The Fermilab summer program for minority students

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The underrepresentation of minorities in science and engineering in the United States is well known and well documented.[1] Many talented young minority people never consider a technical career because there are no members of their ethnic groups to act as role models in technical work, so the disparity tends to be self-perpetuating. In this report, we describe a program at our laboratory to encourage young minority people to prepare for careers in science.

For the past six years, the Fermi National Accelerator Laboratory has sponsored a summer program for undergraduate minority students in physics. Each summer approximately twenty students are brought to the laboratory to work in one of the laboratory technical groups. The primary objective of the program is to stimulate minority students' interest in pursuing a career in science by bringing them in contact with actual technical work and actual technical workers. A number of students who have been in the program have continued in science, so we believe that the program can claim some success.

Although our program is by no means perfect, we believe that our experience, as our program has evolved in its six years of operation, may be helpful to other institutions planning to establish programs for minority students and we offer this review in that spirit. It should be understood that our program is tailored to Fermilab and may not be best for another institution.

Many people have contributed to the Fermilab Summer Program. Among them are Kennard R. Williams, Joyce L. Downs, Robert Sykes, Warren Cannon, Roel Rodriguez, and Joyce Curry of the Fermilab Equal Employment Opportunity Office, and H. Eugene Fisk, E. L. Goldwasser, James Griffin, Brenda Holt, Fred Hornstra, Cordon Kerns, Arlene Lennox, Frank Nezrick, Charles Schmidt, Raymond Stefanski, Dennis Theriot, Timothy Toohig, and Herman White of the Laboratory Summer Program Committee. In writing this review, we are acting as their surrogates.

Evolution of the program

The Fermi National Accelerator Laboratory was begun in 1967 to construct and operate a proton accelerator for research in high-energy physics. The accelerator has been in operation since 1972 on a 10-square-mile site

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Fig. 1. Carolyn Alexander from Virginia State College working on development of a counter hodoscope for the Fermilab single-arm spectrometer.

approximately 30 miles west of the Chicago Loop. About thirteen hundred people are on the laboratory staff. Laboratory staff members carry out high-energy physics experiments, but the major users are physicists from other laboratories and universities in the United States and abroad.

In the first months of the laboratory, the Equal Employment Opportunity Office of Fermilab was begun by Kennard Williams. There have been many programs carried out by the EEO Office to train minority construction workers, technicians, and engineering aides. The Summer Program for Minority Physics Students, started in 1970, represents a departure from earlier programs in both purpose and clientele. Here our goals are of longer range and we aim to produce people who will go on to the highest educational levels. The laboratory sponsored a conference at the close of the first program in 1970 to evaluate it and to recommend guidelines for its evolution. A similar conference was held after the 1974 program.[2] These conferences and evaluations of the program by participants have led to a number of changes, of which the three most significant are the nature of students' assignments, the addition of a resident coordinator, and the establishment of an advisory committee of Fermilab staff members to form a link between the program and the technical work of Fermilab. We shall discuss these in the course of our review.

Selection of institutions

Our program deals largely with undergraduate students. Many graduate students are already immersed in research projects and do not need our program. There are many young people in high school who could benefit from our program, but finding and selecting them would be a program far beyond the reach of a single laboratory.

Throughout most of the history of our program, we have recruited from predominantly minority institutions in the South and Southwest. Three-fourths of the bachelors' degrees awarded to minority students in physics come from these institutions, so they are a source of good students. Many of these institutions do not have large research programs, so their students are in need of the educational experience we can offer.

Over the years, we have developed good working relationships with faculty members from a number of minority institutions and we habitually look to them to advise us on students. We also attempt not to fall into a pattern of dealing with only a few institutions. Although our recruiting has been almost wholly from minority institutions, we have also made efforts to attract some minority students from majority institutions. We have found it difficult to make contact with these students through the physics departments or the Offices of Minority Affairs. Lately we have had more success with approaches through experimenters from these institutions currently doing experiments at Fermilab.

Selection of students

Recruiting for our program takes place during the fall and winter; good students are in enough demand that they are usually committed to a summer job by March or April. A team consisting of a scientist or engineer from the Advisory Committee and a member of the EEO Office visits the schools at prearranged times for interviews. The technical person usually gives a seminar about the work at Fermilab. This talk and informal conversations can give the visit an impact beyond the recruiting of students, because

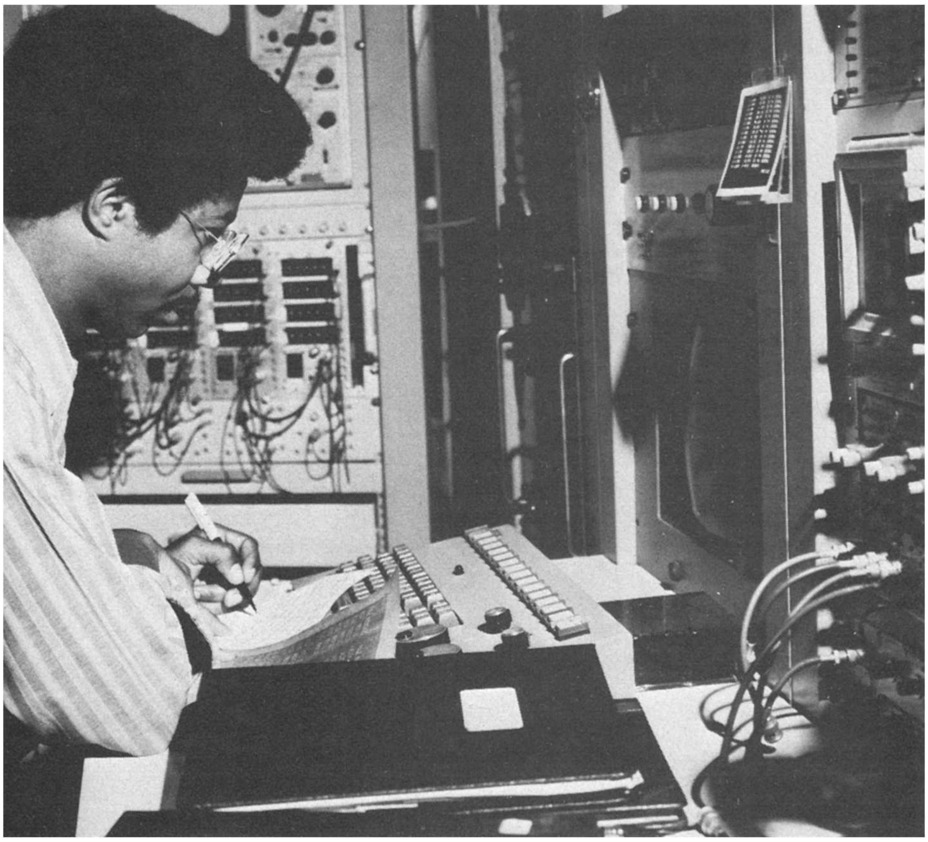


Fig. 2. Wallace Andrews participated in the summer program while he was an undergraduate at Norfolk State College. He has now graduated and is working at Fermilab in Accelerator Operations. He is shown at the control console for the external beam lines.

they can give a student a glimpse (perhaps through a glass, darkly) of new horizons. After these interviews and consultation with the faculty members of the department, the visiting team makes offers to two students for definite places in the program and to two or three more as alternates.

We discussed above our reasons for concentrating on undergraduates. But even within a group of undergraduates, there is still a wide variation in background. What is the earliest and latest in his college career that a student can benefit from the program? We feel the most satisfactory students are those who have completed their junior year, because they have enough academic preparation to have a wide choice of assignments. We also have good success with seniors who are going on to graduate school. We remain flexible in this matter and have taken promising students who have completed only their freshman or sophomore year. This helps them toward a career decision, but difficulties often arise because they lack laboratory skills and have not yet developed enough self-confidence to deal with an extended summer program. Self-confidence is a problem for students of all levels from small institutions without research programs, but it is particularly difficult for younger students.

We have also taken first-year graduate students. These students usually are good members of the summer program. They have, of course, already chosen their fields. We are always concerned that they might be better served by participating in some research project at their own institution, if that opportunity is available.

We frequently take students from outside physics, most often from computer science and mathematics. A large amount of computation is often involved in Fermilab research, and computer-science and mathematics students find many opportunities for worthwhile, challenging projects. A chemistry student who is willing to work with physics apparatus for the summer will fit into the program quite well and will learn valuable laboratory skills. Less frequently, we have had engineering students; few minority institutions have engineering programs.

Our own emphasis has been predominantly on black students. This approach is rooted in Fermilab's history and the laboratory conception of how it can best approach affirmative action. On the other hand, we have always had 25% to 30% participation by Spanish-surname, Chicano and native-American students. There have been no serious problems with integration of the different groups. On occasion, there have been some misunderstandings between these groups of students. Perhaps the most significant concern is that the nonblack students may feel overwhelmed by the number of black participants. We have tried to ameliorate this feeling by including nonblack advisors and making special arrangements in some of our support services for these students.

One might think that there is a possible practical problem concerning the inclusion of women in the program. We have always had minority women and found no problems at all; in fact, it has certainly made the program a richer and livelier experience for both the students and members of the laboratory staff. We like to have the women come in even numbers so they can room together and reduce their housing costs.

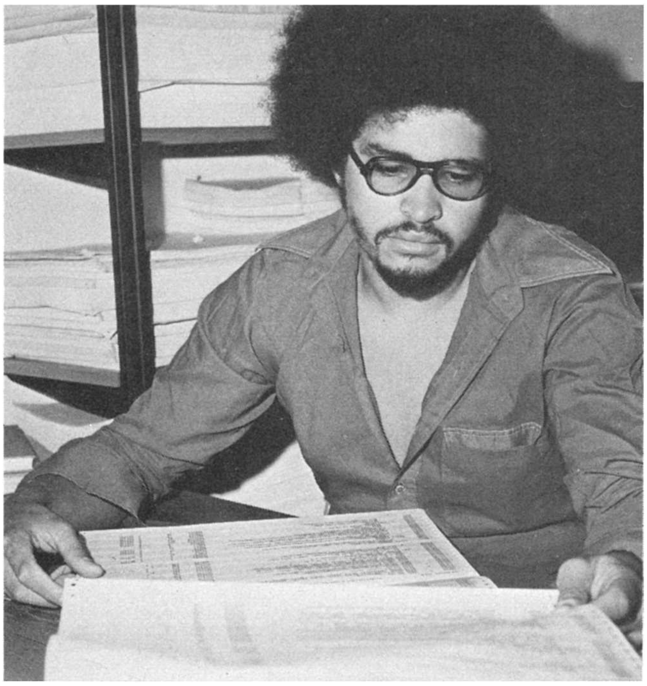


Fig. 3. Aaron Day from North Carolina Agricultural and Technical State University working with computer data from Experiment 118.

Selection of assignments

Early in the evolution of our program, we felt that the best experience for the student would be to serve as an active technician within the laboratory working in a large group on some on-going activity. We believed that this would provide a complementary experience to his normal academic-year course work. He would learn to order from the stockroom, to work with power tools, and all the other myriad things that scientists do, but are never taught.

We found, however, that when the student was exposed to this kind of activity, the effect was not necessarily positive. Many students were disappointed by the fact that they were not as closely connected with a scientific project as they had hoped. Undergraduates are not as sophisticated in appreciating this kind of experience as a well-developed scientist would be. Where many scientists in mid-career would say, "This is exactly what I needed!", the student is not able to see the relevance of the work. After a great deal of experience and discussion, we have shifted more toward assignments in which the student works as a junior scientist directly with a senior scientist or engineer.

At the same time the interview visits are going on, the Advisory Committee circularizes the entire technical staff of the laboratory with a request for proposals of assignments. It is requested that a proposal contain a description of the work the student will do, a commitment to be available by the student's supervisor, and a notice of any unusual working hours (because the Fermilab accelerator is easy to turn off, but difficult to turn on, we operate around the clock). We usually receive approximately 40 to 50 proposals from the 200 technical staff members of the laboratory. What we look for in a proposal is an assignment that will immerse a student completely in technical work and a supervisor who will show him how his work is related to the larger goals of the experiment. It is educational to stack shielding bricks if: a) the student understands why they are needed at that place; and, b) he also does other tasks.

The students' transcripts and interview records are brought back from the selection trips. At this point, the full Advisory Committee is too large and a small subcommittee is usually formed to match the students and proposals. After the students and assignments are matched, final offers, including job descriptions, are sent to the students, following up the preliminary offers made during the campus visit.

Living arrangements and salaries

The laboratory arranges and pays for students' transportation to the summer program and home again. We meet the students at the airport and bring them to their housing.

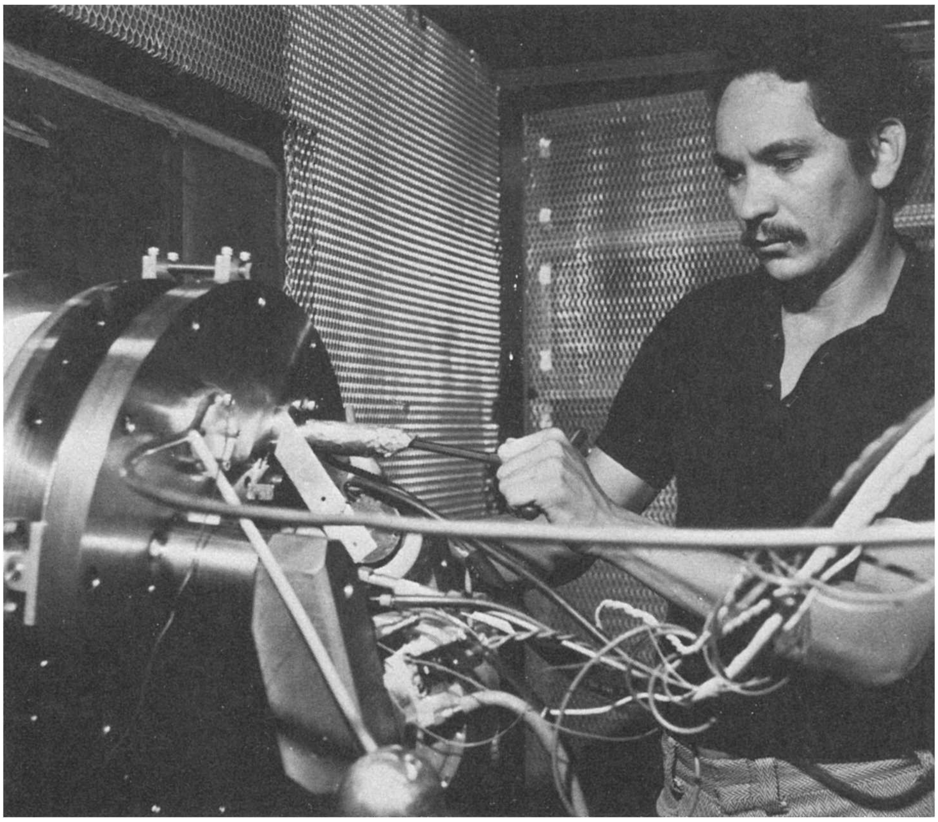
How and where the students are housed is quite important to the character of the program. We believe that the ideal situation would be to house the students at the laboratory. The disadvantages connected with the inaccessibility of the laboratory for shopping and recreation are far outweighed by the advantages; housing at the laboratory would permit more use of the library facilities in off-hours, enable the students to work easily at hours other than normal working ones, permit the students to use the recreation facilities at the laboratory and, finally, allow them to mingle more with the other scientists and their fellow students at the laboratory.

Unfortunately, the laboratory is very short of housing, particularly in the summer months and it has not been possible to house the students at the site. Instead, they are housed at a nearby college. This has resulted in a number of transportation problems. After several summers of expensive and unsatisfactory busing, we have secured permission to lease automobiles (1 car/5 students) for the students' use. The laboratory pays a fuel allowance to cover the costs of getting to the laboratory and back to the college.

In 1976, undergraduate participants were paid a stipend of $650 per month, while graduate students received $700 per month. We do not pay for holidays and overtime or allow an accumulation of vacation time. Free hospitalization insurance is provided, as is the transportation allowance discussed above. The laboratory arranges for student housing at a rate of $10 per week per student. This is not sufficient to cover the total room rent and a supplement for housing is therefore provided by the laboratory. We have not normally provided housing for families, although this situation does arise and, in fact, seems to be coming up more frequently. The laboratory also pays and arranges students' transportation to the summer program and home again.

Student salaries have been established in part by comparison with other summer and cooperative programs. We also recognize certain relationships between the students and our own work force. As an illustration, some of our students later come to work for us and it would be inappropriate that they earn less when they come into a permanent job. There is a wide variability among different institutions in the salaries paid for programs of this sort. Frequently, the observation has been made that students can obtain nearly the same salary working at home. The argument runs that by working at home the student will

Fig. 4. Henry Mulvaney from the University of Texas at El Paso working on development of a negative hydrogen-ion source for the Fermilab accelerator.



considerably cut his living expenses and if we make the economic disadvantage in coming to the program too strong, the student will have to turn down the opportunity that the program offers. This point must certainly be considered in establishing salaries.

We also provide several weekend tours for the students, both to other laboratories and to interesting points in the Chicago area. In addition, we have a get-acquainted dinner where the students can meet socially with their sponsors. We also encourage the sponsors to entertain the students in their homes.

Orientation and lecture series

The orientation given to the students includes a general description of Fermilab, its operation, and radiation and safety talks that are mandatory for all new employees. Chicago is the largest city most of the students have ever seen and we try to tell them something about what they might encounter on trips to the city. The orientation as a whole takes up most of the first day. We have experimented with allowing students to enter the program after the starting date, but they miss the orientation and are not as well integrated as the other students.

It has occasionally been suggested that we run full-scale courses during the summer. We have not taken this approach because of the variety of the academic backgrounds of our students–some early in their college careers and some already into graduate work. We have also felt that course work of this kind is more properly the realm of the individual university. Instead, we have organized a seminar that includes 10 to 15 lectures over the summer given by our staff members. The emphasis of the first lectures is on a quick introduction to the work at the laboratory and some of the important topics that most students find they need. As an example, instead of a computer programming course, we explain something about computers and how to get programs through the Fermilab computer system. We also provide a computer terminal for students interested in programming on their own and a few electronic setups for students who want to increase their experience in this area. One of the electronic engineers of Fermilab who is a member of the Summer Program Committee gives guidance to the students working in this area.

Some of the topics from our most recent program include electronic instrumentation, high-energy physics instrumentation, experimental statistics, applications programming, superconductivity, accelerators, strong and weak interactions, and medical physics. Each of these is related to topics the students are working on for the summer.

Toward the end of the summer, the students take over the lecture series to give reports on their summer work. These oral reports are in addition to the written report each student makes on his summer work. These speaking and writing experiences have been valuable to our students.

Coordination

The Coordinator of the program (who is not a member of the laboratory staff) plays a vital role. He continuously monitors all students' progress to see that the objectives of the program are being met as well as possible. As a person outside the nominal authority structure of the laboratory, he is in a good position to resist pressures for students to work on projects that will benefit a particular laboratory effort more than it will the students' own development.

The Coordinator also solves many student problems. A typical problem that arises in the summer is that the student feels his particular assignment is trivial, or boring. Often, when the situation is reviewed with the student's sponsor, the sponsor will counter with the argument that the student is not prepared to do more complicated work or that, although the work is commonplace, it has to get done. We try, where possible, to ameliorate these situations. The converse also occurs; students feel themselves inadequate to jobs that they regard as too complicated. This problem is usually corrected by getting the sponsor to simplify the assignment or amplify the instructions.

Another problem that often occurs is that the supervisor is not able to provide enough support for the student. The fact that the program occurs in summer particularly causes problems in this area because supervisors are often attending conferences or gone for vacation. We now try to make arrangements to cover vacations of supervisors and provide some backup source of information for the students. In all cases, close monitoring of the students by the Coordinator is most important.

All the normal student supportive problems occur: health problems, homesickness, examples of prejudice, and social problems. We have been particularly concerned with student homesickness. It seems to help to have two students from one institution; a student who is the only one from his institution more often feels homesick. Homesickness has had a stronger impact for people coming from the southwest. In many cases, these students are venturing away from their home territories for the first time.

At the end of the summer, several summaries are made. The student is asked to write the report of his project discussed above and an evaluation of the program. Often the student uses this material to obtain special credit for the summer's work at his school. At the same time, evaluations are composed for each of the students by the student's sponsor and by the Coordinator. The results of these evaluations are sent back to the student's home institution.

The impact of the program

Case histories for several schools can give some feeling for the success of the program. New Mexico Highlands University, basically a Chicano school in northeast New Mexico, has sent ten students to the Fermilab summer program. Six of these students are now in graduate school, two of them in nuclear chemistry, three in math, and one in physics. We have always wanted to educate students in the possibilities of research and not to narrow this only to physics. Thus we regard *any* interest in graduate school as a plus for the program. Of the New Mexico Highlands students who did not go to graduate school, one has gone on to a teaching career in physics and two are still undergraduates.

Students from Virginia State College have participated in the program since its beginning. All of these students have either obtained a bachelor's degree in physics or definitely decided on physics as an undergraduate major. One of these students has completed his first year of graduate work in engineering at a major institution.

Recently, we have undertaken a study of the students who have been in the program over the last five years to see what may have happened to them as a result of the program. Most of the students who passed through the program in 1975 are still either in graduate or undergraduate school. Information is available on about three-quarters of the students in the years from 1971 to 1974. A remarkable 40% of these are in graduate school. A quarter are undergraduates while another quarter have become scientists, technicians, or teachers. Ten percent have gone on to other careers. The laboratory has hired three of the students for its own staff. Any school in the country could be proud of this track record.

Another significant impact of the program has been on Fermilab itself. We have employed a number of the students after graduation. The laboratory's own appreciation of university problems in this area and of the needs and opportunities of minorities in physics has been heightened.

Conclusions

Over some years, Fermilab has developed a successful summer program for minorities. Our students move on into graduate programs or find significant jobs after receiving their bachelor's degrees. We believe that this approach is one successful attack on the problem of enriching minority education. There are other, somewhat similar programs at other institutions, for example, Brookhaven National Laboratory, Stanford Linear Accelerator Center, and Bell Laboratories.

We do, however, see several difficulties. One problem is to get more minority students into science-related programs at colleges and universities and at the same time assure that the students with the highest possible qualifications are going into the programs. On occasions, we have considered the question of whether it is sensible to deflect the very brightest minority students from careers that might influence most dramatically the improvement of minority opportunities, for instance, careers as teachers, lawyers, and public servants. But one of the implications of equality is that individuals should be free to pursue careers that may not have the most direct effect on society, but may be the sort of career the student himself feels he is best suited for. If this argument has any validity, we should inform students of the possibilities in science. The problem of getting more minority students into the sciences has not been given much consideration and should be a high-priority item in developing research scientists.

There are also difficulties in graduate school for minority students, for they may have some problems not shared by majority students. A particular problem we are aware of is that of adjustment to a style of communication and interactions with faculty that is quite different from their experience. Graduate schools need to be aware of this problem and be prepared to help with counseling at the department level. We believe our program may also help students by giving them a taste of this graduate-school style.

Our program is not a large or spectacular one, but is, we believe, one of many small actions that will move us closer to the American goal of equal opportunity for all.

References

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