF THE MATHEMATICAL COMMUNITY WITH OTHER ORGANIZATIONS THAT PROVIDE CAREER INFORMATION.**

Many resource guides were distributed by organizations with which the mathematical community ordinarily does not come into contact. For example, the American Counseling Association distributed 15,000 guides and the National Consortium of State Career Guidance Counselors distributed 5,000 guides.

The National occupational Information Coordinating Committee cooperated with CBMS to plan how we might focus on middle school students. **C. DEVELOP NEW MATERIALS IN PRINT AND VIDEO FORMAT.**

Many CBMS career items were updated; new items were added as needed. We supported the distribution of one career video produced by ORSA that is intended for high school students and supported the production of a second video intended for middle school students. **D. ESTABLISH A SUBSCRIPTION PROGRAM.**

Because of the wide ranges of students represented by the interests of the CBMS societies and the uncertainty associated with the production of new material, this part of our proposal was not carried out as originally envisioned. We have already seen considerable information made available to college and high school faculty and students through electronic media and believe that heightened awareness of the importance of reaching younger students by our member societies will provide programs to reach that audience. Evidence that we have made efforts to reach middle school teachers and students is found in the body of this report.

Final Report
Career Information in the Mathematical Sciences
Submitted by
The Conference Board of the Mathematical Sciences

Member Societies of the Conference Board (CBMS):

American Mathematical Association of Two-Year Colleges (AMATYC)
American Mathematical Society (AMS)
American Statistical Association (ASA)
Association for Symbolic Logic (ASL)
Association for Women in Mathematics (AWM)
Association of State Supervisors of Mathematics
Institute for Operations Research and the Management Sciences (INFORMS), formerly the
Operations Research Society of America (ORSA) and The Institute of Management Sciences
(TIMS)
Institute of Mathematical Statistics (IMS)
Mathematical Association of America (MAA)
National Association of Mathematicians (NAM)
National Council of Supervisors of Mathematics (NCSM)
National Council of Teachers of Mathematics (NCTM)
Society for Industrial and Applied Mathematicians (SIAM)
Society of Actuaries (SOA)

Upon receiving notification of support from the Department of Energy for its proposal to evaluate, create, and distribute information about careers in the mathematical sciences, the Conference Board of the Mathematical Sciences created a Steering Committee of representatives from its member societies. This committee consisted of:

Nancy Flournoy (ASA)
Samuel M. Rankin (AMS)
Leon Seitelman (SIAM)
Frank Trippi (INFORMS)
John Alexander (NAM)
Carol Eaton (AMATYC)
Linda Hall (NCTM)
Jenny Baglivo (AWM)
Ronald Rosier (CBMS Administrative Officer)
Andrew Sterrett (MAA), Chair

The Steering Committee met three times in Washington, DC: May 1-2, 1993; October 16-17, 1993; and March 19-20, 1994. At its first meeting, the Steering Committee agreed that its highest priority was to evaluate existing information about careers in the mathematical sciences, both material produced by member societies and by other organizations, and then create a resource guide of available career information that would be widely distributed. Evaluations of career information produced by CBMS societies were made by students at:

Humboldt State University
Denison University
Hampden-Sidney College
Cedar Crest College

as well as by members of the CBMS Steering Committee, the CBMS Council, and David Lutzer (Chair of the MAA Committee on Advising). Although the overall reactions of the materials were quite favorable, it was clear that the information in several of the brochures needed to be updated and put into a more attractive format. Member societies were cooperative in making such changes, as the following list of revised brochures and books indicates:

Careers in Statistics (ASA)
Actuaries Make a Difference (SOA)
Careers in Operations Research (ORSA)
Mathematical Scientists at Work (MAA)

One hundred thousand copies of the second edition of Mathematical Scientists at Work were distributed in bulk to mathematics departments in two- and four-year colleges and universities and then by departments to their students.

In addition to modifying existing material, several new items were produced by member societies:

Shape the Future: A Career as a Mathematics Teacher (NCTM)
What's Happening in the Mathematical Sciences (AMS)
More Careers in the Mathematical Sciences (MAA)

To complete the first phase of its program, all known information pertaining to careers in the mathematical sciences was collected and published in January, 1994. The booklet, Career Information in the Mathematical Sciences: A Resource Guide, contained 55 references for materials of interest to students ranging from junior high school to college. By the end of the year, the initial printing of 70,000 copies had been distributed. CBMS sent multiple copies to organizations who then distributed copies to their members. Many organizations that are not members of CBMS cooperated in the distribution of the Resource Guide. The distribution of the Resource Guide is included as Appendix A.

The Resource Guide was revised to include 72 items, and 75,000 copies were printed in January, 1995. The distribution of the revised Resource Guide is found in Appendix B.

Rather than relying on individual teachers and professors to write to member societies for career information, the CBMS Steering Committee decided to take the materials, in the form of a "Career Information Kit," to national meetings of NCTM, AMATYC, and MAA/AMS. These kits were immensely popular, even though they added considerable weight to one's return baggage. Kits were distributed without cost (to individuals) at the following national meetings:

MAA/AMS meeting in Cincinnati, January, 1994 (1,000 kits)
NCTM meeting in Indianapolis, April, 1995 (5,000 kits)
MAA/AMS meeting in Minneapolis, August, 1994 (100 kits)

AMATYC meeting in Tulsa, 1994 (800 kits)
MAA/AMS meeting in San Francisco, January 1995 (2,000 kits)
NCTM meeting in Boston, April, 1995 (4,000 kits)

In addition to the distribution at national meetings of professional mathematics societies, CBMS Career Kits were distributed in smaller numbers to many interested groups.

When the printing of materials was a major expense to a member society, costs were charged to this grant, but the large majority of the materials were donated by CBMS societies. However, assembling and distributing the kits was costly, and we ran out of money before meeting the demand even though we had materials available. Nine months after running out of funds, CBMS continues to receive requests for the kits. We intend to try to obtain support to continue a "free" distribution of career kits in the future.

During 1995 and early 1996, the MAA will have published two books that encourage young women and men to study mathematics in high school and college. She Does Math: Real-Life Applications from Women on the Job is a collection of 38 career histories written by professional women whose jobs require constant use of mathematical concepts. Each woman then provides problems typical of her job that require pre-college mathematics for solution. A second book, 101 Careers for a Mathematician is being prepared for publication. This book is a collection of career essays, including many written by women and minorities, intended for students in grades 12-14. These essays show, by example, that mathematics is a useful, and often essential, background for many occupations. Each of these books provides teachers as well as students with answers to the commonly asked question, "Why study math?" Although these books are not a direct result of the grant to CBMS, they do provide additional evidence of the commitment of our profession to the goals of this CBMS project.

Through this grant, the CBMS Steering Committee supported the distribution of a career video intended for high school students and the production of a second video for junior high students. The first video, "Operations Research+You=An Exciting Career," was produced by ORSA and included in their Educational Outreach Kits that they distribute to high school teachers. CBMS provided the resources to distribute 1,000 kits to Presidential Awardees in mathematics and science. During this grant period, ORSA and TIMS joined forces to become the Institute for Operations Research and the Management Sciences (INFORMS) and produced a similar video, but at a level intended for junior high students. CBMS supported the production of this video, "It All Adds Up To Your Future." In September, 1995, this video was shown nationwide on the Public Broadcasting System and, in October, it was awarded a Certificate of Honorable Mention (3rd place) at the 43rd annual Columbus International Film and Video Festival. INFORMS plans a wide distribution of this video to junior high school teachers.

A second video for a junior high audience was revised during this period. "You're Gonna Need Those Numbers," produced by the National Security Agency for the MAA, also makes a convincing case to junior high students that they should stay in school and keep taking math. All three of the videos discussed in this report are available at cost.

Throughout the period of this grant, the MAA conducted Career Fairs at which mathematicians from industry discussed how mathematics is used in industrial settings. These Career Fairs, which were supported by a grant from the EXXON Education Foundation, were given at both national and regional meetings of the MAA.

In late 1993, the MAA published its first issue of *Math Horizons*, a magazine for students, now with a circulation of 20,000 copies. Each issue of *Math Horizons* contains articles about careers in the mathematical sciences -- for the simple reason that input from students before the first issue was published indicated that they want more information on this topic.

During the implementation of this program, we reached out to many organizations interested in promoting careers in the mathematical sciences but not members of CBMS. In particular, in January, 1995, the National Occupational Information Coordinating Committee (NOICC) cooperated with CBMS to sponsor a workshop in Berkeley, California at which junior high teachers, along with representatives of NOICC and CBMS discussed the types of applications that would appeal to junior high students and how to locate and distribute such materials. A "focus group" conducted by Ronald Rosier at the national meeting of NCTM had identified the lack of problems that motivate junior high students as their greatest concern. A summary of the findings of this workshop is found in Appendix D. CBMS intends to apply for support to implement the recommendations made by the participants of the workshop.

When our proposal to the Department of Energy was originally made, we anticipated the need to update career information as new information becomes available. We thought that a subscription program might be devised to meet this need. Because of the wide interests of our audience -- from grade school to graduate school -- and because of the great variation in the type of information being made available -- pamphlets, books, posters, electronic communication and videos -- we decided that a subscription series was not practical. We expect to update the Resource Guide on a regular basis, bringing new materials to the attention of our audiences through that publication as well as through electronic media.

The AMS and SIAM have jointly produced a Mathematical Sciences Career Information home page, accessible beginning in late October, 1995 or early November on the World Wide Web (WWW). The aim is to provide services and information to the mathematical sciences community regarding nonacademic employment. The site includes an interactive careers bulletin board featuring career profiles of mathematicians working in industry or government and a forum that allows questions to be posed directly to the mathematicians profiled. Also accessible from the Career Information home page is a mathematical applications section designed to provide information about the broad range of mathematical fields used in industry and the various types of applied problems mathematicians work on in nonacademic settings. For students interested in how to start a job search, information about books and articles on career planning and links to other online resources, including online job listing services, are also provided. The Career Information home page is accessible either through the AMS e-MATH Employment Information WWW page, <http://www.ams.org/employ/>, or the SIAM WWW page, <http://siam.org/>.

One example of career information that is available electronically is the 1994 SIAM Forum Final Report entitled "Mathematics in Industry: The Job Market of the Future" which is being posted on

the SIAM home page on the WWW. This report, supported by the Department of Energy, contains much information that will interest students who are considering a career in industry.

An innovative pilot project that is intended to help meet the concerns of the CBMS/NOICC workshop in Berkeley is the MathMobile, a project directed by Dr. Leon Seitelman, Senior Applied Mathematician at Pratt&Whitney. This pilot project, now expected to begin in January, 1996, will develop two 40-minute units of interesting applications of mathematics that are appropriate for middle school students. Each unit will incorporate several learning styles (e.g., lecture, experimentation, discussion, collaboration, computers). Teachers guides will be developed. Finally, the units will be field tested in museums to solicit feedback and permit improvements to be made. We have agreed to make a small financial contribution to this project with the understanding that the major support will come from Pratt&Whitney. The administration of this project will be handled by PIMMS (the Project to Improve Mastery of Mathematics), a statewide effort in Connecticut to revitalize math and science education.

An examination of appendices A, B, and C provides an indication of the scope of the outreach of CBMS to other organizations.

Andrew Sterrett, Principal Investigator for this project, spoke on the topic "Careers in the Mathematical Sciences" to students and faculty at

The University of Virginia
Hampden-Sidney College
Thomas Jefferson High School, Virginia
Randolph-Macon College
Longwood College
Kent State University, Tuscarawas Campus

and to counselors at the national meeting of the American Counseling Association. He also described a "Career Kit for Faculty Advisors" at the national meetings of MAA/AMS in Minneapolis and in San Francisco as well as in FOCUS, the newsletter that is distributed to the 30,000 members of the MAA.

The multitude of activities that took place over the past three years that communicate the importance of mathematics to young people of all ages could only have occurred with the broad support of the societies that comprise the Conference Board of the Mathematical Sciences and the support provided by the Department of Energy. For this support, we are deeply grateful.

Dr. Andrew Sterrett
Recipient Project Director
Grant Number DE-FG02-93ER75840.A000
January 1996

Appendix A

Distribution of Career Information in the Mathematical Sciences: A Resource Guide 1994

American Counseling Association	15,000
National Council of Teachers of Mathematics	15,000
National Consortium of State Career Guidance Counselors	5,000
Mathematical Sciences Education Board	3,000
American Mathematical Association of Two-Year Colleges	2,000
American Statistical Association	2,000
National Security Agency	2,000
Mu Alpha Theta	1,400
Operations Research Society of America	1,300
Women and Mathematics Regional Chairs	500
Association for Women in Mathematics	300
Subtotal	47,500
Kits	6,800
Office requests*	700
Total	55,000
Print run	55,000
Remaining	0

*Sampling of office requests

Saint Francis College, Pennsylvania
 high school teachers
 South Carolina Occupational Information Coordinating Committee
 math and science teachers
 South Carolina Department of Education
 Penn State Math Options
 Math and Science Career Day for 7th and 8th Grade Girls
 Virginia View: Virginia's Career Information Delivery System
 New Zealand Mathematics Society
 Urban Systemic Initiative - Dade County Public Schools
 AAAS Directorate for Education and Human Resources Program brochure
 Ohio State University, Center on Education and Training for Employment
 Continuous Electron Beam Accelerator Facility
 University of California Monterey Bay Area Mathematics Project

Appendix B

Distribution of Career Information in the Mathematical Sciences: A Resource Guide 1995

National Consortium of State Guidance Counselors	5,000
American Mathematical Society	5,000
Maryland Science Center	4,000
Virginia View, Virginia Tech	2,000
National Council of Teachers of Mathematics	1,000
National Security Agency	1,000
Nebraska Department of Education	1,000
Ohio Department of Education	1,000
South Carolina Department of Education	1,000
Association of Teachers of Mathematics in New England	1,000
Association for Women in Mathematics	500
Association of Mathematics Teachers of New York State	350
Institute for Operations Research and the Management Sciences	200
State Mathematics and Science Coalitions Project	90
Subtotal	23,140
Kits	6,000
Office requests*	15,360
Total	44,500
Print run	70,000
Remaining	25,500

*Sampling of Office requests

Nazareth College
 University of Houston
 KCPT Puplic TV, Kansas City, Missouri
 Penn State Math Options
 San Jacinto Girl Scouts, Inc.
 Educational Opportunity Center, Denver Colorado
 Cedar Crest College, MathConn 95, Mathematics Awareness Day
 University of Winnipeg, Manitoba, Canada
 Stevens Institute of Technology
 Adirondack Community College
 Career and Counseling Center, South Dakota State University
 Expanding Your Horizons Conference, Loyola Marymount University
 Mississippi Alliance for Minority Participation

Appendix C

Career Kit Distribution at CBMS Booth

Meetings

Joint Mathematics Meetings
January 1994, Cincinnati, 1,000

National Council of Teachers of Mathematics,
April 1994, Indianapolis, 5,000

American Mathematical Association of Two-Year Colleges,
November 1994, Tulsa, 800

Joint Mathematics Meetings,
January 1995, San Francisco, 2,000

National Council of Teachers of Mathematics,
March 1995, Boston, 4,000

Planning Workshop Meeting on "Math in Careers"
Lawrence Hall of Science, University of California, Berkeley
January 13-16, 1995

The purpose of this workshop meeting was to seek ideas and formulate plans for the expansion of the CBMS Careers Project to include a new focus on students at the middle school/junior high school level.

The main purpose of the original Careers Project was to link the efforts of the various parts of the mathematical sciences community with other organizations to provide information to students and teachers about careers in the mathematical sciences in the broadest sense. Our target audience was primarily students and teachers at the high school and college level. We attempted to reach the teachers and, through them, students, with good information about the varieties of exciting careers that are open to persons with a background in mathematics.

From all our advisory groups and from many of the teachers who have received our materials, we received the same message — that what we have been doing is needed, but that there is an even greater need to reach students at the crucial 7-8-9 grade level. We want to encourage participation in mathematics throughout high school by making students aware of the necessity and importance of math in all careers. The need is for more good engaging materials that inform students, or even better, that allow them to experience, how mathematics is used in many different careers so that they will not deny themselves opportunities by their choice of mathematics courses in high school. This will entail a shift in our theme from "Careers in the Mathematics" to "Mathematics in Careers."

The Berkeley meeting brought together a diverse group of teachers with broad experience with students at this level to brainstorm and make recommendations about what kinds of materials and activities the CBMS project should plan to undertake so as to convey this message successfully and efficiently.

The workshop developed detailed recommendations to guide the design of the next phase of this project. Some of the highlights are summarized below.

Above all, materials produced or promoted should

- be child oriented,
- show students how useful everything they already know is,
- make them aware of all the opportunities out there, and
- make them aware of how to get information and to follow-through.

All materials should have the following characteristics. They should be

- highly interactive,
- integrate math and careers,
- use a broad view of what mathematics is (numerical, geometric, analytic, logical reasoning, spatial, statistical, change and chance),
- show workers in process of actively using math,
- show workers of both sexes, all ethnic groups, and all ages,
- value items of individual cultures,
- motivate teachers to get involved,
- encourage teachers to bring workers from the outside, and
- involve the parents.

The group also compiled a listing of known materials of the type we are seeking, and a listing of organizations and key contacts that we should work with.

Finally the group identified three projects which should get first priority:

- Resource Guide for Middle School/Junior High Teachers. This should build on the current resource guide "Career Information in the Mathematical Sciences," but should have a much broader focus. It should include information for math teachers about how to start a career information program and how to run a career day, hints on how to find outside workers to visit the classroom and how to make their classroom appearances most effective, and information on how to get some of the very useful print and video information published by special trade groups (e.g. math for plumbers, math in the airline industry, etc.)
- Develop and distribute widely several activity oriented materials that teachers can use in their classrooms to generate career awareness activities. Examples would include "Math in Careers" posters and calendars which show people involved in careers exciting to students at this age and which have lots of suggestions for classroom activities and projects.
- Identify teachers who can write good "Math in Careers" articles for the NCTM journals "The Middle School Teacher" and "The Mathematics Teacher," with the aim of generating enough good material to make a "Math in Careers" column a regular feature of these journals.

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Appendix D submitted by Ronald Rosier