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ABSTRACT

There are numerous examples of highly trained, capable individuals that face layoffs because of technological or economic changes that have eliminated the need for their services. This project was designed to provide a one-step opportunity for people such as these to identify opportunities in emerging technologies, to plan a retraining program, to complete courses that had been designed specifically toward their needs and scheduled during non-working hours. Technical aspects of emerging technologies rather than management aspects are emphasized. This document contains the background, course descriptions, project results, case studies, summary and conclusions from the biotechnology, physics, mathematics, and chemical and physical analysis tracks. Appendices include a schedule of the biotechnology, and advanced techniques of chemical and physical analysis learning tracks, and an information sheet to be completed by course participants. (CW)

# EDUCATIONAL BRIDGES TO OPTIONS IN HIGH TECHNOLOGY EMPLOYMENT

## FINAL REPORT



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# EDUCATIONAL BRIDGES TO OPTIONS IN HIGH TECHNOLOGY EMPLOYMENT

## FINAL REPORT


Grant Organization: San Diego State University Foundation
5300 Campanile Drive
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| Year 1 | $ 77,384 |
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PROJECT SUMMARY

Programs were developed to provide retraining and updating for employed postbaccalaureate scientists who were at transition points in their careers. Courses were offered in two subject areas: (1) a two year sequence leading to a certificate in Advanced Techniques of Chemical and Physical analysis, and (2) a sequence leading to a certificate in Recombinant DNA Technology. All courses were scheduled in the early evening and on weekends. The programs were publicized and 10 to 20 postbaccalaureate students were recruited and enrolled in each of the 24 courses that made up the two programs. The students were diligent and gave high ratings to the courses, and the biology and chemistry departments gained an increased awareness of the local interest in continuing education.

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Final Report: Educational Bridges to Options in High Technology Employment

## EXECUTIVE SUMMARY

Project Title: Educational Bridges to Options in High Technology Employment
Grantee Organization: San Diego State University Foundation
5300 Campanile Drive
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Project Director: Dr. Celia Marshak
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### PROJECT OVERVIEW

The objective of this project was to develop courses to retrain and update working professionals who had previously earned degrees in science and were at transition points in their careers. Two programs were offered: (1) a two year sequence leading to a certificate in Advanced Techniques of Chemical and Physical Analysis, and (2) a sequence leading to a certificate in Recombinant DNA Technology. Courses were offered on evenings and Saturdays and were taught by senior members of the university faculty. Between 10 and 20 postbaccalaureate students were recruited and enrolled in each of the 24 courses that made up the two programs. The students were diligent and gave high ratings to the courses, and the biology and chemistry departments gained an increased awareness of the local interest in continuing education.

### PURPOSE

In today's society there are numerous examples of highly trained, capable individuals who are facing lay offs because technologic or economic changes have eliminated the need for their services. Many of these individuals could become competitive in the current job market if they had the opportunity to complete a few specialized courses and gain the expertise that is being sought by local industries.

This project sought to provide a one-step opportunity for candidates to identify opportunities in emerging technologies, to plan a retraining program and to complete courses that had been designed specifically for their needs and scheduled during non-working hours. Certificate programs were offered to accomodate those students who wished to receive documentation of their completion of an orderly sequence of retraining courses. The program emphasized the technical, rather than the management, aspects of emerging technologies because there were existing opportunities for management training in the San Diego area, and there was no need to duplicate these courses.

### BACKGROUND AND ORIGINS

The current program was an outgrowth of a career facilitation program for women scientists that was conducted at San Diego State University from 1981-83 under the sponsorship of the National Science Foundation. The participants in

the NSF program had completed their formal education in science but had not been able to seek career positions because of conf'icting family responsibilities. They were given individualized academic advising and in-depth career counseling. Refresher courses were developed to lessen the shock of reentering the University, but after an initial orientation, these women attended regular daytime University classes.

The current progam was designed for both men and women scientists who completed their formal education a number of years ago and were presently employed full time. In contrast to the earlier NSF prgoram, these participants were already familiar with the local job market and did not need to be re-introduced through seminars and tours that were part of the women's program. The target population for the current program could not attend daytime University classes since they worked during the day. Therefore, it was necessary to develop special evening courses for them or persuade the University faculty to offer some of the regular daytime courses in the evening. Both of these options were exercised.

Experience with the NSF project showed that a well-focused, timely, publicity campaign was essential to the success of the program. Accordingly, the program was publicized with special brochures, newspaper ads and display announcements in University publications. As a result, sufficient numbers of students were recruited to insure the success of the program.

PROJECT DESCRIPTION

The first six months of the project was devoted to planning specific course offerings in three subject areas: (1) Biotechnology, (2) Advanced Techniques of Chemical and Physical Analysis and (3) Physics and Mathematics. The project director, co-director and an advisory board of eight local industry representatives and eight science faculty members was responsible for formulating the plans.

It was determined that three kinds of evening and weekend courses would make up the learning modules:

"A" courses: Especially designed intensive review courses for students who have previously had a formal course in the subject.

"B" courses: Courses from the regular curriculum offered in the evening.

"C" courses: Courses offered in a non-traditional time frame and/or divided into modules.

Three sub-committees were appointed to recommend specific course offerings for each of three learning tracks: (1) Biotechnology, (2) Advanced Techniques for Chemical and Physical Analysis and (3) Physics and Mathematics. As a matter of policy, the learning tracks were designed to complement already existing programs whenever it appeared feasible and appropriate. Specific details of each program follow.

Biotechnology Learning Track

In the spring of 1984 the Biology Department at SDSU initiated a new certificate program in Recombinant DNA Technolkogy to prepare individuals for

the outstanding employment opportunities that exist in this field in San Diego. This certificate program was designed for full-time students and could not easily be completed by individuals who were employed full time. However, there were individuals who could arrange to enroll in the essential daytime courses if they had some way to complete part of the program in the evenings. The Biotechnology learning track was designed to enable these individuals to pursue the the Recombinant DNA certificate program with a minimum disruption of their employement. All of the required courses are taken from the regular University curriculum (i.e. "B" courses); therefore, no new courses had to be developed. Non-credit refresher courses in mathematics, organic chemistry and biochemistry had been developed under a previous NSF project and were offered again as part of the Biotechnology learning track. The program was publicized by distributing a special brochure to 2500 members of the local scientific community, by display announcements in University catalogs and by placing ads in local newspapers.

Specific course offerings, schedules, enrollment statistics and outcomes are discussed in the following section of this summary under PROJECT RESULTS.

Advanced Techniques of Chemical and Physical Analysis Learning Track

The Analytical Chemistry learning track was designed to stand alone, since there was no existing program that it could complement or relate to. A committee of Chemistry faculty and Advisory Board members designed a two-year sequence of courses to lead to a formal certificate in Modern Analytical Chemistry. All courses were designed especially for the program and were offered through the College of Extended Studies rather than the regular University currriculum. Course instructors were chosen from the full-time University faculty--usually those who taught the corresponding courses in the regular curriculum.

The first year program included six five-week refresher courses in the following topics:

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|---|---|
| Analytical Chemistry I | Inorganic Chemistry |
| Analytical Chemistry II | Organic Chemistry |
| Physical Chemistry | Biochemistry |

The second year program consisted of two semesters of Instrumental Methods of Analysis. These courses were similar to the offerings from the regular curriculum except that demonstrations were substituted for some of the normal laboratory work.

The program was publicized by distributing a brochure to approximately 2800 members of the local scientific community. A display ad was also included in the Extended Studies 1984 fall catalog.

Specific details of the results are given in the follcwing section of this report.

Physics and Mathematics Learning Track

Development of this program started with the offering of refresher courses in electricity and calculus. The courses were well publicized by proven methods, but there was insufficient interest to justify giving the courses. The initial experience indicated that there was no large pool of underemployed physicists who were seeking to be retrained. The Project

Directors decided to terminate work on the physics learning track and use the allocated resources to expand the other two learning tracks.

PROJECT RESULTS

Results are summarized separately for each of the two learning tracks since each track involved different methodologies. For each track the following tasks were accomplished:

1. Enlist faculty to prepare and teach the courses
2. Recruit students by publicizing course offerings
3. Provide support for faculty and students during the teaching phase

Biotechnology Learning Track

At the time this project was initiated, the certificate program in Recombinant DNA Technology was being offered for the first time to regular, daytime University students and was struggling to maintain adequate enrollements. The faculty agreed to offer one course, "Fundamentals of Biochemistry", at 5:30 p.m. during the summer session as a test case, and the project directors agreed to use funds from the grant to publicize the course. The initial test was so successful that the biology faculty continued to offer evening courses without any further urging from the project directors. Subsequent course offerings were publicized each semester to a select group of 65 individuals who held responsible positions in the local biotechnology industry. Enrollment continued to be excellent in the evening courses, and it is hoped that the interest will continue when the special publicity campaigns are no longer undertaken.

The results of the program were evaluated by questioning the students, the faculty and local industry. During the last week of every course, each student filled out an evaluation questionnaire which was reviewed by the project directors and the course instructor. Any major dissatisfactions were corrected but most students were satisfied and continued to enroll for several successive semesters. The faculty were surprised and pleased at the qualifications and diligence of the postbaccalaureate students. A high level of acceptance by industry was demonstrated by the increasing numbers of students whose course fees were paid by their employers.

Advanced Techniques of Chemical and Physical Analysis Learning Track

This program was offered as a certificate program in the College of Extended Studies rather than in the regular University curriculum. Members of the regular chemistry faculty planned the curriculum and developed and taught the courses. Initially, they were concerned that employed individuals would find the two year program too demanding and would drop out. However, these fears were unfounded. More than 40 individuals inquired about the program, 15 took the placement tests and enrolled and 9 completed all the work for a certificate. The few drop-outs were caused by job transfers and related problems.

The program was evaluated by the same techniques that were used for the biotechnology program, and similarly favorable ratings were given. In addition, some of the Chemical and Physical Analysis students were seriously

considering graduate school as a means of continuing their education. There are no plans to repeat the programs at the present time, but it could be repeated if there were sufficient demand.

## SUMMARY AND CONCLUSIONS

Retraining and updating programs for postbaccalaureate scientists were successfully planned and implemented in two subject areas: (1) Advanced Techniques of Chemical and Physical Analysis and (2) Recombinant DNA Technology. Three factors contributed to the success of the program: (1) a demonstrated need, (2) highly qualified and experienced teachers, and (3) careful and timely publicity.

# EDUCATIONAL BRIDGES TO OPTIONS IN HIGH TECHNOLOGY EMPLOYMENT

## FINAL REPORT

### PROJECT OVERVIEW

Because of the rapid technological advances in the past two decades, scientifically educated adults who are at transition points in their careers are returning to the universities in increasing numbers for retraining and updating. These individuals have neither the resources nor the desire to give up full time employment and return to the university as regular day time students. The objective of this project was to develop courses that provided the necessary refreshing and retraining in a minimum amount of time and still permitted the students to continue working full time. Courses were offered in two subject areas: (1) a sequence leading to a certificate in Advanced Techniques of Chemical and Physical Analysis, and (2) a sequence leading to a certificate in Recombinant DNA Technology. Senior members of the university faculty taught the courses. Announcements of course offerings were sent to local scientific firms, newspapers, scientific societies and prominent individual scientists. Between 10 and 20 postbaccalaureate students were recruited and enrolled in each of the 24 courses that made up these two programs. The students gave high ratings to the courses, and the faculty were favorably impressed with the abilities and diligence of the students. The biology and chemistry departments gained an increased awareness of the interest in continuing education and plan to continue offering some of the courses as long as the demand continues.

### PURPOSE

The engineers and scientists in today's work force must work in a climate of rapid technological changes. Sometimes these changes merely alter the design of a product or modify its production process, and the product continues to be manufactured by the same company that has produced it for many years. In other instances, the technological changes may eliminate the need for a product altogether and cause the company to shut down or switch to a different product that may require new technical expertise not possessed by the previous technical staff. In today's society there are numerous examples of highly trained, capable individuals who are facing lay offs because technologic or economic changes have eliminated the need for their services.

This project is concerned with such individuals who have college degrees in science or engineering and are seeking new positions that offer equivalent technical challenges.

Some specific examples will be cited to help the reader identify the situations that are of concern. Many operations that formerly were carried out manually are now done automatically with the aid of computers. An older scientist may not be competent to operate modern equipment or select new instrumentation unless he is able to secure additional training in modern electronics and microprocessors. This may require a comprehensive sequence of learning opportunities rather than a single course. In this case the scientist does not expect to look for another job; he merely wishes to secure training to enable him to be effective in his current position.

Medical technologists and clinical microbiologists are faced with diminishing opportunities for employment in hospital and clinical laboratories as a result of policy changes in the health care industry and the trend toward simplified tests. These individuals would be eligible for positions in the rapidly growing biotechnology industry if they could become familiar with the theory and techniques of recombinant DNA technology, special techniques for production of monoclonal antibodies, use of plasmid analysis for susceptibility and/or epidemiological purposes, and development of gene probes for rapid diagnosis of various infectious diseases. These techniques can be taught in a few specialized courses without requiring an individual to return to campus as a full time student.

The individual scientist in the San Diego area is faced with two problems when he realizes that his current position is becoming obsolete. First, he needs to determine where the current opportunities may be found and what kinds of expertise are being sought. Secondly, he must formulate a plan for securing the necessary training--preferably on a schedule that permits him to keep his present job. At the present time there is no single source for this information. Professional societies are sometimes helpful in describing the types of expertise that are in demand, but they seldom are able to suggest ways to secure systematic training. The two local universities and the community colleges offer an assortment of courses that are designed for the typical undergraduate and are seldom appropriate for retraining. In addition, many of the courses are offered at times that are impossible for a student who is employed full time. The University extension courses offered by San Diego State University and by the University of California at San Diego provide some relevant learning opportunities, but they do not provide a sequence of related courses that are offered at pre-scheduled times to enable a student to plan a

definite program a year or two ahead of time. In addition, many of these courses cost as much as $925 for a three-day short course. Most individuals who are retraining at their own expense could not afford to take a sequence of short courses at these prices even if the appropriate subject matter were presented. Students who need refresher courses in calculus, physics, organic chemistry, et cetera, have great difficulty in finding appropriate courses at any of the local learning centers for any price.

The new program provided a one-stop opportunity for candidates to identify opportunities in emerging technologies, to plan a retraining program and to complete courses that had been designed specifically for their needs. The program emphasized the technical, rather than the management, aspects of emerging technologies because there were already opportunities for management training in the San Diego area, and there was no need to duplicate these courses. The courses were offered during non-working hours so that participants who were employed could continue to work full time.

## BACKGROUND AND ORIGINS

From 1981-83 a career facilitation project was conducted at San Diego State University under the sponsorship of the National Science Foundation, for Women-in-Science. The program was designed for women scientists who had completed their formal education at least five years previously and now wished to refresh their skills in preparation for reentering or advancing in the job market. Thirty women participated in the program, and almost all achieved their goals and found rewarding employment. The participants required individualized academic advising and in-depth career counseling. Each woman followed a course of study that was individually designed to fit her career aspirations and personal goals. This highly successful retraining program formed the framework for the project that is the subject of this report.

The current program was designed for both men and women scientists who completed their formal education a number of years ago and were presently employed full time. In contrast to the earlier NSF program, these participants were already familiar with the local job market and did not need to be re-introduced through seminars and tours that were part of the Women-in-Science program. Many of the women in the NSF program were able to attend regular University classes in the daytime, but the current target population could only attend classes on evening and weekends. The NSF project provided valuable experience in involving representatives from industry in University course offerings, in developing review courses, in planning coordinated sequences of retraining courses and in recruiting students for

special University programs. In addition, working relationships were developed with faculty members and administrators that were continued into the present project. In general, successful techniques from the NSF project were adapted to the present project with minor modifications to accommodate the necessary differences in scheduling and counseling needs.

The project was carried almost exactly as planned. University faculty and industry representatives cooperated enthusiastically, and students were recruited successfully for most of the course offerings. An unexpected increase in the local demand for engineers and physicists made it unnecessary for individuals to seek retraining in order to advance in their careers. Employers were apparently willing to provide on-the-job retraining. As a result, there was so little demand for retraining in physics and electronics that the proposed programs were not offered. On the other hand, the demand for retraining in biotechnology and instrumental analysis was greater than originally anticipated, and these programs were expanded. As the project progressed, it became easier to recruit students without intensive publicity campaigns. In the final year of the project, many local biotechnology companies had become aware of the University's retraining programs and referred their employees to the program without any special publicity efforts on our part.

PROJECT DESCRIPTION

The project, as initially conceived, was to provide retraining opportunities for postbaccalaureate scientists in three subject areas: (1) Biotechnology, (2) Advanced Techniques of Chemical and Physical Analysis and (3) Physics and Mathematics. All courses were to be offered outside normal working hours so that employed scientists could attend. The first six months of the project was devoted to planning the specific course offerings. The project director, co-director and the advisory board were responsible for the plans.

The advisory board of 18 scientists and educators provided liaison between the local scientific community and the University College of Sciences. Eight members of the board were from local scientific industries where they have high level management or research and development responsibilities. Eight members of the board were from the science faculty at San Diego State University. One member was from the personnel department of a large local industry and another member was from Counseling Services and Placement at San Diego State University. At the first Board meeting, project objectives were reviewed and needs of the local scientific community were delineated. There

was an excellent interchange of ideas between the industrial and academic components, but no clear cut consensus emerged about specific programs and course offerings. Therefore, the Project Directors decided to make tentative proposals of programs with the assistance of sub-committees selected from the Advisory Board, and re-submit these programs to the entire Board for review.

The Project Director, in collaboration with participating faculty members, determined that three kinds of evening and weekend courses would make up the learning modules:

"A" courses: Especially designed intensive review courses for students who have previously had a formal course in the subject.

"B" courses: Courses from the regular curriculum offered in the evening.

"C" courses: Courses offered in a non-traditional time frame and/or divided into modules.

Three sub-committees were appointed to recommend specific course offerings for each of three learning tracks: (1) Biotechnology, (2) Advanced Techniques for Chemical and Physical Analysis and (3) Physics and Mathematics. As a matter of policy, the learning tracks were designed to complement already existing programs whenever it appeared feasible and appropriate.

The sub-committee recommendations were reviewed by the full Board. The program content was discusses as well as the need for the program and the most appropriate ways to publicize the courses. Once again, the Advisory Board had a wide diversity of opinions, and no consensus emerged. Nevertheless, a number of specific suggestions were made that could be incorporated into the program design. The director and co-director made the final course recommendations based on the suggestions of industry as well as academia. Specific details are presented on the following pages.

## Biotechnology Learning Track

In the spring of 1984 the Biology Department at SDSU initated a new certificate program in Recombinant DNA Technology to prepare individuals for this outstanding employment opporcunities that exist in this field in San Diego. This certificate program was designed for full-time students and could not easily be completed by individuals who were employed full time. However, there were individuals who could arrange to enroll in the essential day time courses if they had some way to complete part of the program in the evenings.

The Biotechnology learning track was desinged to enable these individuals to pursue the Recombinant DNA certificate program with a minimum disruption of their employment. All of the required courses are taken from the regular University curriculum (i.e. "B" courses); therefore, no new courses had to be developed. It was necessary, however, to convince the faculty that there was a pool of capable students who would enroll in early-evening courses. The resources of the grant were used to publicize the course offerings and insure adequate enrollment without requiring any effort on the part of the faculty.

In addition, some special, non-credit refresher courses were offered for those individuals who had not attended college for several years. Recent graduates in the biological sciences have much more training in mathematics than was typical eight or ten years ago, and they must use these skills to understand modern biochemical concepts. Therefore, refresher courses in mathematics were obisous elections for the biotechnology track. In addition, refresher courses in organic chemistry and biochemistry were recommended. Since similar courses had already been developed under an NSF grant, it was possible to start the biotechnology learning track in January, 1984---very shortly after this project was initiated.

The inital course offerings were publicized by listing them in the Winter Session catalog and by mailing a special "Bridges" brochure to 1500 individuals and institutions from the College of Extended Studies' mailing list for science course announcements and to 1000 secondary school math and science teachers. Summer session courses were publicized by a display announcement in the summer session catalog and by several ads in local newspapers. In addition, a brochure describing the Recombinant DNA Certificate Program was distributed.

Specific course offerings, schedules, enrollment statistics and outcomes are discussed in the following section of this report under PROJECT RESULTS.

Advanced Techniques of Chemical and Physical Analysis Learning Track

The Analytical Chemistry learning track was designed to stand alone, since there was no existing program that it could complement or relate to. A committee of Chemistry faculty and Advisory Board members designed a two-year sequence of courses to lead to a formal certificate in Modern Analytical Chemistry. All courses were designed especially for the program and were offered through the College of Extended Studies rather than the regular University curriculum. Course instructors were chosen from the full-time

University faculty--usually those who taught the corresponding courses in the regular curriculum.

The first year program included six five-week refresher courses in the following topics:

Analytical Chemistry I
Analytical Chemistry II
Physical Chemistry
Inorganic Chemistry
Organic Chemistry
Biochemistry

The chemistry faculty believed strongly that a good foundation in all branches of chemistry was necessary for a certificate in Analytical Chemistry, however, students were allowed to omit one of the subject areas if they chose. The second year program consisted of two semesters of Instrumental Methods of Analysis. These courses were similar to the offerings from the regular curriculum except that demonstrations were substituted for some of the normal laboratory work.

The program was publicized by distributing a brochure to approximately 800 members of the local section of the American Chemical Society, 1000 secondary school math and science teachers and an additional 1000 individuals and institutions from the College of Extended Studies' mailing list for science course announcements. A display ad was also included in the Extended Studies 1984 fall catalog.

Specific details of the results are given in the following section of this report.

Physics and Mathematics Learning Track

San Diego offers substantial opportunities to physicists with expertise in microelectronics, instrument design and specialized military and aerospace applications. The SDSU Department of Physics offers a non-thesis masters degree program that can be completed in the evening, but there are very few candidates enrolled in the program. The first step in the development of the physics learning track was to evaluate the reasons for the lack of interest in the existing graduate program and determine whether the "Bridges" program

could make a contribution. Two possibilities were considered:

1. A pool of underemployed, out-dated physicists does not exist because the demand for physicists far exceeds the supply.

2. There are physicists who would be interested in more training, but they are unaware of the opportunity.

It had previously been determined that there was no pool of underemployed women physicists who were interested in retraining under the NSF Career Facilitation program, but the status of male physicists was unknown.

Refresher "A" courses in electricity and calculus were offered along with a regular "B" course in computer science (Pascal). These courses were publicized by methods described previously for the Biotechnology learning track. Enrollment in the mathematics courses was sufficient to justify giving the courses, but none of the enrollees had training or interest in physics. The Overview of Electricity course was not given because only three individuals attended. Two of these were high school teachers who wished to upgrade their competence in physics, and the other was considering engineering. None of them wished to pursue a career in physics. This initial experience indicated that there was no large pool of underemployed physicists who were seeking to be retrained. It was neither feasible nor appropriate to consider developing a learning track in Mathematics without a Physics component. Although many mathemeticians were seeking to be retrained in computer science, there were already programs available to fill this need without developing new programs with funds from this grant.

The Project Directors decided to terminate work on the physics learning track and use the allocated resources to expand the other two learning tracks.

## PROJECT RESULTS

Results are discussed separately for each of the two learning tracks since each track involved somewhat different activities. For each track the following tasks were accomplished:

1. Enlist cooperating faculty to prepare and teach the courses.
2. Publicize course offerings and recruit students
3. Provide support for faculty and students during the teaching phase

The methodology differed slightly for each of the two tracks.

Biotechnology Learning Track

The biotechnology learning track was designed to support a new certificate program in Recombinant DNA Technology that was offered as part of the regular University undergraduate curriculum. As a result, it was unnecessary to use the resources of the grant to plan the certificate program because University funds had already been used for this purpose.

The first DNA certificate courses were offered during the same semester that this grant wss awarded. Initially the courses were offered during the daytime with disappointingly low enrollment and less than outstanding students. The biology faculty were ready to accept any assistance that might increase enrollment and attract better qualified students. As a consequence, the faculty agreed to offer one course, "Fundamentals of Biochemistry" at 5:30 p.m. during the summer session as a test case. The project directors agreed to use the resources of the grant to publicize the course and the Recombinant DNA certificate program. This initial test was so successful that the biology faculty began to offer more courses in the evenings without any further urging from the project directors.

Publicity was provided in two different ways. First, the project directors worked with the College of Extended Studies on the University csmpus to use their existing publicity procedures. Catalog copy was provided and display ads were designed for the regulsr Extended Studies bulletin. The Extended Studies graphics department designed a special brochure which wss then printed using funds from the grsnt. Extended Studies mailed their bulletin and the special "Bridges" brochure to individuals on their general mailing list snd also to a special science mailing list of approximately 2500 individuals.

Secondly, the projects directors worked with the project Advisory Bosrd to plan a more focused publicity campaign. A list of local biotechnology firms was assembled and one or more contact individuals wss identified at each firm. Each of the 65 individuals on this mailing list received a brochure describing the Recombinsnt DNA Technology certificate program as well as announcements of individual course offerings (mailed shortly before the start of each semester). They were asked to pass the information along to their colleagues.

After the courses were offered, enrollees were asked to complete a questionnaire that included one question about the way they learned about the

course. This feedback indicated that the mailings to biotechnology firms were more effective than the large generalized mailings. Accordingly, the large mailings and display ads were not continued beyond the first year. The second year course publicity was limited to the normal course listings in the Extended Studies Bulletin and special mailings to 65 key individuals in the local biotechnology community.

Specific course offerings are listed in the appendix of this report. Five different courses were offered and most were repeated in several different semesters. In addition to the regular courses, non-credit review courses in organic chemistry and biochemistry were also made available. (These non-credit courses are discussed in more detail under the Analytical Chemistry learning track.) Support for faculty and students was provided as follows: (1) salaries for special teaching assistants; (2) purchase of teaching aids; and (3) faculty stipends to cover special course revisions and evaluations. Each type of support is explained more fully below.

In several instances the University was willing to schedule extra evening sessions of laboratory courses on a trial basis but was unable to provide laboratory assistants for these courses. Funds from the project were used to provide laboratory assistants so that the faculty members would have the same support that is normally provided for regular daytime sesssions. Alternate funding sources have been identified by the Project Director to provide similar support when the project funds are no longer available.

Two audio-visual teaching aids were purchased to upgrade the resources of the biotechnology staff. A slide/tape course in HPLC was acquired as well as a video course in techniques of genetic engineering. Students are required to use both of these aids, with the result that the faculty has more time to devote to other subjects. The use of these materials will continue long after the current project is completed.

Stipends were provided to the teaching faculty to permit them to update certain courses and incorporate all of the newest technological developments that would be of particular interest to postbaccalaureate students who were already working in the field. This was especially necessary for the beginning biochemistry courses that covered material that was changing rapidly. This support from the project provided the necessary incentive to allow faculty to make changes in their courses in response to questions and suggestions from students during the teaching period. In the future it is believed that faculty

members will be able to continually update their courses without additional support now that the project has funded the major updates and revisions.

The results of the total biotechnology effort were evaluated from three different perspectives:

1. Satisfaction of the students with the course content and schedule
2. Satisfaction of the faculty with the qualifications and diligence of the students
3. Perceptions of the program by the local biotechnology community

Each postbaccalaureate student was asked to complete a questionnaire during the final weeks of the course. A copy of the questionnaire is included in the Appendix. Many of the students wrote comments and suggestions that were reviewed by the Project Directors and by the course instructors. Whenever a clear consensus was evident, changes were recommended. In most cases conflicting comments and suggestions were made and no clear course of action was indicated. A high level of student satisfaction was also inferred from the fact that enrollment increased steadily and students continued to enroll for several successive semesters. A high level of acceptance by industry was demonstrated by the fact that increasing numbers of students were being reimbursed by their employers for all course fees.

The evaulation by the faculty was particularly gratifying. Prior to their experience with this program, most of the biology and biochemistry faculty assumed that working adults who enrolled in evening classes would be distracted by other responsibilities. The faculty anticipated that the students would be poorly prepared and would attend irregularly. Each course instructor was interviewed by the Project Director at the beginning and end of each course to see whether these initial presumptions had been borne out. In every case the faculty were surprised and pleased at the qualifications and diligence of the postbaccalaureate students. In most classes the highest grades went to regular full-time students, but the postbaccalaureate students did as well or better than the average full-time students. As stated earlier, the faculty voluntarily continued to schedule courses in the evening without being urged to do so by the Project Director.

The biotechnology faculty were supported in still another way that had nothing to do with the course offerings. Members of local biotechnology firms

were asked to predict the qualifications they will be seeking in entry level employees hired ten years in the future. The project Advisory Board and additional key individuals selected from the mailing list assisted the Project Directors in the task of identifying appropriate individuals to interview. In all, eight persons were contacted, but only three felt that they were able to address the subject of future personnel needs. Most of the new, rapidly growing companies were too busy with immediate problems to give much thought to the future.

The three individuals who were willing to predict future needs agreed on several points:

1. Biology and organic chemistry are essential disciplines that must come together as a unified whole to provide a type of training that does not now exist.
2. Training in statistics and in computer use will continue to be important. Current students are adequately prepared in these areas, and this preparation must continue in the future.
3. Students must have an opportunity to become comfortable using sophisticated laboratory instruments. They will always encounter some instruments that have become extremely user friendly and other instruments that are less well developed and much harder to use. A knowledge of electronics is not crucial.

Advanced Techniques of Chemical and Physical Analysis Learning Track

In contrast to the biotechnology learning track, this program was developed as a separate entity in response to a need that was perceived by the Project Directors but not necessarily by the chemistry faculty or the project Advisory Board. The Project Directors were convinced that there was a need for retraining opportunities for locally employed chemists and persuaded the chemistry faculty to offer a program on a trial basis. Possible courses of action were discussed by the Advisory Board and the chemistry faculty, and the following recommendations were made by a committee of analytical chemistry faculty:

1. It is not feasible to offer laboratory courses from the regular curriculum in the evening.
2. Special courses should be offered in which demonstrations are substituted for the regular laboratory work.

3. A two year sequence of courses should be given and should include a review of all branches of chemistry in addition to intensive work in analytical chemistry.
4. The program should be offered as a certificate program in the College of Extended Studies rather than in the regular University curriculum.

Members of the regular chemistry faculty agreed to teach the courses.

To publicize the Analytical Chemistry certificate program, funds from the grant were used to produce a brochure that was distributed to 800 members of the local section of the American Chemical Society, 1000 secondary school math and science teachers and an additional 1000 individuals and institutions from the College of Extended Studies mailing list for science course announcements. A display ad was also included in the Extended Studies catalog. As a result of these efforts, more than 40 individuals inquired about the program, and 15 of these took the required placement tests and enrolled. The course offerings for this program are shown below:

First Semester - Three five-week courses,
two 1 1/2 hour sessions per week
Analytical Chemistry I
Analytical Chemistry II
Physical Chemistry

Second Semester - Three five-week courses,
two 1 1/2 hour sessions per week
Inorganic Chemistry
Organic Chemistry
Biochemistry

Third Semester - One 15-week course,
two 1 1/2 hour sessions per week
Instrumental Methods of Analysis I

Fourth Semester - One 15-week course,
two 1 1/2 hour sessions per week
Instrumental Methods of Analysis II

Faculty and students were supported in a number of ways thoughout this two year program. Stipends were provided from the grant to compensate faculty

members for the time spent in preparing and organizing these new courses. Additional compensation was provided by the College of Extended Studies at the time each course was offered. Student assistants were provided by the grant to help the faculty with laboratory demonstrations. The enrollees were supported by providing them with parking permits and textbooks purchased with funds from the grant. Students paid their own course fees, but some were reimbursed by their employers. In addition, the Project Director was present briefly at most of the class meetings to provide career advising for those students who wished to change jobs.

The results of the Analytical Chemistry certificate program were evaluated by soliciting opinions from the faculty and the students. The faculty maintained their enthusiasm throughout the program and found that the performance of the enrollees tended to equal or exceed the performance of the average regular University student. The students demonstrated their satisfaction with the program by their diligence and faithful attendance during the entire two years of the program. Nine of the original 15 students completed all the required work and were awarded certificates. No one dropped out because of dissatisfaction or lack of interest, but some could not complete the program because they were transferred to jobs away from the local area.

The following case studies may give a better picture of the student's expectations and their achievements.

Case Study 1:

Tom has had several career changes since receiving his Master's degree in Chemistry in 1966. He has been employed as a high school and later a community college Chemistry instructor, as a clinical chemist and is currently the Director of the Nuclear Medicine Department of a major hospital in San Diego. Employment opportunities for the mid-career scientis in this field have been declining due to restrictions imposed by new medical legislation and a rapidly changing diagnostic technology. He predicts that his career advancement and employment stability depends on refreshing and updating his knowledge and technical skills in analytical chemistry, which he feels are now

obsolete. Tom has excellent administrative and computer skills and, technologically, is at the state-of-the-art in nuclear medicine. Because of these strengths and his outstanding communication skills, Tom is not only very employable but also very promotable. Tom participated in the two-year, non-credit Certificate Program in Modern Analytical Chemistry. He committed a substantial amount of time to the classes and homework required to complete the review modules in analytical chemistry, physical chemistry, inorganic chemistry, organic chemistry and biochemistry during the first year of the program. The second year, consisting of Wednesday evening and all day Saturday classes in Modern Instrumental Methods, covered lectures and laboratory work in such topics as:

Optical Emission Spectroscopy, X-ray Emission and Fluorescent Spectrometry

Separation Science including Gas, Liquid and Planar Chromatography

Mass Spectrometry

Nuclear Magnetic Resonance Spectroscopy

Organic Quantitative Analysis

Laser Spectroscopy in Chemical Analysis

Surface Methods of Analysis

Thermal Methods of Analysis

Radiochemical Methods of Analysis

Signal Modifying Integrated Circuits; Computer Interfacing

Tom completed the certificate program in 1986 with excellent grades. His presence in the group enhanced the retraining of other participants in the program since he took a leadership role in forming study groups for this intensive retraining sequence. Tom can use the participating faculty members (all are tenrured faculty with senior rank) for references

should the need arise for him to seek other employment or advance to a higher level at his present employment.

Case Study 2:

Jeff was employed as a chemist by a large industrial firm in San Diego which produces various products from marine kelp. Jeff enrolled in the Analytical Chemistry Certificate Program because his company was bought by a large national pharmaceutical firm and the interests of the company shifted to biotechnology. Jeff felt that he needed broader technical knowledge and updating on instrumentation and concepts developed since he earned the baccalaureate degree ten years ago.

The company did indeed terminate the employment of 42 scientifically trained individuals and Jeff was in the group dismissed. Jeff used the resources of the FIPSE project directors office to locate names of companies and his peers in the program as well as the participating faculty all served as a network to help Jeff locate a suitable job. He was hired as an analytical chemist by another industrial firm with a substantial increase in salary. He feels that the expertise gained through the program was a key factor in obtaining three firm offers and enabling him to be selective in choosing an excellent employment opportunity. Jeff finished the program although he was involved in a new and very demanding position because he felt that the skills he was learning gave him a safety net of marketable skills in the event of a future layoff or change in the economic situation for San Diego.

No attempt was made to offer the two year sequence of certificate courses on a continuous basis because the grant funds were not sufficient to permit

this. No efforts were made to publicize the program after the initial intensive publicity campaign because the faculty did not wish to enourage students to enter the program in the middle. From time to time, students asked about joining the program and were permitted to enroll for individual courses when they were properly qualified. At the present time there are no plans to offer the certificate program in the immediate future, but if the demand should arise the program could be repeated rather easily.

SUMMARY AND CONCLUSIONS

In almost all aspects the grant activity proceeded as originally planned. This is not surprising, because the program was created to fill a need that had become apparent to the Project Director as she advised students in the College of Sciences. There proved to be a sufficient number of postbaccalaureate scientists with interest in retraining to sustain this program in the San Diego area. At the time the program was conceived, the local job market for scientists was depressed and many individuals needed retraining to obtain and hold jobs. The job market improved greatly during the period covered by the grant, but the interest in retraining continued. This situation was actually advantageous since students enrolled because of their interest in the course subject matter rather than to make contacts that they hoped would lead to jobs. As a result of this limited experience, it appears that retraining programs can be successful in all kinds of job markets.

The importance of a well thought out publicity campaign was demonstrated in this project as well as in an earlier "Women in Science" project. The normal University catalog announcements were not adequate to publicize new programs and no funds for special publicity were available through normal University channels. By having grant funds it was possible to prepare and mail special brochures and place display ads in local newspapers. It was also possible to publicize the program in a timely fashion since off-campus graphic artists and printers could be used for quick turnaround services. In the opinion of the Project Directors, the special publicity campaigns were extremely important in contributing to the overall success of the program.

All courses that were offered under these programs were taught by regular full time members of the University faculty. It is believed that this contributed to the uniformly high level of satisfaction reported by the students. There were no poorly prepared courses or inexperienced teachers as

sometimes occurs when individuals from industry teach on an occasional basis. In addition, the faculty were able to hand out course outlines, notes and other useful materials that they normally distributed to their students in the regular University currriculum. Non-faculty instructors would not have time to prepare similar materials specifically for a course that they were teaching for the first time. The Project Directors are convinced that the success of the program was highly related to the quality of the teaching. The mature postbaccalaureate student seems to be less tolerant of poor teaching than the average collegiate undergraduate.

In summary, the following suggestions may be helpful to individuals who would like to carry out similar projects:

Plan your program to fill a demonstrated need. For example, develop courses that students have asked for but are not offered.

Recruit highly qualified and experienced teachers--preferably from the regular University faculty

Publicize the program by a carefully developed, timely campaign

Ask the students to evaluate each course and be prepared to make occasional modifications to be more responsive to the needs of the students.

# APPENDIX

Biochemistry Learning Track Courses

Course Questionnaire

Advanced Techniques of Clinical and Physical Analysis Learning Track Courses

BIOTECHNOLOGY LEARNING TRACK COURSES
(Scheduled in the Evening)

Courses Offered

| | '84 | | | | '85 | | | '86 | |
|---|---|---|---|---|---|---|---|---|---|
| | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring |
| "A" Courses* | | | | | | | | | | |
| Overview of Modern Organic Chemistry | X | | | | X | X | | | X | |
| Overview of Biochemistry | | | X | | | X | | | | |
| Overview of Algebra and Trigonometry | X | | | | | | | | | |
| Use of Programmable Calculator | X | | | | | | | | | |
| Overview of Calculus | | | X | | | | | | | |
| "B" Courses** | | | | | | | | | | |
| Fundamentals of Biochemistry, Part A | | | | | | | X | X | | |
| Fundamentals of Biochemistry, Part B | | | X | | | | | | | |
| Prokaryotic and Eukaryotic Molecular Biology | | | | | | | X | X | | X |
| Recombinant DNA | | | | | | X | | X | | |
| Radioisotope Techniques in Biology | | | | X | | | | X | | |

*Wintersession courses offered twice a week for 3 weeks as 2 1/2 hour sessions; all other sessions twice a week for 5 weeks as 1 1/2 hour sessions

**Number and duration of class sessions corresponded to regular University schedule

INFORMATION SHEET

Course_____ Date_____

The course you are attending is being offered in the evening as part of a program sponsored by the Fund for the Improvement of Postsecondary Education to provide educational opportunities for working professionals. To help us find out whether we are reaching the goals of this program, we would appreciate your answering a few questions. Your participation is entirely voluntary.

NAME_____ TELEPHONE_____

MAILING ADDRESS_____

STUDENT STATUS

Which of the following describes your status as a student?

☐ Regular undergraduate ☐ Regular graduate ☐ Extension or Open University

Major field? _____ Degree _____ Year granted _____

If you are an undergraduate student, you do not need to answer the rest of the questions.

CAREER STATUS (Postbaccalaureate students only)

Which of the following describes your career situation?

☐ Working in chosen career and taking courses in free time.

☐ Preparing for chosen career and working in non-career job.

☐ Unemployed and looking for a career position.

☐ Other (describe)_____.

What is your chosen career?_____

Who is your present employer?_____

COURSE EVALUATION

Did you enroll in this course to further your chosen career? ___Yes ___No
Does your employer reimburse you for the course fees? ___Yes ___No
Are you working toward a specific degree or certificate? ___Yes ___No
Did this course meet your expectations? ___Yes ___No
How could the course (or the whole program) be changed to better meet your needs?_____

_____

_____

How did you learn of this course? ☐ Catalog ☐ Brochure

☐ Other (specify) _____

ADVANCED TECHNIQUES OF CHEMICAL AND PHYSICAL
ANALYSIS LEARNING TRACK COURSES

"A" Courses* (to prepare students for certificate program)

- Overview of Algebra and Trigonometry
- Overview of Calculus
- Use of Programmable Calculator
- Overview of Modern Organic Chemistry
- Overview of Biochemistry

"A" Courses* (5 of the 6 were required for the certificate)

- Analytical Chemistry I
- Analytical Chemistry II
- Physical Chemistry
- Inorganic Chemistry
- Organic Chemistry
- Biochemistry

"C" Courses** (required for the certificate)

- Instrumental Analysis I
- Instrumental Analysis II

* Two 1 1/2 hour sessions per week for 5 weeks except for Wintersession courses which were two 2 1/2 hour sessions per week for 3 weeks

** Two 1 1/2 hour sessions per week for 15 weeks