A HISTORY AND ASSESSMENT OF AT&T LABS PH.D. FELLOWSHIP PROGRAMS 1972 - 2002

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Abstract -- *During 2002, AT&T will celebrate the 30th anniversary of its sponsorship of Ph.D. fellowship programs for under-represented minorities and women in science and engineering. In the early 1970s the leadership of AT&T's research and development organization, then known as "Bell Laboratories," initiated efforts to recruit minority students for technical positions within the Labs. These efforts were the result of petitions from the African American and women's communities within the R&D organization to increase the number of women and minorities in the workforce. Since the numbers of minority students graduating with Ph.D.s in disciplines relevant to the work of the Labs was very small, the leadership realized that they would have to take an active role in identifying, encouraging, and supporting students to pursue studies in mathematics and engineering. This paper summarizes the launch of these programs and the use of internships and mentors in their operation.*

Index Terms--Fellowships, Mentoring, Minorities, Ph.D. programs, Women.

Introduction

Ph.D. fellowship and grant programs were launched at AT&T in 1972 and 1974, the first for minorities and the second for women. These programs were initially funded by the AT&T R&D organization and later by the AT&T Foundation. With AT&T's trivestiture in 1996, Bell Labs was split between AT&T and the newly formed Lucent Technologies. The Bell Labs name was retained by Lucent, and AT&T's R&D organization became known as AT&T Labs. The fellowship and grant programs continued in the two companies and the students in progress in them were split between the two organizations based on their disciplines and research focus. Fellowships provide students with funds for tuition, books, fees, educational expenses for summer study or university research, an allowance for living expenses while at school, and support to attend approved scientific conferences. Grants, which are smaller in size, provide stipends for expenses not generally covered by other awards.

Both fellowships and grants are renewable annually for up to a period of 6 years provided that sufficient progress has been made in completing the Ph.D. Over the 30 years of the fellowship and grant programs' existence, over 300 students from the combined AT&T and Lucent programs have benefited from their support and have completed Ph.D.s in disciplines such as electrical engineering, physics, chemistry, computer science, mathematics, operations research, statistics, and psychology. Key to the success of the programs in addition to the funding provided to the students has been the involvement of the R&D staff in selecting, mentoring, and working with them from their initial summer internship after award of the fellowship or grant, through the five to six year period of their Ph.D. studies. The graduates of the programs today work in industry, academia and government and are among the influential leaders in the fields of engineering and science.

Fellowship and Grant Program History

In the 1970s when the effort to develop Ph.D. fellowship and grant programs was undertaken, the AT&T R&D leadership had few models on which to base their programs. Programs such as the National Consortium for Graduate Degrees for Minorities in Engineering and Science were first introduced in 1974 and supported students in completing Master's degrees. Other minority fellowship programs were initiated later, such as the National Science Foundation's Graduate Minority Fellowship Program [1] and the Ford Foundation Fellowships for Minorities that began awards in 1978 and 1979. As a result, the ideas for the AT&T fellowship and grant programs came from the Labs technical staff and their leadership.

The first of the programs, the Cooperative Research Fellowship Program (CRFP) was started in 1972 as a small pilot seeking minority students from the area local to Bell Labs. The schools from which students were recruited were City College of New York, Columbia University, New York University, Polytechnic University, Rutgers University, Stevens Institute of Technology, and Princeton University. Students selected for the program spent the first summer after their senior year of college working at the Labs under the guidance of a technical mentor who was a member of the R&D staff. Top researchers were selected as mentors and worked closely with students, guiding the student's work in a research project and monitoring their progress. In the fall, the students went on to graduate school but maintained a relationship with their mentors who helped them navigate through their Ph.D. programs, acting as sounding boards and champions for the students as well as ensuring that they were making satisfactory progress towards their degrees. Since students had their own funds to pay for school and a

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stipend for their living expenses, they were not dependent on identifying funding through their university advisors or having to take on laboratory or teaching assistantships in order to finance their studies. This provided the students with unique financial and professional support not available through other fellowship programs.

A special feature of this program was that of the academic advisor who was a distinguished member of academia who was selected by the Labs to act as an advocate for students on campus on AT&T's behalf. This neutral party could work with university graduate advisors on behalf of students to address issues that company mentors would not be able to handle. Interventions on behalf of students to help change the focus of their research, change graduate advisors, or adjust their programs based on unforeseen personal needs were some of the activities the academic advisor got involved in on behalf of the students in this program. In many cases this intervention made the difference in students being able to successfully complete their Ph.D. studies.

In 1974 the Graduate Research Program for Women (GRPW) was launched as a result of the need to develop a program that would address the issues of women pursing advanced degrees in the sciences. The challenges of competing in male dominated disciplines, the need for professional role models as well as the competitive nature and limited funding to support advanced studies in technical disciplines by women were contributing factors to establishment of GRPW. In this program the awards were equally divided between fellowships and grants, while in CRFP only fellowships were awarded. Grant students were assigned mentors as well and were required to spend the first summer before attending graduate school as a research intern at the Labs.

In the early years, four to five students were identified annually for fellowship or grant support in each of the CRFP and GRPW programs with support continuing for a five to six year period provided students were making adequate progress in their studies. By the 1990s, the number of students grew to a total of 16 students selected annually in the combined programs with half being awarded grants. When Bell Labs was split in 1996 between AT&T and Lucent Technologies, 40% of the students were designated to be supported by AT&T Labs and the balance by Lucent's Bell Labs. Lucent retained the CRFP and GRPW program names and continues to administer these programs, selecting up to 6 students for CRFP and up to 6 for GRPW annually. AT&T Labs combined these two programs and renamed the combined program the AT&T Labs Fellowship Program (ALFP). Each year AT&T Labs selects 4 students for fellowships and 4 students for grants, half of each being designated for under-represented minorities and the other half for women.

Program Results and Recognition

Over the past 30 years, approximately 340 students have completed Ph.D.s in the combined AT&T and Lucent CRFP, GRPW, and ALFP programs. This reflects a completion rate of 70-75% of the students entering the programs. This rate compares favorably with other fellowship programs for minorities that report completion results at this level and slightly lower [2]. It also compares well with overall 50% completion rate for all students entering Ph.D. programs [3]. Among the reasons for the consistent high completion rate for students is the mentoring and summer internship required the first year students complete their undergraduate work. This close working relationship with seasoned researchers and the opportunity to begin to explore topics for research are seen as helping students to get well-grounded before beginning their formal graduate work [4].

The fields of study in which students of the programs have completed Ph.D.s reflect the focus of AT&T's R&D work over the thirty year period, with high numbers of students completing Ph.D.s in electrical engineering, physics, and chemistry. In more recent years, based on the shift of the focus of

AT&T's business, there has been an increase in the numbers of students completing degrees in computer science, while chemistry and areas such as mechanical and industrial engineering have been curtailed. The fields of study in which students have majored over the thirty-year period are summarized below.

TABLE I

Major Fields of Study	%
Electrical Engineering	31%
Physics	17%
Chemistry	14%
Computer Science	12%
Mathematics	4%
Others*	22%

* Includes Material Science, Mechanical Engineering, Operations Research, Statistics, Industrial Engineering, Economics, Computer Engineering, Biological Engineering, Engineering Psychology, Psychology.

While many graduates of the programs (approximately 30-40%) began their professional careers at the Labs (AT&T and Lucent), many have gone on to other companies and research institutes. Some of the organizations graduates of the fellowship programs have been employed by are provided in the following chart. It is notable that several are among the research leaders, vice presidents, and in one case, the founder of a technology company.

TABLE II

Companies and Research Institutes Fellowship Alumni are Employed by

Agilent Labs
Allied Signal
Apple
AT&T
Bell South
Bose
Corning
Dow
Dupont
GE Research
Goddard Institute
Hewlett Packard
IBM
Jet Propulsion Laboratory
Lawrence Berkeley Lab
Los Alamos National Laboratory
Lotus
Lucent Technologies
Kodak
Mitre
Motorola
National Institute of Standards
NASA
Nuclear Regulatory Commission
Rockwell Semiconductor Systems
Sandia National Laboratory
Segate Technologies
Schlumberger
Silicon Graphics
Texas Instruments
Xerox

Approximately 30% of the graduates of the programs have as well gone on to become professors, deans, and administrators of universities, continuing to share their knowledge and commitment to developing and mentoring students for future jobs in the profession. The schools at which alumni teach or are part of the administration number among the top schools in the United States. The schools are listed below.

TABLE III

Universities at which Fellowship Alumni Teach or are Administrators

Arizona State University
Atlanta University Center
Barnard College
Boston University
California Institute of Technology
Carnegie Mellon University
Colorado College
Cornell University
Dartmouth College
Duke University
Florida A&M University
Georgia Institute of Technology
Georgia State University
Harvard University
Harvey Mudd Ciollege
Hiriam College

Howard University
James Madison University
Loyola University
Massachusetts Institute of Technology
Morehouse College
Morgan State University
North Carolina A&T University
New Jersey Institute of Technology
Northwestern University
Pennsylvania State University
Pomona College
Princeton University
Rutgers University
Southern University
Spelman College
Tuskegee University
University of California--Berkeley, Davis, Irvine, San Diego
University of Chicago
University of Illinois
University of Maryland--Baltimore County, College Park
University of Massachusetts--Lowell
University of New Mexico
University of Puerto Rico
University of Texas--Austin
University of Virginia
University of Wisconsin – Madison
Williams College
Yale

In 1998, the AT&T Labs Fellowship Program committee applied for the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring and received this award in a ceremony at the White House. This award, administered and funded by the National Science Foundation recognizes "outstanding individual and organizational programs designed to increase the participation of under-represented groups in mathematics, engineering and science" through the graduate level [5]. In recognition of AT&T's efforts in encouraging women in pursing engineering careers, AT&T Labs was also awarded the Women in Engineering Programs and Advocates Network (WEPAN) Breakthrough Award in 1998. With these two awards, the programs conceived more than 20 years earlier and sustained through AT&T reorganizations and restructures were recognized for their commitment to excellence in mentoring that successfully produced a significant number of women and minority Ph.D. graduates in the fields of science, mathematics, and engineering.

Over the years the fellowship programs have been cited as among the best, "distinctive in their

combination of support over the entire graduate career, the provision for summer employment opportunities and mentoring [6]". It is these elements that have contributed to the numbers of students successfully completing Ph.D.s and joining the ranks of distinguished researchers. Added to these elements, is the involvement and commitment of the technical staff who continue to actively recruit, select, and participate in program committees in addition to doing their technical work. They ensure that their organizations continue to provide the funding support for the programs and contribute their time and interest to ensure that the programs

remain viable through company and industry changes. Recognizing and rewarding role model mentors among them annually keeps the value of the program and its results in the minds of all and ensures a continuing stream of volunteers to act as mentors and committee members.

Recommendations for the Future

As the industry and AT&T continues to evolve, challenges to continuing support for programs such as this often are raised. Some lessons from the thirty years of the programs operation may be applied to help sustain and revitalize the programs. The program graduates comprise a network of professional leaders in industry and academia that might be tapped to help continue to encourage and support women and under-represented minorities in pursuing advanced studies in technology areas. This network might be able to provide mentoring support to students, role models, internships and co-ops in their companies and possibly a website to highlight alumni accomplishments and contributions to industry and academia. Their knowledge, experience, and commitment to helping other students pursue Ph.D.s in engineering and scientific disciplines may be one of the best ways to begin to meet the critical shortage of skilled American workers in the technical workforce[7]. This new effort would be a fitting legacy for the programs that have been sustained over the past thirty years through industrial and technological changes and challenges.

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