

1989 Annual AMS-MAA Survey

(Second Report)

Enrollments, Faculty Characteristics,
and Update on New Doctorates, Fall 1989
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Highlights

1. The final (spring) count of new doctorates in the mathematical sciences records 419 U.S. citizens among the 919 recipients of doctorates granted by U.S. institutions from July 1, 1988 through June 30, 1989. These U.S. citizens account for only 46% of the new mathematical sciences doctorates awarded by U.S. institutions.
2. The number of U.S. citizens receiving doctorates in 1988-1989 is less than 60% of the comparable number for a range of years in the mid-1970s.
3. Women received 24% of the doctorates in mathematical sciences awarded to U.S. citizens. This is the largest percentage ever and a significant increase over the 20-21% awarded in the last six years. The 100 doctorates awarded to women U.S. citizens in 1988-1989 is exceeded only by the 102 awarded in 1980-1981.
4. Slightly less than 1.5% of the fall 1988 full-time faculty in the mathematical sciences, Groups I, II and III combined, retired or died by the fall of

1989. (See box on this page for descriptions of the groupings used in this Survey.) Slightly less than 1.75% of the fall 1988 full-time faculty in Groups M and B retired or died by fall 1989.

5. One-third of the current full-time faculty at departments that responded to the Survey will have died or reached age 65 by the year 2005.
6. A substantial portion of the upper division (junior/senior) mathematics majors are women: 46% in each of Groups M and B, 39% in Groups I, II and III combined.

A first report of the 1989 Survey appeared in the November 1989 *Notices*, pages 1155-1188, with corrections in the December 1989 *Notices*, page 1372. It included a report on the 1988-1989 new doctorates, starting salaries, faculty salaries, and a list of the names and thesis titles of the 1988-1989 doctorates. A supplementary list of 1988-1989 doctorates appeared in the May/June issue of *Notices*.

The 1989 Annual AMS-MAA Survey represents the thirty-third in an annual series begun in 1957 by the Society. The 1989 Survey was under the direction of the AMS-MAA Committee on Employment and Educational Policy (CEEP), whose members were: Donna L. Beers, Morton Brown, Stefan A. Burr, Edward A. Connors (chair), Philip C. Curtis, Jr., David J. Lutzer, and James J. Tattersall. The questionnaires were devised by CEEP's Data Subcommittee whose members were: Edward A. Connors (chair), Lincoln K. Durst (consultant), John D. Fulton, James F. Hurley, Charlotte Lin, Don O. Loftsgaarden, David J. Lutzer, James W. Maxwell (ex officio), Donald E. McClure, and Donald C. Rung. As of January 1990 the subcommittee became a standing AMS-MAA committee. Comments or suggestions regarding the Annual Survey may be directed to members of the new AMS-MAA Data Committee.

Groups I and II include the leading departments of mathematics in the U.S. according to the 1982 assessment of Research-Doctorate Programs conducted by the Conference Board of Associated Research Councils in which departments were rated according to the quality of their graduate faculty.¹

Group I is composed of 39 departments with scores in the 3.0-5.0 range.

Group II is composed of 43 departments with scores in the 2.0-2.9 range.

Group III contains the remaining U.S. departments reporting a doctoral program.

Group IV contains U.S. departments (or programs) of statistics, biostatistics and biometrics reporting a doctoral program.

Group V contains U.S. departments (or programs) in applied mathematics/applied science, operations research and management science which report a doctoral program.

Group Va is applied mathematics/applied science; **Group Vb** is operations research and management science.

Group VI contains doctorate-granting departments (or programs) in the mathematical sciences in Canadian universities.

Group M contains U.S. departments granting a master's degree as the highest graduate degree.

Group B contains U.S. departments granting a baccalaureate degree only.

¹ These findings were published in *An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences*, edited by Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, National Academy Press, Washington, D.C., 1982. The information on mathematics, statistics and computer science was presented in digest form in the April 1983 issue of *Notices*, pages 257-267, and an analysis of the above classifications was given in the June 1983 *Notices*, pages 392-393. For a listing of departments in Groups I and II see April 1988 *Notices*, pages 532-533.

I. Introduction

We present several items of general and specific interest to the mathematical community and its observers. Our analysis is based on the data gathered in the 1989 Annual AMS-MAA Survey. As is customary we begin with an update on the employment status of the 1988-1989 class of new doctorates in the mathematical sciences. We then turn our attention to some of the information obtained from the departmental responses to the Departmental Profile Survey, and to the distribution of faculty by age section of the Faculty Status Survey. The data on faculty age is a new feature which we intend to repeat on a regular basis, perhaps biennially. We have discontinued our collection and analysis of faculty flow and mobility data (to the delight, undoubtedly, of numerous departmental assistants, heads, chairs, and, to be sure, of this author).

As in last year's report, we choose not to extrapolate from the raw data and thus we do not provide estimates of various faculty populations or course enrollments. Instead, we focus on faculty retirement and death rates (Table 3A), faculty composition by sex (Tables 3B and 3C), percentage change in faculty composition (Tables 3D and 3E), faculty age distribution (Table 3F and Figures 1-6), percentage changes in enrollments from fall 1988 to fall 1989 (Tables 4A and 6), undergraduate enrollment distribution patterns (Table 4B), percentages of women among junior/senior mathematics majors and graduate students (Tables 5 and 7), and percentages of U.S. citizens among graduate students (Table 8). The 1990 Survey of the Conference Board on the Mathematical Sciences (CBMS) will provide hard estimates of various faculty populations and course enrollments in the mathematical sciences, based on data gathered for fall 1990.

Finally we direct your attention to the information on response rates at the end of this report, and to the bibliography, which is a comprehensive and current compendium of references on data sources and recent reports in the mathematical sciences, science and engineering.

II. Update on the 1988-1989 New Doctorates

In the First Report of this Survey (November 1989 issue of *Notices*, pages 1155-1168) we reported a fall count of 904 new doctorates in the mathematical sciences granted by U.S. universities (since then increased to 905 because of a late departmental correction). We now update the fall counts to produce the 1988-1989 spring counts: 919 doctorates in the mathematical sciences awarded by U.S. institutions, and 62 awarded by Canadian institutions. Fall and spring counts for the last five years are given in Table 1.

Of the 919 doctorates awarded by U.S. universities, citizenship status was reported as known for 896, 419 of whom were U.S. citizens (319 men and 100 women). The 62 Canadian doctorates went to 54 men and 8 women.

TABLE 1: New Doctorates, Fall and Spring Counts

	84-85		85-86		86-87		87-88		88-89	
	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	
U.S.	732	765	756	782	779	808	804	828	905*	919
Canada	37	42	45	45	66	66	52	55	53	62
Total	769	807	801	827	845	874	856	883	958*	981

*Increased from the fall count reported in the November 1989 *Notices*.

Employment data for new doctorates are updated in Tables 2A, 2B and 2C. We do not, however, include the additional new doctorates in our updated employment matrices. 18% of the new doctorates reported taking foreign academic or nonacademic employment (compared to 20% for 1987-1988 doctorates). By spring 1990 7% of new doctorates were either not seeking employment, were not yet employed, or their status was unknown (compared with 5% for 1987-1988 doctorates in the spring of 1989). 11.5% of the new doctorates were hired by Group B institutions (compared with 8% for 1987-1988 doctorates, and an average of 8.6% for the previous six years).

The research fields of the new doctorates continue to have an applied flavor (see Table 2C). For the last seven years half, or nearly half, of the new doctorates specialized in statistics, applied mathematics, operations research or computer science. 27% of the 1988-1989 new doctorates reported statistics as the field of thesis.

Finally, we note that the names of the 1988-1989 new doctorates and their thesis titles were published in *Notices* (November 1989 issue and a supplemental list in the May/June 1990 issue).

III. Faculty Characteristics

Two separate surveys provide the data reported in this section. Tables 3A through 3D are produced by responses to the Departmental Profile Survey conducted in fall 1989; Table 3F and Figures 1-5 are produced by responses to the Faculty Status Survey conducted in spring 1989.

In Table 3A we provide the attrition rates of full-time faculty in the mathematical sciences. The numbers we report are obtained from the departmental response to our request for the number of full-time faculty in fall 1988 as well as the number of these who had permanently retired or died by fall 1989. Note the differences among Groups I, II and III (comparable rates in last year's report were 1.26%, 1.65% and 1.76% respectively). Groups I, II and III combined yield a rate of 1.43% (compared to 1.57% last year). The 1.72% for Groups M and B combined is the same as last year's rate.

In last year's report we promised to "ascertain more information on age distribution of full-time faculty and thus better analyze the greying of the contemporary mathematical sciences faculty". Our data for 1989 are

**TABLE 2A: Employment Status of 1988-1989 New Doctorates
in the Mathematical Sciences**

Type of Employer	Algebra and Number Theory	Real and Complex Analysis	Geometry and Topology	Logic	Probability and Statistics	Applied Mathematics	Discrete Mathematics and Combinatorics	Numerical Analysis	Linear and Nonlinear Optimization	Other	Total
Group I	15	32	24	8	4	18		3		3	107
Group II	8	8	7	2	5	14	2	1	1		48
Group III	11	11	4		10	8	1	5		3	54
Group IV					32						33
Group V	1				4	7			1	2	14
Masters	8	18	9	2	14	21	4	3	1	3	83
Bachelors	21	21	15	1	19	9	12	1	2	9	110
Two-year Colleges	2	1	2		1	2		1			9
Other Academic Departments	2		3		25	13	2	5	8	12	70
Research Institutes	3	2	8		6	3		2		2	26
Government	1	1			9	6			1	1	19
Business and Industry	1	4	5	4	48	17	1	3	9	8	100
Canada, Academic	2	8	1		12	2	4	1			30
Canada, Nonacademic			1		2	4					7
Foreign, Academic	19	23	20	1	41	28	7	4	6	6	155
Foreign, Nonacademic		2	2	1	5	5		1	3	3	22
Not seeking employment	1	1	3		3	2	1	2			13
Not yet employed (Spring 1990)	3	2	4	1	9	4		2	1	3	29
Unknown	2	8	3	2	8	2		3		1	29
Total	100	142	111	22	257	165	34	37	34	56	958

**TABLE 2B: Employment Status of 1988-1989 New Doctorates
in the Mathematical Sciences
Females Only**

Type of Employer	Algebra and Number Theory	Real and Complex Analysis	Geometry and Topology	Logic	Probability and Statistics	Applied Mathematics	Discrete Mathematics and Combinatorics	Numerical Analysis	Linear and Nonlinear Optimization	Other	Total
Group I	1	3	1	2	1	1					9
Group II	1	3	2	1	1	2					10
Group III	2		1		2			1	1		7
Group IV					8						8
Group V					1	2				1	4
Masters	2	5	2	1	4	5	1				20
Bachelors	6	3	5		4	8	7			5	38
Two-year Colleges	2	1			1						4
Other Academic Departments					7	3		1	2	1	14
Research Institutes		1			1	1					3
Government					2	1					3
Business and Industry			2		15	1		1	3		22
Canada, Academic			1		3						4
Canada, Nonacademic											
Foreign, Academic		3	5		7	4				1	20
Foreign, Nonacademic											
Not seeking employment			3		1						4
Not yet employed (Spring 1990)		1	1		5			1			8
Unknown					1					1	2
Total	14	20	23	4	64	28	8	4	6	9	180

Table 2C: Fields of New Doctorates

Number (Fall Count)	Year Surveyed					
	1983-1984	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989
Specialty:	789	769	801	845	856	958
Applied Math	110 (14%)	115 (15%)	149 (19%)	142 (17%)	142 (17%)	165 (17%)
Statistics	173 (22%)	189 (25%)	171 (21%)	182 (22%)	173 (20%)	257 (27%)
Operations Research	66 (8%)	41 (5%)	62 (8%)	51 (6%)	59 (7%)	34 (3%)
Computer Science	20 (3%)	15 (2%)	16 (2%)	18 (2%)	16 (2%)	37 (4%)
Total	369 (47%)	360 (47%)	398 (50%)	393 (47%)	393 (46%)	493 (51%)

presented in Table 3F and, in graphical form, in Figures 1-5. Similar data for the years 1975 and 1985 for academic Ph.D. scientists and engineers are presented in Figure 6. See also [27] page 64, Figure 5.9, and page 117, Figure A5.9.

V have by far the largest percentage of faculty age 35 or less (25%). The under-30 cohort accounts for 9% of the total faculty in Group I, and 6% in Group V. Group I has the largest percentage of faculty over 60 (13%). In fact, all 5-year age spans from 35-on for Group I hover around 13%, with the largest being 14% in the 45-50 age group. However, this age group (part of the silent generation) accounts for nearly 20% of the total faculty in each of the other survey groups and, indeed, in all survey groups combined. Groups I and V have nearly one quarter of their faculty at age 55. For all groups combined slightly more than one third of the total faculty is age 50 or older and thus will have either died or reached the age of 65 by the year 2005. Likewise, for all groups combined, slightly less than one fifth of the total faculty is age 55 or older.

Table 3A: Faculty Attrition*

Group	Full-time Faculty %
I	.96
II	1.40
III	1.88
I+II+III	1.43
IV	1.33
V	.73
M	1.75
B	1.69
M+B	1.72

*Percentage of full-time faculty who were in the department in fall 1988 but were reported to have retired or died by fall 1989.

Table 3B: Percentage of Women among Doctoral Full-time Faculty, fall 1989

Groups							
I	II	III	I+II+III	IV	V	M	B
%	%	%	%	%	%	%	%
5.7	7.4	8.0	7.0	11.3	6.8	13.1	16.9

Table 3C: Percentage of Women among all Full-time Faculty, fall 1989

Groups							
I	II	III	I+II+III	IV	V	M	B
%	%	%	%	%	%	%	%
6.5	9.5	12.5	9.5	12.0	6.8	20.0	25.0

Our graphs in Figures 1-5 use 10-year intervals based on age 30, but the raw data are in 5-year spans. Some of the following comments are based on the raw data, which are available for each survey group. Groups I and

Table 3D: Percentage Change in Doctoral Nontenured Faculty, fall 1988 to fall 1989

	Groups						
	I	II	III	I+II+III	M	B	M+B
	%	%	%	%	%	%	%
Male	+16	+10	+10	+12	+3	--	+1
Female	+96	+15	+7	+24	+17	+9	+13
Total	+21	+11	+10	+14	+5	+2	+4

Table 3E: Percentage Change in Doctoral Tenured Faculty, fall 1988 to fall 1989

	Groups						
	I	II	III	I+II+III	M	B	M+B
	%	%	%	%	%	%	%
Male	-3	--	-7	-4	+3	+3	+3
Female	-6	--	-3	-4	+7	+2	+4
Total	-3	--	-7	-4	+3	+3	+3

In Figure 3 and Table 3F we provide the age distribution of female faculty in all survey groups combined. Note that only 15% of the female faculty is age 55 or older and that the age 40-45 cohort, at 18% of the total, is the largest (and, in particular, is larger than the 45-50 age group). In Tables 3B and 3C we provide percentages of women among full-time faculty, for doctoral faculty and all faculty respectively.

Table 3F: Age distribution of mathematical sciences faculty, all groups*

	Total Faculty %	Male % of total males	Female % of total females
Under 30	5	5	8
30-35	12	12	15
35-40	13	13	16
40-45	16	15	18
45-50	20	20	15
50-55	15	16	13
55-60	11	11	8
Over 60	8	9	7

* The use of 5-year intervals in this table and 10-year intervals in Figures 1-5 results in slight differences because of rounding.

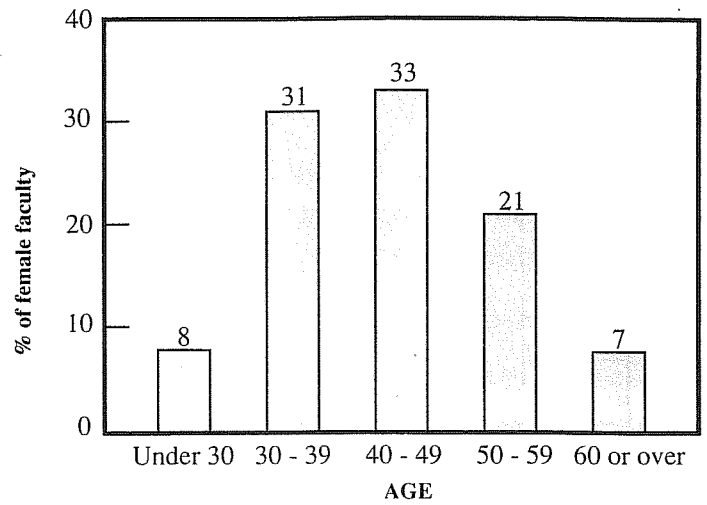


Figure 3. Age distribution of female mathematical sciences faculty, all groups.

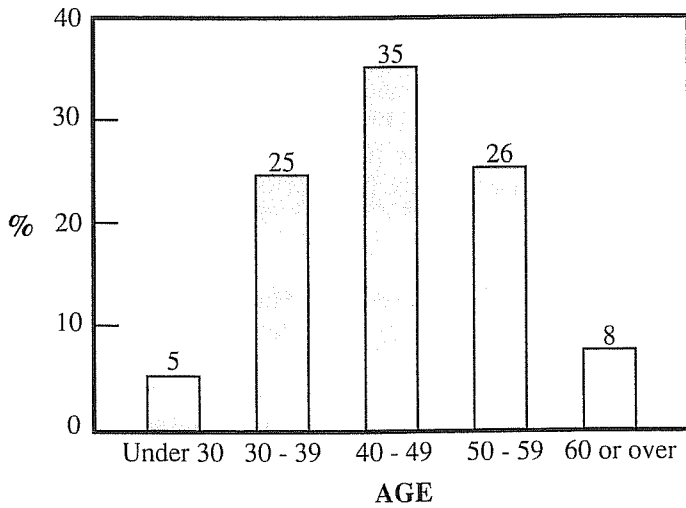


Figure 1. Age distribution of mathematical sciences faculty, all groups.

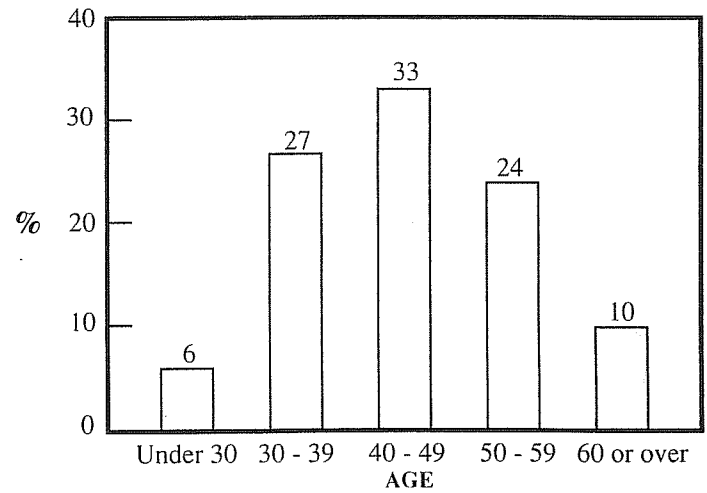


Figure 4. Age distribution of mathematical sciences faculty, Groups I, II, III.

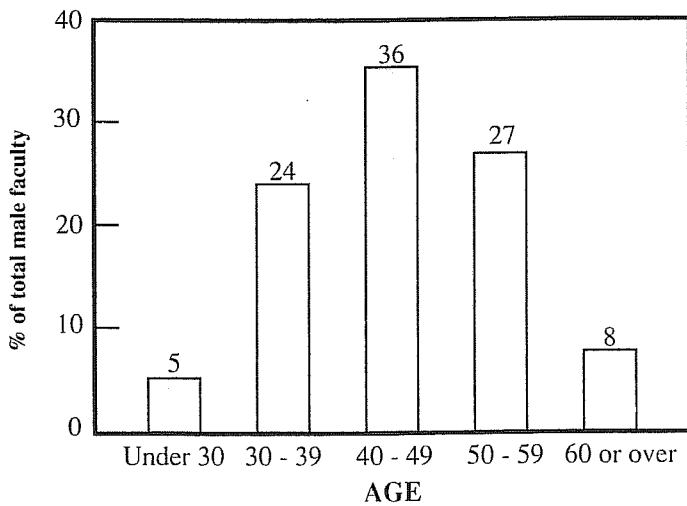


Figure 2. Age distribution of male mathematical sciences faculty all groups.

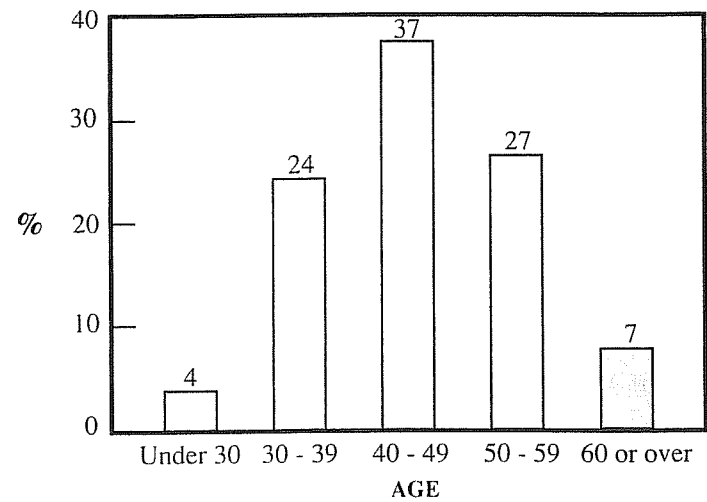


Figure 5. Age distribution of mathematical sciences faculty, Groups M and B.

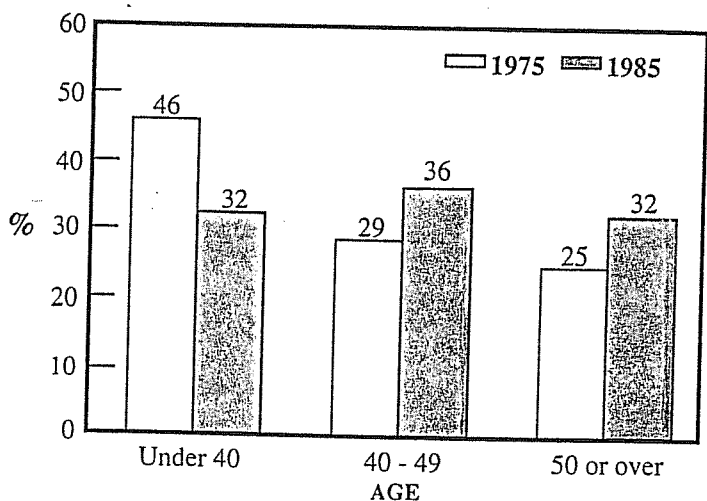


Figure 6. Age of Academic PhD Scientists and Engineers, 1975 and 1985. (Source: Commission on Professionals in Science and Technology Occasional Paper 89.3. Data Source: National Science Foundation)

IV. Undergraduate Enrollment Profile and Majors

The data in Table 4A are based on fall 1988 and fall 1989 enrollments reported on the 1989 Departmental Profile survey form, which requests two years' data on enrollments and departmental size. In particular, the comparisons in Table 4A are from the same set of respondents and do not use the results of last year's Annual Survey.

Table 4A: Percentage Change in Undergraduate Enrollments, fall 1988 to fall 1989

Groups				
I	II	III	M	B
-1%	-1%	0%	+3%	+3%

Table 4B: Undergraduate Enrollments Distribution, fall 1989

Group	Remedial Mathematics*	Remedial Mathematics + Pre-calculus	Remedial Mathematics + Pre-calculus + 1st-yr. Calculus
	%	%	%
I	9	24	60
II	7	28	59
III	11	35	58
I+II+III	10	31	59
M	15	33	49
B	19	35	49
M+B	17	34	49

*Arithmetic, high school algebra, geometry.

Table 5: Percentage of Women among Junior/Senior Majors (including double majors), fall 1989

Groups							
I	II	III	I+II+III	IV	V	M	B
%	%	%	%	%	%	%	%
36	41	42	39	43	28	46	46

V. Graduate Enrollments in the Mathematical Sciences, Sex and Citizenship

The data in Table 6 are based on fall 1988 and fall 1989 enrollments reported on the 1989 Departmental Profile survey form, which requests two years' data on enrollments and departmental size. In particular, the comparisons in Table 6 are from the same set of respondents and do not use the results of last year's Annual Survey.

We report a large drop of 15% from fall 1988 to fall 1989 in first-year full-time graduate students in Group I, but a large increase of 21% in Group III. For Groups I, II and III combined the numbers of full-time graduate students increased by 3% for first-year students, and 4% for all years.

Table 6: Graduate Students Percentage change, fall 1988 to fall 1989

	Groups				
	I	II	III	I+II+III	IV
	%	%	%	%	%
First year, full-time	-15	+8.4	+21	+3	-9
All years, full-time	-1	+8	+7	+4	+1

Table 7: Percentage of U.S. Citizen Women among U.S. Citizen Graduate Students, fall 1989

	Groups						
	I	II	III	I+II+III	IV	V	M
	%	%	%	%	%	%	%
First year, full-time	23	34	39	32	46	21	46
All years, full-time	22	30	36	29	46	20	45

Table 8: Citizenship of Graduate Students, fall 1989*

	Groups				
	I	II	III	IV	M
	%	%	%	%	%
First year, full-time	53	58	58	56	77
All years, full-time	50	53	59	47	74

*Percentage of U.S. citizens among graduate students whose citizenship is reported as known.

USEABLE RESPONSES

Survey	Groups							
	I	II	III	IV	V	VI	M	B
	%	%	%	%	%	%	%	%
Departmental Profile*	92	81	80	75	23	59	54	44
Faculty Age	64	84	87	69	32	69	57	43

* There are 4 parts to the Departmental Profile form (Enrollments, Majors, Departmental Size, and Graduate Students). The number given is the percentage of returns with a useable response on the departmental size.

Acknowledgement

The Annual AMS-MAA Survey attempts to provide an accurate appraisal and analysis of various aspects of the academic mathematical scene vital to the entire mathematical community. Yearly, collegiate departments in the United States, and the doctorate-granting departments in Canada, are provided the opportunity to respond. The quantity and quality of the responses directly determine the quality of the information in these reports. Without the dedicated cooperation of the secretarial and administrative support staff in the mathematical science departments we would not be able to conduct a survey, nor be confident in our analysis of its results. We are, unfortunately, unable to thank personally all the departmental assistants for their cooperation, but it is nonetheless appreciated. However, we are able to thank the administrative support staff of the AMS, especially Marcia Almeida, Monica Foulkes, and James W. Maxwell, whose efforts are acknowledged and appreciated.

Bibliography

- [1] *Nurturing Science and Engineering Talent: A Discussion Paper*. Government-University-Industry Research Roundtable, National Academy of Sciences, Washington, DC, July 1987.
- [2] *Undergraduate Science, Mathematics and Engineering Education*, NSB 86-100, March 1986. NSB Task Committee on Undergraduate Science and Engineering Education.
- [3] *Plans and Expectations for Retirement: Survey of TIAA-CREF Participants Ages 55-70*, Research Dialogues, Issue Number 25, April 1990, Teachers Insurance and Annuity Association, New York, NY.
- [4] National Science Foundation. *Science and Technology Data Book*, (NSF 88-332). National Science Foundation, Washington, DC, 1989.
- [5] *Scientific Manpower-1987 and Beyond. Today's Budgets-Tomorrow's Workforce*. Proceedings of a Symposium, October 15, 1986, Washington, DC, sponsored by the Commission on Professionals in Science and Technology.
- [6] *Foreign Citizens in U.S. Science and Engineering: History, Status and Outlook*, NSF 86-305 Revised, (Washington, DC, 1987).

[7] Rand Publication Series. Reports on teaching and education: *Beyond the Commission Reports: The Coming Crisis in Teaching*. R-3177-RC, July 1984. *Steady Work: Policy, practice and the reform of American education*. R-3574-NIE/RC, February 1988. *The Evolution of Teacher Policy*. JRE-01, March 1988. *Assessing Teacher Supply and Demand*. R-3633-ED/CSTP, May 1988.

[8] *Teaching Assistants and Part-time Instructors: A Challenge*, MAA Notes, 1987.

[9] Bettye Anne Case, *Keys to Improved Instruction by Teaching Assistants and Part-time Instructors*, MAA Notes Number 11, Mathematical Association of America, Washington, D.C., 1989.

[10] D. J. Albers, R. D. Anderson, and D. O. Loftsgaarden, *Undergraduate Programs in the Mathematical and Computer Sciences. The 1985-1986 Survey*, MAA Notes, 7.

[11] *The Annual Report on the Economic Status of the Profession 1988-1989*, Academe: Bulletin of the American Association of University Professors, March-April 1989, Washington, D.C.

[12] *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective*, Stipes Publishing Co., Champaign, Illinois, January 1987.

[13] *Competition for Human Resources in the 1990s*, Proceedings of a Symposium, Commission on Professionals in Science and Technology, May 1988.

[14] *Science and Engineering Doctorates: 1960-86*, NSF 88-309, Washington, DC 1988.

[15] *Educating Scientists and Engineers: Grade School to Grad School*, U.S. Congress, Office of Technology Assessment, OTA-SET-377, Washington, DC, June 1988.

[16] *Boon or Bane - Foreign Graduate Students in U.S. Engineering Programs*, Institute of International Education Research Report Series, Number 15, 1988.

[17] National Research Council. *Summary Report 1988, Doctorate Recipients from United States Universities*, National Academy Press, Washington, DC, 1989.

[18] Edward A. Connors, *A Decline in Mathematics Threatens Science-and the U.S.*, The Scientist, November 28, 1988.

[19] Edward A. Connors, *America's Scientific Future is Threatened by the Decline in Mathematics Education*, The Chronicle of Higher Education, January 11, 1989.

[20] National Research Council. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. National Academy Press, Washington, D.C., 1989.

[21] *Elementary and Secondary Education for Science and Engineering*. U.S. Congress, Office of Technology Assessment, OTA-TM-SET-41. Washington, D.C., December 1988.

[22] *Higher Education for Science and Engineering: a background paper*. U.S. Congress, Office of Technology Assessment, OTA-BP-SET-52. Washington, D.C., March 1989.

[23] *Changing America: The New Face of Science and Engineering*. Interim Report, Task Force on Women, Minorities, and the Handicapped in Science. September 1988.

[24] Commission on Professionals in Science and Technology. Occasional Papers, prepared by Betty M. Vetter. *Look Who's Coming to School* (89-0), December 1988. *Women in Science. Progress and Problems* (89-1), February 1989. *Recruiting Doctoral Scientists and Engineers* (89-2), February 1989. *American Minorities in Science and Engineering* (89-3),

Replacing Science and Engineering Faculty in the 1990s (89-4), Supply and Demand for Engineers in the 1990s (90-1). CPST, Washington, D.C.

[25] *Meeting the Needs of a Growing Economy: The CORETECH Agenda for the Scientific and Technical Workforce*. CORETECH, Washington, D.C. 1988.

[26] *Measuring National Needs for Scientists to the Year 2000*. Report to the National Science Foundation. Commission on Professionals in Science and Technology, Washington, D.C., July 1989.

[27] Bernard L. Madison and Therese A. Hart, *A Challenge of Numbers: People in the Mathematical Sciences*. Washington, D.C.: National Academy Press, 1990.

[28] National Research Council. *Renewing U.S. Mathematics: A Plan for the 1990s*. Washington, D.C.: National Academy Press, 1990.

[29] National Science Board. *Science and Engineering Indicators - 1989*. Washington, D.C.: U.S. Government Printing Office, 1989 (NSB 89-1).

[30] Commission on Professionals in Science and Technology. *Salaries of Scientists, Engineers and Technicians: A Summary of Salary Surveys*, 14th Ed. Washington, D.C., 1990.

[31] Commission on Professionals in Science and Technology. *Professional Women and Minorities - 1989*. Washington, D.C., December 1989.

[32] *1989-1990 Faculty Salary Survey by Discipline*. Stillwater, OK: Office of Institutional Research, Oklahoma State University, 1990.

[33] Aerospace Education Foundation. *America's Next Crisis: The Shortfall in Technical Manpower*. Arlington, VA: Aerospace Education Foundation, September 1989.

[34] National Science Foundation. *Report on the National*

Science Foundation Disciplinary Workshops on Undergraduate Education. Recommendations of the disciplinary taskforces concerning critical issues in U.S. undergraduate education in the Sciences, Mathematics and Engineering. National Science Foundation, Washington, D.C., April 1989.

[35] Mathematical Sciences Education Board. *Mathematics Education: Wellspring of U.S. Industrial Strength*. Report of a Symposium held December, 1988. National Research Council, 1990.

[36] David Blackwell and Leon Henkin, *Mathematics: Report of the Project 2061 Phase I Mathematics Panel*. American Association for the Advancement of Science, Washington, D.C. 1989 (AAAS Publication 89-03S).

[37] National Academy of Sciences. *Engineering Personnel Data Needs for the 1990s*. National Academy Press, Washington, D.C., 1988.

[38] Commission on Professionals in Science and Technology. Proceedings of a symposium, "Human Resources in Science and Technology: Improving U.S. Competitiveness" held March 15-16, 1990. Commission on Professionals in Science and Technology, Washington, D.C., to appear.

[39] Roman Czujko and David Bernstein, *Who Takes Science?: A Report on Student Coursework in High School Science and Mathematics*. American Institute of Physics, New York, NY, December 1989 (AIP Publication Number R-345).

[40] National Science Foundation. *A Guide to NSF Science/Engineering Resources Data*. National Science Foundation, Washington, D.C., 1987.

[41] Christine M. Matthews, Congressional Research Service Issue Brief, *Science, Engineering and Mathematics Precollege and College Education*. Library of Congress, Washington D.C., 1989.