PAUL B. EDWARDS

THE JHU/APL EVENING COLLEGE CENTER

This article discusses the status of a major graduate educational operation at APL and the people who contribute to its success. It describes the special educational needs of employed scientists and engineers, why and how the Center came into existence, how it satisfies educational needs, and why it is successful.

THE EDUCATIONAL NEEDS OF SCIENTISTS AND ENGINEERS

The graduate educational needs of employed scientists and engineers differ in several important aspects from the needs of full-time graduate students in science or engineering departments of universities.

Full-time students usually live conveniently close to the center of an institution's educational activity and thus suffer little or no inconvenience if required to attend classes during the day two or three times a week, or to carry out research during that time. This is not true of employed students, who must often drive long distances to reach the university and then remain alert in evening classes after having completed a full day's work.

Full-time students usually are heading for an advanced degree and are intensely interested in one area of specialization without any real knowledge as yet of its application to real-life problems. Employed students usually desire more knowledge of tools and techniques with which to attack the problems facing them daily and find a broad master's degree program to be more desirable and useful than a specialized doctoral program or a predominantly abstract approach.

Recent attempts by educational institutions to make their offerings more accessible to employed individuals are encouraging. Continuing education is imperative because professionals in any field face almost certain obsolescence if their education (either formal or informal) is not continued.

A crucial consideration is the composition of the faculty that can most effectively continue the education of employed scientists and engineers.[1] The faculty controls or materially influences the content, orientation, and quality of the programs as well as the time and frequency of class periods — all of which are important factors in the success or failure of such an undertaking.

Many college and university faculty members are reluctant to offer courses at off-campus locations. Some are skeptical of the abilities of students who exhibit characteristics and needs that are different from those of full-time students.

A study for the National Science Foundation[2] of 24 universities located near 17 research and development laboratories found that all the schools reported that credit courses off campus were not as satisfactory as those on campus. One reason given is that the students are "different." One dean was reported to have said, "All kinds of students show up who have no business being there." It is not clear if he considered that the courses might offer what *faculty members* thought should be included but that this might not really be what the *students* needed or desired. A second reason was more subtle. The academic people interviewed believed that faculty members who teach credit courses off campus inevitably lower their standards of student performance. The report pointed out a lack of information on whether this assumption is generally valid.

During 1966 and 1967, the Federal Council for Science and Technology, through its Committee on Federal Laboratories, carried out a study of the degree and nature of Federal laboratory/university collaboration, obstacles to further collaboration, and ways to extend collaboration. In March 1968, the results were published in a report entitled, "Education and the Federal Laboratories."[3] It stated that it was evident that Federal laboratories frequently contain unique or unusual facilities and staff members possessing special skills; both could effectively contribute, through cooperative arrangements with universities, to meeting the total educational needs of the nation. It recommended that any national effort to expand graduate educational resources should explicitly take into account the potentials of the Federal laboratories.

At a 1968 symposium[4] in Washington, D.C. that followed this study, Dr. Donald F. Hornig, then chairman of the Federal Council and Special Assistant to the President for Science and Technology, said that university people are accustomed to laboratories that are not highly problem-oriented, and that other laboratories where things are done from a different point of view can make valuable contributions.

Dr. Allen F. Astin, then Director of the National

Bureau of Standards and Chairman of the Committee on Federal Laboratories, noted the lack of enthusiasm on the part of many university professors for collaboration between universities and Federal laboratories and noted their skepticism concerning the benefits that their universities could expect from such an association. He suggested that one important benefit could be the opportunity to move a little closer to real-life problems.

A special task force of the then Department of Health, Education and Welfare issued a critique of higher education[5] in March 1971, urging colleges and universities to leaven their faculties with outstanding practitioners and encouraging more experience away from the campus.

These analyses suggest that:

1. University faculty members generally tend to resist offering courses off campus;
2. The typical university curriculum is not sufficiently oriented toward problem solving and real-life situations. The university environment, by its nature, forces faculty members to direct their efforts toward abstract investigations and theoretical model building, rather than toward concrete problem solving;
3. Students who work and continue their education part-time have different, but not inferior, needs from those of full-time students.

From the foregoing, it may be concluded that a special faculty is needed to provide optimal continuing education programs for employed students. But such a revised faculty composition is not easy to bring about, even for experimentation. Traditionally, faculties have been understandably reluctant to delegate their teaching responsibilities to individuals who have not undergone the screening inherent in the faculty appointment process. After all, the faculty bears a major responsibility in determining the character of the institution. Some will even argue that the faculty *is* the institution. To obtain such a special faculty to instruct in the Evening College Center at the Applied Physics Laboratory, The Johns Hopkins University Evening College draws on the staff of APL.

THE GRADUATE CENTER AT APL

APL, as part of The Johns Hopkins University, is dedicated to scientific and engineering excellence. The spectrum of work presently performed is broad, ranging from basic research in science to engineering development of hardware. The Laboratory's programs and products require that it have an outstanding staff. Approximately 1300 employees are on the professional staff, where a college degree or its equivalent is required. About 50% of the professional staff members hold advanced degrees. Many are nationally or internationally recognized in their areas of specialty. All are concerned with keeping abreast of current developments, and many are interested in teaching.

As early as 1958, the JHU Evening College sponsored a few courses, but no degree programs, on APL premises for APL staff members. These courses were taught by APL senior scientists or engineers and were not open to the public. In 1963, arrangements were made to designate the APL operation as an Evening College Center to offer the master of science degree in electrical engineering there as well as on the Baltimore campus, and to open to the public the offerings at the APL Center.

In the fall of 1964, the APL Evening College Center formally began operation. Since then it has grown greatly, as shown by the class registration totals in Fig. 1 and Table 1. The Center is now an important component of the JHU Evening College. Individuals enrolled in the APL Center last year accounted for 26.7% of *all* individuals enrolled for graduate credit in the JHU Evening College. They accounted for 17.8% of all individuals enrolled for

Table 1

RECENT CLASS REGISTRATION GROWTH

Fall Term	*Registration Totals*	*Increase Over Previous Fall*	
		Numerical	*Percentage*
1975	696	110	18.8
1976	748	52	7.5
1977	868	120	16.0
1978	954	86	9.9
1979	1147	193	20.2
1980	1287	140	12.2

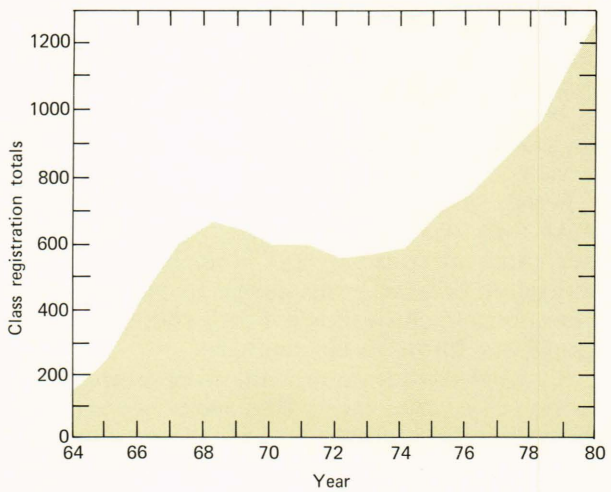

Fig. 1—Class registration totals. The growth rate was very pronounced from 1964 to 1968, when students were entering the program, but were not sufficiently far along to graduate. A nearly steady state period followed until 1974, when the number of new students entering the program was less than the number of students graduating with master's degrees and leaving the program. In 1974, the growth rise began again as the number of new students registering more than offset the number graduating. Numerically, the recent trend is shown in Table 1.

graduate or undergraduate credit in the Evening College. The number and sources of these students are shown in Fig. 2.

When the APL Evening College Center opened in 1964, the master's degree in electrical engineering was the only degree offered. A master's program in numerical science was initiated in 1966 and one in applied physics and another in space technology in 1967. In 1971 the master's degree program in computer science was added to the Center's selection. Present plans are to add a sixth master's degree program, in technical management, in the fall of 1981. The enrollment in these degree programs is shown in Fig. 3.

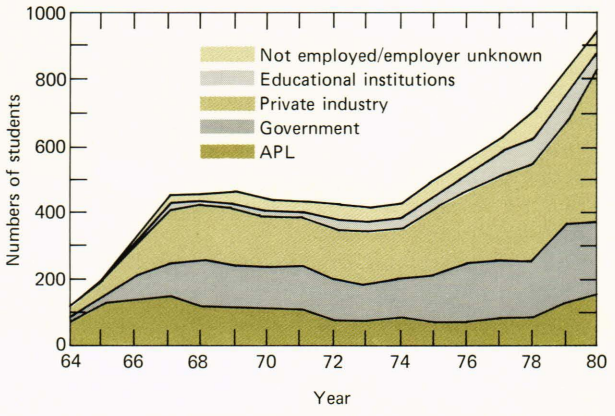

Fig. 2—Number of students (by type of employer). While students were mostly APL staff members at the start of the Center's program, they constituted only 16% of the student body by 1980. (Because some students take more than one course per term, the number of students is always smaller than the class registration totals.)

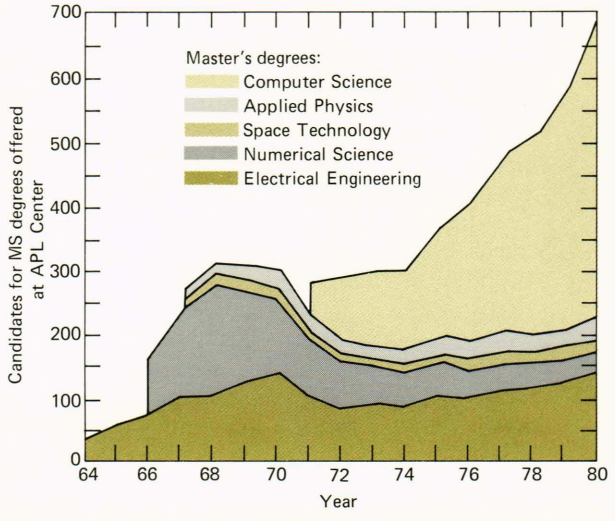

Fig. 3—Candidates for master's degrees offered at the APL Evening College Center by academic areas. The electrical engineering program has been consistently strong; numerical science enjoyed phenomenal success until the advent of the computer science program in 1971; space technology and applied physics have had modest success; and computer science is currently the most popular program, with 66% of all degree candidates working in that area.

Since APL constitutes a large reservoir of applied scientific and engineering expertise within the university, the Evening College is able to draw heavily on that source for faculty, guidance, and support. The value of the close cooperation between APL and the Evening College is demonstrated by the major role the APL Evening College Center plays in the granting of master's degrees in *technical* areas. In 1979-80, of those receiving M.S. degrees in technical areas from the University's Evening College, 91% of the students had completed their programs at the APL Center. Over a 13 year period, 77% of all recipients of such technical degrees have been students of this Center. Figure 4 provides details on the master's degrees awarded.

The instructors in the Center are carefully selected individuals with outstanding academic credentials and professional experience in the areas in which they instruct. They have also demonstrated an understanding of the particular abilities and needs of the employed scientists or engineers who continue their education on a part-time basis. APL staff members constitute about 73% of the instructional staff, although experts from other organizations are brought in whenever necessary. The composition of the 1980-81 faculty is shown in Table 2.

The APL Evening College Center administration is

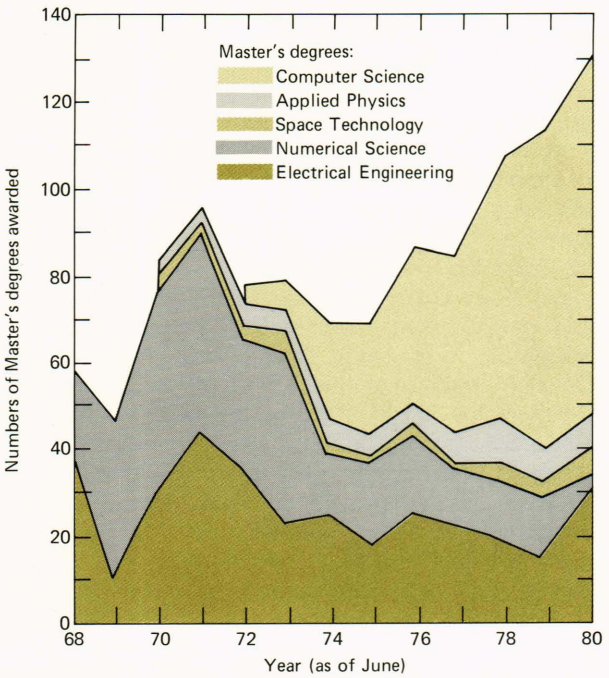

Fig. 4—Numbers of master's degrees awarded (by academic area) for APL Evening College Center programs. The Center opened in Fall 1964, and its first graduates completed their programs and received their degrees in 1968. To date, 1095 master's degrees have been awarded by The Johns Hopkins University to students of the APL Center. Of that number, 175 (16%) were to APL staff members, and 920 (84%) to others. In the academic year 1979-80, 131 master's degrees were awarded, the largest number in any one year. The fact that 64% of that total (84 of 131) were in computer science illustrates the popularity of that specialty.

Table 2

1980-81 FACULTY, JHU/APL EVENING COLLEGE CENTER

Employer	*Highest Degree Held*		*Total*
	Ph.D.	*M.S.*	
The Johns Hopkins University			39
Applied Physics Laboratory			
Principal Professional Staff	10*	2*	
Senior Staff	15*	9*	
Homewood Faculties			
Professor	2	--	
Associate Professor	1	--	
Other			10
Computer Sciences Corp.	2	--	
Honeywell Federal Systems	1	--	
Mitre Corporation	3	--	
Naval Research Laboratory	2	--	
RLG Associates	1	--	
U.S. Naval Academy	1	--	
Total	38	11	49

* These staff members have published over 400 articles in professional journals. One holds 22 patents.

alert to the need to keep offerings current and of high quality. Information necessary to do this is gleaned from questionnaires completed by students, from close monitoring of APL needs as shown by attendance at short technical courses and part-time study programs, and from stimulation of instructors to produce pertinent courses or to revise presently offered ones where needed. As one result, 11 new courses were added in 1979-80 and 14 more new ones are scheduled for 1980-81.

When the Center began its operation in 1964, all six courses were taken from the existing JHU curriculum. However, since that time over 100 different courses have been offered here. Some were designed by JHU faculty members from the Baltimore campus and a few were originated by APL Evening College Center instructors who are primarily employed by other organizations, but most were created by APL staff members. By academic area, these break down to mathematics, 14; applied physics, 10; space technology, 8; general engineering, 13; electrical engineering, 19; probability and statistics, 4; languages, 2; and computer science, 34.

The courses have been taught by 107 different instructors. Of these, 75 were APL staff members, 17 were faculty members from the Baltimore campus, and 15 were staff members of other scientific and engineering organizations in the Washington-Baltimore area. Both the part-time faculty and the students have met the criteria set by the University for participation in the Evening College program. Standards are the same for the APL Center as for the Evening College at the Homewood campus.

The program has been critically judged continuously since 1964 by one important group — the students — primarily mature, employed individuals. By means of questionnaires sent directly to them by the APL Center administration and returned unsigned to that office, they have regularly evaluated instructors and courses. Instructors helped to develop the questionnaire, they strongly support its use, and they effectively utilize the results to improve course content and instructional techniques. Numerous engineering educators[6-12] have agreed that student evaluation of instructors and courses, if properly done, is a valuable and valid tool. R. C. Wilson[6] says that evaluations of this type indicate excellent agreement among students, and between faculty and students, about the effectiveness of particular teachers.

Each instructor is given a detailed report of his students' responses (see Fig. 5). He is told the number of replies to each item as well as the percentage of replies in that area. In addition, he can see the percentage of replies made for all APL Evening College Center courses as a group and can use that as a reference point for judging his own performance as seen by the students. This particular feedback device and the manner in which it has been used by the administration and faculty have contributed greatly to the success of the Center.

SUMMARY

Who benefits from the operation of the APL Evening College Center? Certainly the following do:

1. APL staff members, who can choose from a variety of courses and programs that would be impossible to provide for APL staff members alone;
2. The entire scientific and engineering community of the Baltimore-Washington area, both individuals and organizations, because of the variety of high-quality programs offered at the Center;
3. Howard County and the State of Maryland, for which a graduate scientific center of such size and quality is an educational asset; and
4. The Johns Hopkins University, because additional instructor and student resources are made available. The Evening College is able to draw instructors from a group of exceptionally well-qualified individuals who are primarily involved in research and development, and the APL Center attracts students who find it difficult to commute to the main Baltimore campus.

Judged in terms of the number of programs offered, students attracted, graduates produced, contributions made to the community, and favorable student evaluations of instruction, the program certainly is successful.

Some of the reasons for this success are:

1. *A special faculty.* The majority of the courses are taught by individuals who like to teach,

SPRING 1977 — SUMMARY OF STUDENT OPINION QUESTIONNAIRES, APL CENTER — THE EVENING COLLEGE OF THE JOHNS HOPKINS UNIVERSITY

COURSE: 11.709 MATRIX THEORY

QUESTION	RESPONSES THIS COURSE #	THIS COURSE %	ALL COURSES %
NUMBER OF QUESTIONNAIRES DISTRIBUTED: 26			
STUDENTS RESPONDING	18	69%	65%
1. I AM (WAS) ENROLLED IN THIS COURSE FOR			
1 GRADUATE CREDIT	18	100%	93%
2 UNDERGRADUATE CREDIT	0	0%	3%
3 AUDIT	0	0%	3%
2. I AM (WAS) A CANDIDATE FOR			
1 NO CERTIFICATE OR DEGREE	1	6%	13%
2 AN ASSOCIATE DEGREE	0	0%	0%
3 A BACHELOR'S DEGREE	0	0%	0%
4 A MASTER'S DEGREE	15	83%	83%
5 AN ADVANCED CERTIFICATE	2	11%	4%
6 A DOCTORATE	0	0%	0%
3. I CONSIDER THIS COURSE TO BE			
1 VERY INTERESTING	2	11%	38%
2 INTERESTING	16	89%	55%
3 DULL	0	0%	7%
4. TO ME, THIS COURSE IS EDUCATIONALLY			
1 VERY VALUABLE	2	11%	25%
2 VALUABLE	12	67%	44%
3 ADEQUATE	4	22%	23%
4 INADEQUATE	0	0%	8%
5 USELESS	0	0%	1%
5. THE LEVEL AT WHICH SUBJECT MATTER IS PRESENTED IS			
1 USUALLY TOO HIGH	1	6%	3%
2 SOMETIMES HIGH	4	22%	19%
3 USUALLY RIGHT	12	67%	63%
4 SOMETIMES LOW	1	6%	11%
5 USUALLY TOO LOW	0	0%	3%
6. THE SPEED OF COVERAGE OF SUBJECT MATTER IS			
1 MUCH TOO FAST	0	0%	1%
2 TOO FAST	1	6%	12%
3 ABOUT RIGHT	14	78%	68%
4 TOO SLOW	3	17%	17%
5 MUCH TOO SLOW	0	0%	1%
7. THE RELATIONSHIP OF THE COMPUTING LABORATORY TO THE CLASSROOM INSTRUCTION IS			
1 EXCELLENT	0	0%	
2 GOOD	0	0%	
3 ADEQUATE	0	0%	
4 POOR	0	0%	
5 THERE IS NO LABORATORY	18	100%	
8. THE TEXT IS			
1 EXCELLENT	0	0%	6%
2 GOOD	9	50%	23%
3 ADEQUATE	6	33%	22%
4 POOR	1	6%	18%
5 NO TEXT IS USED	2	11%	29%
9. THE REFERENCE MATERIALS ARE			
1 EXCELLENT	0	0%	12%
2 GOOD	1	6%	30%
3 ADEQUATE	1	6%	27%
4 POOR	0	0%	8%
5 THERE ARE NONE	16	89%	21%
10. HOMEWORK OR FIELD WORK ASSIGNMENTS ARE			
A IN QUANTITY			
1 TOO MUCH	0	0%	5%
2 CORRECT	17	94%	70%
3 TOO LITTLE	1	6%	14%
4 NONE	0	0%	7%
B IN EDUCATIONAL QUALITY			
1 EXCELLENT	4	22%	14%
2 GOOD	9	50%	45%
3 ADEQUATE	5	28%	23%
4 POOR	0	0%	9%
C IN RELATIONSHIP TO CLASSWORK			
1 EXCELLENT	3	17%	18%
2 GOOD	10	56%	45%
3 ADEQUATE	4	22%	20%
4 POOR	0	0%	5%
11. THE TESTS AND EXAMINATIONS ARE			
1 UNRELATED TO THE SUBJECT COVERED	0	0%	4%
2 PERTINENT, BUT TOO HARD	1	6%	14%
3 GOOD	15	83%	55%
4 TOO EASY	2	11%	2%
5 MUCH TOO EASY	0	0%	0%
6 THERE WERE NO TESTS	0	0%	21%
12. AT THE BEGINNING, THE COURSE OBJECTIVES WERE CLEARLY STATED BY THE INSTRUCTOR.			
1 YES	14	78%	85%
2 NO	4	22%	13%
IF YES, DO YOU THINK THESE OBJECTIVES WERE ATTAINED?			
1 YES	11	79%	68%
2 PARTIALLY	3	21%	26%
3 NO	0	0%	3%

QUESTION	RESPONSES THIS COURSE #	THIS COURSE %	ALL COURSES %
13. AT THE BEGINNING, THE INSTRUCTOR MADE IT CLEAR HOW STUDENTS WOULD BE EVALUATED			
1 YES	16	89%	84%
2 NO	2	11%	13%
14. THE INSTRUCTOR'S KNOWLEDGE OF SUBJECT MATTER APPEARS TO BE			
1 OUTSTANDING	10	56%	44%
2 MORE THAN ADEQUATE	8	44%	37%
3 ADEQUATE	0	0%	15%
4 QUESTIONABLE	0	0%	4%
5 INADEQUATE	0	0%	0%
15. IN RELATION TO OTHER TEACHERS I HAVE HAD, THIS ONE IS			
1 ONE OF THE BEST	6	33%	20%
2 ABOVE AVERAGE	9	50%	39%
3 AVERAGE	3	17%	31%
4 BELOW AVERAGE	0	0%	5%
5 ONE OF THE WORST	0	0%	4%
16. THE INSTRUCTOR'S PREPARATION FOR CLASS IS			
1 EXCELLENT	6	33%	35%
2 GOOD	8	44%	41%
3 ADEQUATE	3	17%	11%
4 VARIABLE	1	6%	9%
5 POOR	0	0%	3%
17. WHEN SPEAKING, THE INSTRUCTOR			
1 SPEAKS DISTINCTLY	18	100%	83%
2 SPEAKS TOO FAST	0	0%	8%
3 SPEAKS TOO SLOWLY	0	0%	2%
4 SPEAKS TO THE BLACKBOARD, WALL, CEILING, ETC.	0	0%	4%
5 MUMBLES	0	0%	2%
18. IN REPLY TO QUESTIONS, THE INSTRUCTOR			
1 GIVES EXCELLENT ANSWERS	6	33%	30%
2 USUALLY HAS A GOOD ANSWER	12	67%	58%
3 GIVES ANSWERS OFTEN UNSATISFACTORY OR CONFUSING	0	0%	12%
4 DOES NOT ANSWER	0	0%	0%
5 NO QUESTIONS ARE ASKED	0	0%	0%
19. BESIDES LECTURES, THE INSTRUCTOR UTILIZES OTHER TEACHING/LEARNING METHODS			
1 OFTEN	1	6%	14%
2 FREQUENTLY	0	0%	21%
3 INFREQUENTLY	5	28%	29%
4 NEVER	11	61%	31%
20. IN MEETING CLASSES, THE INSTRUCTOR			
1 IS SOMETIMES LATE	0	0%	4%
2 IS FREQUENTLY LATE	0	0%	1%
3 SOMETIMES HOLDS US OVERTIME	1	6%	9%
4 FREQUENTLY HOLDS US OVERTIME	0	0%	1%
5 OBSERVES THE SCHEDULED TIMES	16	89%	87%
21. IN GENERAL, THE INSTRUCTOR'S ATTITUDE IS			
1 HELPFUL	16	89%	70%
2 COOPERATIVE	4	22%	41%
3 INDIFFERENT	0	0%	3%
4 ARROGANT	0	0%	1%
5 PATRONIZING	0	0%	1%
6 ANTAGONISTIC	0	0%	0%
22. I FOUND THE CLASS HOURS TO BE			
1 EXCELLENT	6	33%	20%
2 GOOD	8	44%	42%
3 ADEQUATE	3	17%	29%
4 INCONVENIENT	1	6%	8%
23. PARKING FACILITIES ARE			
1 EXCELLENT	2	11%	12%
2 GOOD	4	22%	30%
3 ADEQUATE	10	56%	46%
4 POOR	2	11%	9%
24. CLASSROOM FACILITIES ARE			
1 EXCELLENT	5	28%	17%
2 GOOD	9	50%	48%
3 ADEQUATE	3	17%	32%
4 POOR	1	6%	1%
25. THE COMPUTING LABORATORY FACILITIES ARE			
1 EXCELLENT	0	0%	
2 GOOD	0	0%	
3 ADEQUATE	0	0%	
4 POOR	0	0%	
5 THERE IS NO LABORATORY	18	100%	

NOTE: A SUMMARY OF INDIVIDUAL COMMENTS MADE BY STUDENTS IS ATTACHED.

Fig. 5—Sample questionnaire results furnished to an instructor of matrix theory.

who teach in areas of particular interest to them, who are practicing scientists or engineers, and who possess outstanding academic credentials.

2. *Well-designed degree programs.* Five different master's degree programs are offered in areas attractive and important to employed scientists and engineers.
3. *Convenient schedules.* Classes are scheduled with the employed individual in mind. Most last from 4:30 to 7:10 PM or from 7:15 to 10:00 PM. All meet only one day per week.
4. *Appropriate mechanisms for student feedback.* As early as 1964, the APL Center administration was obtaining the reactions of students to courses and instructors by means of questionnaires and has continued that practice. The results have contributed materially to improved instruction, degree programs, and scheduling.
5. *Physical location.* The APL Center is conveniently located halfway between Baltimore and Washington in a rural area easily reached by excellent highways.
6. *Adequate parking.* There is no charge for parking, and the lots are large.
7. *Good classrooms.* Classrooms are modern, air-conditioned, and well lighted.

All these reasons are important, but most important of all is the first — a special faculty. Because of the nature of their work and their daily contacts with co-workers whose problems are similar to those of the students attending the Center, most of the instructors understand the needs of their students very well.

REFERENCES

[1] P. B. Edwards, "An Effective Faculty of Practicing Scientists and Engineers," *Eng. Ed.* **64**, No. 2, pp. 112-115 (1973).
[2] Social Research Inc., *Continuing Education for R&D Careers*, NSF 67-11, Government Printing Office (1967).
[3] Federal Council for Science and Technology, *Education and the Federal Laboratories*, Clearinghouse for Federal Scientific and Technical Information (1968).
[4] Federal Council for Science and Technology and American Council on Education, *Proc. Symposium on Education and Federal Laboratory-University Relationships*, Government Printing Office (1969).
[5] *Chronicle of Higher Education*, U.S. Dept. of Health, Education and Welfare (Mar 1971).
[6] R. C. Wilson, "Teaching Effectiveness: Its Measurement," *Eng. Educ.* **62**, No. 6 (1972).
[7] W. R. Hill, "Student Rating of Teachers," *Eng. Educ.* **60**, No. 2 (1969).
[8] J. J. McKetta, "Measuring Teaching Effectiveness," *Eng. Educ.* **60**, No. 4 (1969).
[9] J. E. Stice, "I'm for Evaluation of Teaching, but," *Eng. Educ.* **62**, No. 6 (1972).
[10] G. W. Fischer, "Mandatory Student Evaluation of Instruction," *Eng. Educ.* **58**, No. 2 (1967).
[11] H. L. Ashlock, "Grading the Professors," *QUEST*, Washington State University College of Engineering (1972).
[12] P. B. Edwards, S. Favin, and J. L. Teesdale, "Evaluation of Educational Programs: Why? How? By Whom?" *Proc. IEEE/ASEE Conference on Frontiers in Education*, pp. 323-330 (1979).