A STUDY OF POST SECONDARY CHEMICAL TECHNICIAN EDUCATION PROGRAMS

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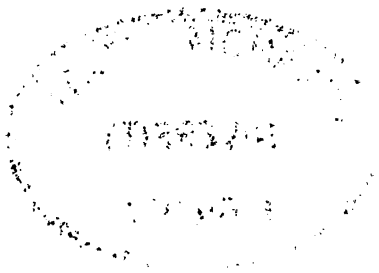

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Thesis Approved:

Thesis Adviser

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PREFACE

This study was concerned with analysis of current and projected future two-year associate degree chemical technician education programs in the United States and its territories. The primary objective was to determine what subject areas are currently being taught, what area of revisions is necessary to provide a relevant model program due to the emergence of related careers, and to determine the attitudes of science and chemistry department chairmen and/or instructors and their concepts toward the implementation of a model program. A questionnaire, school catalogs and bulletins were used in the analysis and collection of data.

The author wishes to express his appreciation to his thesis chairman, Dr. Cecil W. Dugger, for his guidance and assistance throughout this study. Appreciation is also expressed to the other committee members, Dr. Donald S. Phillips and Dr. Richard W. Tinnell, for their invaluable assistance in the preparation of the final manuscript.

A note of thanks is given to Dr. Kenneth Chapman, Assistant Head of Special Projects, Department of Educational Activities of the American Chemical Society. Thanks is also extended to Paula Keller for the excellence of the final copy and her valuable suggestions concerning form. In addition, appreciation is extended to the American Chemical Society and to the thirty-four schools that provided data for the study.

Finally, special gratitude is expressed to my wife, Rowanna, our son, Michael, and our daughters, Melissa, Suzanne, and Tchinina, for their understanding, encouragement, and many sacrifices.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The development of viable programs in the paraprofessional areas of chemistry, chemical technology, and related careers has received emphasis at the national level. The Department of Health, Education, and Welfare published a series of technology guides for use in planning and developing programs to train highly skilled technicians in various scientific and engineering disciplines, including chemical technology (1).

The concern over the type, dimension, and depth of chemical technician training at the associate degree level activated the American Chemical Society (2) to investigate and subsequently publish in 1967 a proprosed curriculum guide for a structured program of chemical technology (3). As a result, in 1972, the suggested curriculum was reduced from 68-76 semester hours to 61-68 semester hours. This reduction and revision was made to eliminate nonessential courses and to strengthen essential components providing a more realistic level of training for career opportunities and employment requirements.

Statement of the Problem

During the early 1960's, career training in chemical technology at the two-year associate degree level became an increasing concern. The emphasis on services and non-production activities in business and industry at that time made speicalized education and/or skills necessary to

fill many jobs. However, very few trained personnel were available. In an effort to promote adequate training, the Department of Health, Education, and Welfare and the American Chemical Society (1, 3) published dual guides in chemical technology. Since that time the emergence of related careers dealing with chemical systems has developed and suggestion guides are not available for administrators and chemical technology instructors to use in developing appropriate chemical technology programs dealing with the emergence of related careers.

Need for the Study

While there were efforts to update chemical technology programs during the 1960's, program revision is essential now to include the emergence of related careers in the field of chemical technician programs. The American Chemical Society revision guides of 1972 were designed primarily on a curriculum basic to chemical oriented systems. However, there are indications that the majority of schools offering various types of chemical technician programs are not using the American Chemical Society's revision guides of 1972. In order for students at the associate degree level to adequately meet the challenges and opportunities of a career in chemical technology, a model curriculum needs to be developed to provide the basic core for related career programs. At the present time data is not available to develop a timely model chemical technology curriculum.

Purpose of the Study

The purpose of the study is:

1. To determine what subject areas are currently being taught in selected chemical technician programs in the United States;
2. To determine if revisions should be made to provide a relevant model program to accommodate the emergence of related careers in chemical technology programs; and
3. To determine the attitudes of science and chemistry department chairmen and/or instructors in two-year associate degree level programs and their concept toward a relevant model program that would include the emergence of related careers.

Assumptions Basic to the Study

For the purpose of this study, the following assumptions were made:

1. That schools selected for the study were representative of other schools offering similar academic or paraprofessional programs in their respective geographical areas.
2. That school catalogs and bulletins provided accurate information about the current curriculum content of existing chemical technology programs.

Scope and Limitations of the Study

This study was limited to forty selected schools offering two-year chemical technician education at the associate degree level.

Definition of Terms

Technician. For the purpose of this study, a technician is defined as an intermediate between that of a professional chemist and that of a routine operator or laboratory worker. The technician must be skillful in the accumulation of data and their presentation, he must be able to recognize inconsistencies in significance of experimental results; he must have sufficient understanding of chemistry to appreciate the meaning of his results, but generally, data interpretation will be the responsibility of professional personnel (3).

Chemical Technology. A two-year program which prepares a student for immediate entry into a career as a chemical technician in industry, health, and related systems.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this study was (a) to determine what subject areas are currently being taught in chemical technician programs throughout the United States; (b) to determine if revisions should be made to provide a relevant model program to accommodate the emergence of related careers in chemical technology programs; and (c) to determine the attitudes of science and chemistry department chairmen and/or instructors in two-year associate degree level programs and their concept toward a relevant model program that would include the emergence of related careers.

In order to achieve the purpose of the study, a review of literature related to chemical technician education was made. It was found in the review of literature that the rapid and continuous expansion of vocational and technical education at the post-secondary level during the early 1960's resulted in career training in chemistry at the two-year associate degree level. This became an increasing concern to the American Chemical Society and the Department of Health, Education, and Welfare (1, 2). The emphasis on services and non-production activities in business and industry made special education and/or skills necessary to fill many job opportunities. However, there were very few trained personnel available. One of the first efforts of the American Chemical Society to promote adequate training was the formation in 1964 of an ad hoc

group, the Technician Curriculum Committee, commissioned to study technician training under the chairmanship of Dr. William Young of the University of California at Los Angeles, California. The results of this study culminated in the formation in 1966 of another ad hoc committee group under the chairmanship of Dr. Carleton Roberts, then of Dow Chemical in Midland, Michigan. The new committee group was given the task of developing course outline topics from the proposed guidelines of the Young committee (3).

In 1967, after a review of the rate of enrollments in two-year colleges, the American Chemical society decided to become more active in the role of chemical education by creating a new post in the Society. One of the main goals was to assist the American Chemical Society in the development of a chemical technology curriculum for two-year colleges. This program would provide the proper training of individuals to fill the gap between labor and the professional force. The preparation and publication of CHEM-TEC training series, Modern Chemical Technology resulted from this study (4).

The Division of Chemical Education of the American Chemical Society has been active since 1960 in its efforts to improve chemical technician education. The Committee on Chemistry in Two-Year Colleges (5, 6) periodically publishes bulletins which contain papers and discussion summaries from various symposia and conferences dealing with the chemistry programs of the two-year college. A typical illustration is Bulletin Number Two (5) published in late 1971. It contains articles on curriculum and program course content, new courses, chemical technology, special topics on instrumentation, and new instructional methods.

In the latter part of 1969, two additional organizations began an investigation into their respective areas of interest. The American Society for Engineering Education initiated a study of engineering technology to ascertain the subject areas covered in any one technology and the extent to which the subject matter was used. In the final report of the American Society for Engineering Education (7), a description of a model program was compiled from a survey and comparison of 120 two-year associate degree engineering technology curriculums.

The American Institute of Chemical Engineers delegated to their newly established Committee for Technicians' and Technologists' Affairs the task of locating and compiling a list of schools that offered either a two-year associate degree of four-year bachelor degree in chemical engineering technology (8). Later the study was extended to include a program review in both two-year and four-year chemical engineering technology programs.

The stated purpose and the desirable characteristics of a chemical technician education program were adopted as follows (3, p. 24):

> The basic program for chemical technicians is designed to provide a student the knowledge and skills necessary for him/her to be immediately useful as a chemical technician, upon successfully completing a two-year study resulting in an associate degree.

Since one of the major efforts of chemical technician education is to teach an individual to make accurate and reliable measurements with paraprofessional understanding, in a two-year program the laboratory training phase is more important than in a program leading toward a baccalaureate degree.

In attempting to locate new schools offering chemical technology and review the old listings of schools for discontinued programs, these

sources were reviewed (9, 10, 11). In Technician Education Yearbook 1974-75 (9), there were 146 different schools claiming to offer chemical technology. The College Blue Book 1972 indicates there were 159 different schools claiming to offer a chemical technology program or similar area of study. The Blue Book of Occupational Education 1973 cites 121 different schools claiming to offer a chemical technology program or related study. Therefore, an apparent misunderstanding of the meaning of chemical technology exists, since the previous listings consulted were inconsistent when attempting to match the program names with actual program content. This attempt to locate schools offering chemical technology or related programs resulted in a request to the Department of Educational Activities of the American Chemical Society (12). They responded with several listings that contained the names and location of one hundred colleges, universities, technical institutes, and technical education centers claiming to offer a chemical technology type or similar program.

CHAPTER III

METHODOLOGY

The purpose of this study was to collect and analyze data from (40) schools offering two-year chemical technician programs throughout the United States. The purpose of this chapter is to describe the design, population, and the instrument. This study was conducted by first determining a population of schools offering two-year post-secondary chemical technician education programs, selecting a sample which would represent the population, and designing and mailing out a questionnaire to technology instructors and/or chairmen in the randomly selected schools. (See Appendix A.)

Population

The population comprised of one hundred schools offering two-year chemical technician education or related programs. The names and location of the one hundred schools were obtained from a list furnished by the American Chemical Society. It was felt that a 40 percent sample would be adequate to produce a representative sample of the population. The 40 schools utilized in this study were selected by a computer generated list of randomly assigned numbers between 1 and 100 discarding any repeated numbers. A number 1 and 100 was then assigned each school on the list of schools offering chemical technician education or a similar type of related program obtained from the American Chemical

Society. The list of names and location of the one hundred (100) schools is included in Appendix A. The names of the forty (40) randomly selected schools utilized in this study are listed in Table I.

Instrument

The instrument developed and used in this study utilized questions pertaining to two-year associate degree level programs in chemical technician education and/or related programs. This questionnaire was developed with the aide of Oklahoma State University teacher-educators and graduate students. A copy of the questionnaire and the letter of transmittal which accompanied it are included in Appendix B.

The letter of transmittal in addition to other information, asked that school representatives send a copy of their schools' latest catalog and/or bulletin.

The final step was a comparative summation of the selected variables encountered in analyzing the data received from the responses to the questionnaire and the school catalogs and bulletin.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Approximately one hundred technical institutes, junior colleges, community colleges, technical education centers, four-year colleges, and universities in the United States offer a chemical technology type program. Forty (40) of these schools were randomly selected for the study. The names of the forty (40) randomly selected schools and their programs are given in Table I. The curriculum units of study are also included in the same table.

However, in order to present the schools and their programs in a logical and systematic compilation, the following program differentiation was used in Table I. In the compilation of curricular information, 34 schools responded to the questionnaire and request for school catalogs and bulletins. Also in one case, one school responded with curricular information on its chemical technician education program but no specified data was given on the availability of courses offered in the program. The remaining five schools did not respond to either the questionnaire or request for school catalogs and bulletins in time to include the information in the study.

Of the 35 schools responding with curricular information, there were 13 junior colleges, 13 community colleges, 1 technical education center, 2 four-year colleges, 3 universities, and 3 technical institutes.

TABLE I

ANALYSIS OF CHEMICAL TECHNOLOGY PROGRAMS IN FORTY RANDOMLY SELECTED SCHOOLS COMPILED IN SEMESTER HOURS

Curriculum Unit of Study	Agriculture & Technical College at Alfred	Allegany Community College	Arapahoe Junior College	Barstow College	Bessemer State Technical Institute
Technical Specialty	Chemical Technology	Chemical Technology	Chemical Technology	Mathematics & Chemistry	Chemical Technology
Chemistry	25	26	-	-	20
Technical Options	12	-	-	-	8
Support Technical Subjects	-	3	-	-	23
Physics	6	8	-	-	8
Mathematics	10	8	-	-	30
Communications	5	12	-	-	13
Humanities & Social Studies	8	6	-	-	-
Other Courses	6	8	-	-	-
Total Semester Hours	72	71	-	60	102
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	no school response	1974-75 catalog or bulletin	1972-73 catalog or bulletin

TABLE I (CONTINUED)

Curriculum Unit of Study	Brigham Young University	Bronx Community College	Brunswick Junior College	Camden County College	Chaffey College
Technical Specialty	Chemical Technician	Chemical Technology	Analytical Technology	Laboratory Technology	Chemical Technology
Chemistry	13	24	16	16	-
Technical Options	8	9	16	15	-
Support Technical Subjects	8-9	-	-	7	-
Physics	8	8	7	8	-
Mathematics	9	6	10	6	-
Communications	6	6	7	6	-
Humanities & Social Studies	13	7-9	10	3	0
Other Courses	3	5-6	4	11	-
Total Semester Hours	68-69	68-71	70	72	-
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	no school response

TABLE I (CONTINUED)

Curriculum Unit of Study	Charles Stewart Mott Community College	Chattanooga State Community Technical College	DeKalb Community College	Ferris State College	Florissant Valley Community College
Technical Specialty	Chem. Lab. Technician	Chemical Technology	Chemical Technology	Ind. Chem. Technology	Chem. Engr. Tech. ACS-CHEMTEC
Chemistry	24	29	36	23	30
Technical Options	-	9	-	14	-
Support Technical Subjects	-	5	3	-	4
Physics	8	6	8	4	4
Mathematics	10	10	7	3	-
Communications	6	6	7	3	7
Humanities & Social Studies	4	-	6	12	9
Other Courses	10	6	7	8	13
Total Semester Hours	62	71	74	67	67
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin

TABLE I (CONTINUED)

Curriculum Unit of Study	Greenville Technical Education Center	Kellog Community College	Loop College, City College of Chicago	Los Angeles Trade Technical College	Mercer County Community College
Technical Specialty	Chem. Tech. ACS-CHEMTEC	Chemical Technology	Chem. Tech. ACS-CHEMTEC	Chem. Tech. ACS-CHEMTEC	Laboratory Technology
Chemistry	36	16	32	16	-
Technical Options	-	-	-	15	-
Support Technical Subjects	11	10	-	1	-
Physics	-	5	-	8	-
Mathematics	10	12	6-10	6	-
Communications	5	9	6	6	-
Humanities & Social Studies	6	3	6	8	-
Other Courses	-	8	9-10	2	-
Total Semester Hours	68	63	60-63	62	-
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1970-71 catalog or bulletin	no school response

TABLE I (CONTINUED)

Curriculum Unit of Study	New York City Community College	Onondaga Community College	Orange Coast College		Owens State Technical College	Phillips County Technical College
Technical Specialty	Chem. Tech. ACS-CHEMTEC	Chemical Technology	Chemical Technician		Chem. Engr. Technology	Chemical Technology
Chemistry	20	34	24	24	19	16
Technical Options	14	-	8	-	-	-
Support Technical Subjects	-	6	-	3	11	6
Physics	8	8	8	8	5	10
Mathematics	8	8	4	4	10	13
Communications	6	6	3	3	7	6
Humanities & Social Studies	6	3	10	10	8	-
Other Courses	3	3	3	8	1	12-13
Total Semester Hours	65	68	60	60	60	63-64
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin		1972-73 catalog or bulletin	1974-75 catalog or bulletin

TABLE I (CONTINUED)

Curriculum Unit of Study	Pima College	Raymond Walters General & Technical College, University of Cincinnati	Rhode Island Junior College	San Jacinto College	Seattle Central Community College
Technical Specialty	Chemical Technology	Science Technology	Chem. Tech. ACS-CHEMTEC	Chemical Technology	Chem. Tech. ACS-CHEMTEC
Chemistry	-	18	36	12	-
Technical Options	-	10	-	16	-
Support Technical Subjects	-	5	-	11	-
Physics	-	-	8	-	-
Mathematics	-	6	6	10	-
Communications	-	8	3	9	-
Humanities & Social Studies	-	18	-	3	-
Other Courses	-	-	9	3	-
Total Semester Hours	-	65	62	64	-
Remarks	no school response	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	no school response

TABLE I (CONTINUED)

Curriculum Unit of Study	Shoreline Community College	Skagit Valley College	State Technical Institute at Memphis	Staten Island Community College, CUNY	Sullivan County Community College
Technical Specialty	Chemical Technology	Science Technology	Chemical Technology	Science Lab. Technology	Science Lab. Technology
Chemistry	6	17	20	16	20
Technical Options	12	27-32	19	-	4
Support Technical Subjects	8	9	3	3	3
Physics	10	0	6	8	8
Mathematics	12	6-7	10	7	6-8
Communications	6	2	8	14	6
Humanities & Social Studies	3	-	8	9	9
Other Courses	2	2	-	7	6-8
Total Semester Hours	59	63-69	74	64	62-66
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin

TABLE I (CONTINUED)

Curriculum Unit of Study	Texas State Technical Institute	Thomas Moore College	Victor Valley College	West Hills College	William Rainey Harper College
Technical Specialty	Chem. Tech. ACS-CHEMTEC	Chemical Technology	Science-Math Major Certificate Prog.	Physical Science Lab. Technology	Chemical Technology
Chemistry	23	23	23	23	14
Technical Options	21	-	-	6	18
Support Technical Subjects	-	8	-	4	-
Physics	6	8	4	8	8
Mathematics	6	4	0	6	6
Communications	4	6	9	6	6
Humanities & Social Studies	-	9	9	6	9
Other Courses	12	6	15	4.5	4
Total Semester Hours	72	64	60	63.5	65
Remarks	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1974-75 catalog or bulletin	1970-71 catalog or bulletin	1974-75 catalog or bulletin

The remaining 5 schools that did not respond with curricular information included 3 junior colleges and 2 community colleges.

There are eight or more different program types in which a student can pursue chemical technology study, such as process and quality control technician, chemical engineering technician, industrial chemistry technician, material science technician, electronics and instrumentation technician, radiation science technician, biological science technician, environmental science technician, analytical system technician, and others such as pulp and paper technician and pharmaceutical technician. The different program types available in each of the 40 randomly selected schools are given in Table II.

In summary, the data recorded in Table II was as follows. Of the 40 schools listed, 35 schools (88 percent) responded with catalogs and/or bulletins. It was found that none of the responding schools gave the students an opportunity to specialize as chemical engineering technicians, material science technicians, electronics and instrumentation technicians, environmental technicians, pulp and paper technicians, or pharmaceutical technicians. Four schools (10 percent) gave students the opportunity to specialize as biological science technicians; 11 schools (28 percent) gave the students the opportunity to specialize as process and quality control technicians; 18 schools (45 percent) gave the students the opportunity to specialize as industrial chemistry technicians; and 24 schools (60 percent) gave the students the opportunity to specialize as analytical systems technicians. Five schools (13 percent) did not respond with catalogs and/or bulletins which contained information on their technical specialty areas; 13 schools (33

TABLE II

THE FORTY RANDOMLY SELECTED SCHOOLS' TECHNICAL SPECIALTY AND PROGRAM TYPES

Name of School	Technical Specialty	Process & Quality Control Technician	Chemical Engineering Technician	Industrial Chemistry Technician	Material Sciences Technician	Radiation Sciences Technician	Biological Sciences Technician	Electronics & Instrumentation Technician	Environmental Sciences Technician	Analytical Systems Technician	Pulp & Paper Technician	Pharmaceutical Technician
Agriculture & Technical College at Alfred	Chemical Technology			x						x		
Allegany Community College	Chemical Technology			x						x		
Arapaho Junior College	Chemical Technology											
Barstow College	Mathematics & Chemistry			x								
Bessemer State Technical Institute	Chemical Technology	x								x		
Brigham Young University	Chemical Technician				x							
Bronx Community College	Chemical Technology				x				x			

TABLE II (CONTINUED)

Name of School	Technical Specialty	Process & Quality Control Technician	Chemical Engineering Technician	Industrial Chemistry Technician	Material Sciences Technician	Radiation Sciences Technician	Biological Sciences Technician	Electronics & Instrumentation Technician	Environmental Sciences Technician	Analytical Systems Technician	Pulp & Paper Technician	Pharmaceutical Technician
Brunswick Junior College	Analytical Technology	x								x		
Camden County College	Laboratory Technology						x					
Chaffey College	Chemical Technology											
Charles Stewart Mott Community College	Chemical Lab. Technician			x						x		
Chattanooga State Technical Community College	Chemical Technology			x						x		
DeKalb Community College	Chemical Technology									x		
Ferris State College	Industrial Technology	x								x		
Florissant Valley Community College	Chem. Engr. Tech. ACS-CHEMTEC			x								

TABLE II (CONTINUED)

Name of School	Technical Specialty	Process & Quality Control Technician	Chemical Engineering Technician	Industrial Chemistry Technician	Material Sciences Technician	Radiation Sciences Technician	Biological Sciences Technician	Electronics & Instrumentation Technician	Environmental Sciences Technician	Analytical Systems Technician	Pulp & Paper Technician	Pharmaceutical Technician
Greenville Technical Education Center	Chemical Tech. ACS-CHEMTEC	x										
Kellog Community College	Chemical Technology	x		x								
Loop College, City College of Chicago	Chemical Tech. ACS-CHEMTEC			x						x		
Los Angeles Trade Technical College	Chemical Tech. ACS-CHEMTEC	x								x		
Mercer County Community College	Laboratory Technology											
New York City Community College	Chemical Tech. ACS-CHEMTEC									x		
Onondaga Community College	Chemical Technology									x		
Orange Coast College	Chemical Technician						x			x		

TABLE II (CONTINUED)

Name of School	Technical Specialty	Process & Quality Control Technician	Chemical Engineering Technician	Industrial Chemistry Technician	Material Sciences Technician	Radiation Sciences Technician	Biological Sciences Technician	Electronics & Instrumentation Technician	Environmental Sciences Technician	Analytical Systems Technician	Pulp and Paper Technician	Pharmaceutical Technician
Owens State Technical College	Chemical Engr. Technology			x								
Phillips County Community College	Chemical Technology			x								
Pima College	Chemical Technology											
Raymond Walters General & Technical College University of Cincinnati	Science Technology						x					
Rhode Island Junior College	Chemical Tech. ACS-CHEMTEC	x								x		
San Jacinto College	Chemical Technology	x								x		
Seattle Central Community College	Chemical Tech. ACS-CHEMTEC											

TABLE II (CONTINUED)

Name of School	Technical Specialty	Process & Quality Control Technician	Chemical Engineering Technician	Industrial Chemistry Technician	Material Sciences Technician	Radiation Sciences Technician	Biological Sciences Technician	Electronics & Instrumentation Technician	Environmental Sciences Technician	Analytical Systems Technician	Pulp & Paper Technician	Pharmaceutical Technician
Shoreline Community College	Chemical Technology	x								x		
Skagit Valley College	Science Technology						x			x		
State Technical Institute at Memphis	Chemical Technology			x								
Staten Island Community College, CUNY	Science Lab. Technology	x								x		
Sullivan County Community College	Science Lab. Technology			x								
Texas State Technical Institute	Chemical Tech. ACS-CHEMTEC	x								x		
Thomas Moore College	Chemical Technology			x								
Victor Valley College	Science-Math Maj. Cert. Program			x						x		

TABLE II (CONTINUED)

Name of School	Technical Specialty	Process & Quality Control Technician	Chemical Engineering Technician	Industrial Chemistry Technician	Material Sciences Technician	Radiation Sciences Technician	Biological Sciences Technician	Electronics & Instrumentation Technician	Environmental Sciences Technician	Analytical Systems Technician	Pulp & Paper Technician	Pharmaceutical Technician
West Hills College	Physical Science Lab. Technology			x						x		
William Rainey Harper College	Chemical Technology			x						x		

percent) provided students with one specialty area and 22 schools provided students with two specialty areas.

Table III presents curricular information on the 35 chemical technician education programs. This table contains information on courses such as chemistry, technical option, auxillary or support technical subjects, physics, mathematics, communications, social studies/humanities, and other courses. The information in Table III, compiled in semester hours, shows the median to be 65, the mode to be 60, and the range to be 59 - 102 semester hours in the 35 programs studied.

Of the 35 schools which responded with comments and remarks on the returned questionnaire, 20 schools (58 percent) were favorable toward the implementation of some type of a two-year associate degree model program, being paraprofessional in nature and which would include the emergence of similar or related careers. Seven schools (21 percent) indicated that due to the wide variation of curriculums in chemical technician education, they felt that one inflexible program could not be established and still meet their school's program objectives. Yet, they indicated that they would be very receptive toward the implementation of a model program. Six schools (17 percent) indicated that there was not any need for a model program or was any revision necessary in existing programs since their current curriculums could handle the emergence of related careers. Two schools (5 percent) did not respond with remarks or comments. Some selected comments and remarks are listed below.

- A timely model program is long past due.
- Program revisions in this area are certainly needed in order to keep abreast of the technology training.

TABLE III

THE STUDY AREAS OF 35 CHEMICAL TECHNOLOGY PROGRAMS COMPILED IN SEMESTER HOURS

Study Areas	Semester Hours			
	Mean	Median	Mode	Range
Chemistry Core				
Chemistry	22.0	23.0	16	6- 36
Technical Option	7.5	8.0	0	0- 27
Support Technical Subjects	4.4	3.0	0	0- 23
Physics	6.2	8.0	8	0- 10
Mathematics	7.9	7.0	6	0- 30
Communications	6.5	6.0	6	2- 14
Social Studies/ Humanities	6.3	6.0	0, 6, 9	0- 18
Other	5.7	6.0	3	0- 15
Total (2-Year Associate Degree Program	66.6	65.0	60	59-102

- Need to develop a model program which includes the emergence of health careers.
- No changes needed.
- One inflexible program cannot be established and still meet the school's objectives.
- Fine, we would be receptive toward revisions in existing course content.
- No changes needed, since our objectives are geared to the training of industrial chemical technicians.
- A change definitely needed since our program was established many years ago.
- No revisions necessary since existing programs can easily handle the emergence of related and health careers.
- We would be favorable toward the implementation of a model program.
- Certainly, a model program is a must today.
- A paraprofessional model program is much needed.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Career training in chemical technology at the two-year associate degree level became an increasing concern among science educators during the 1960's. The emphasis at that time was on services and non-production activities in business and industry. This made specialized education and/or skills necessary to fill many career opportunities. Yet, there were very few trained personnel available. One of the first efforts to promote adequate training was the publication of dual guides in chemical technology by the Department of Health, Education and Welfare and the American Chemical Society. Since that time there has been an emergence of related careers dealing with chemical systems.

While there were numerous past efforts to update chemical technology programs during the 1960's, it appeared that a re-evaluation of current chemical technology programs was needed to accomodate training in these newly defined related areas. In order for students at the two-year associate degree level to adequately meet the challenges and opportunities of a career in chemical technology, a model curriculum needed to be developed to provide the basic core for related careers.

Summary

The purposes of this study were (a) to determine what subject areas were currently being taught in selected chemical technician education programs in the United States; (b) to determine if revisions should be made to provide a relevant model program to accommodate the emergence of related careers in chemical technology programs; and (c) to determine the attitudes of science and chemistry department chairmen and/or instructors in two-year associate degree level programs and their concept toward a model program that would include the emergence of related careers. The next step described was the design for the study, including the development of the instrument, selection of the population, and method of data collection. The next step was the selection of the schools which was made by consulting several sources (10, 11, 12, 13, 14) to locate new schools offering the chemical technology program and reviewing old listings for discontinued programs. Finally, 40 schools were randomly selected from a list of 100 schools which were assumed to offer various types of chemical technician education programs. The names and location of the 100 schools (see Appendix A) were obtained from the American Chemical Society. Thirty-five schools responded by returning a questionnaire and school catalogs or bulletins. Of the 35 schools responding with curricular information, 13 were junior colleges, 13 were community colleges, 1 was a technical education center, 2 were four-year colleges, 3 were universities, and 3 were technical institutes.

The questionnaire (See Appendix B) which was developed for this study was administered to gather basic information pertaining to the objectives of the three stated purposes of the study. The information on the various chemical technology programs obtained from the 35 school

catalogs or bulletins provided beneficial program information (See Table II). The recipients of the questionnaires were encouraged to make open-ended remarks and comments on their school's existing program. They were also asked to comment on a model program which would include training for emerging related careers. The data collected from their remarks and comments were as follows. Twenty respondents were favorable toward the implementation of some type of a two-year associate degree program, paraprofessional in nature and including training for emerging related careers. Incidentally, the majority of the twenty respondents suggested that some type of a comprehensive study or program evaluation was needed to identify courses that could be eliminated and to propose guidelines to strengthen existing curriculum to reconcile the level of training and employment requirements. Seven indicated that due to the wide variation of curriculums in chemical technician education, they felt that one inflexible program could not be established and still meet their school's program objectives. Yet, they indicated that they would be very receptive toward the implementation of a model program that met their needs. Six indicated that there was not any need for a model program and that revisions were unnecessary in existing programs since current curriculums could handle the emergence of related careers. Two did not respond with remarks or comments about current or future programs and revisions.

Curricular data used in the study came from 34 schools. One of those schools offered two programs. However, in one school, a program was specified but no course content information was available. The remaining five schools did not respond to either the questionnaire or request for school catalogs or bulletins in time to be included in the study.

All the curricular areas studied were based upon the semester hour of credit (one credit hour per 50 minute lecture). Where the school program was in quarters, the credits were adjusted to semester hours.

The 35 programs in the 34 schools reflected the following information based upon credit hour averages: chemistry, 22 credit hours; technical option, 7.5 credit hours; support technical subjects, 4.4 credit hours; physics, 6.2 credit hours; mathematics, 7.9 credit hours; communications, 6.5 credit hours; social studies and humanities, 6.3 credit hours; and other courses, 5.7 credit hours. The total average credit hours of the 35 programs studied was 66.5 semester hours.

Findings, Conclusions, and Recommendations

The basic purpose of this study was to first determine what subject areas were currently being taught in chemical technician programs in the United States. It was found that a majority of the programs existing today were based on chemical technology curriculum guides published in 1964 and 1967 respectively by the United States Department of Health, Education, and Welfare and the American Chemical Society. The analysis of the questionnaires and letter requests indicated that some schools have terminated or suspended their chemical technology programs. Declining enrollment is the probable cause of this decrease. Vocational counselors need pertinent, current information to give high school students so that they can make well-informed career decisions pertaining to the chemical occupation system. Perhaps when students realize the potential available in the field, increased enrollments will reflect the counseling effort. The writer is firmly convinced that post secondary schools must become active at the high school level in acquainting

science teachers and counselors with the merits of the chemical and related professions.

The study also reveals that some schools have instituted the chemical technology curriculum as a new addition to their programs. These new chemical technician level programs are generally oriented toward analytical and related systems study with strong laboratory emphasis. In spite of the termination of some programs, these new chemical technology offerings resulted in a net increase in the total number programs. The total of these programs currently operating in the United States is approximately one hundred.

It is concluded, that inadequacies exist today in chemical technology programs since the majority of the schools studied are using curriculum guides that were developed during the 1960's. It is therefore recommended that program revisions are essential in order to keep abreast of the current level of training and employment requirements.

The second basic purpose of the study was to determine if revisions should be made to provide a relevant model program to accommodate the emergence of related careers in chemical technology programs. The findings in the review of literature reflected that technological human resource requirements of chemical industries have been steadily on the increase since the early fifties, especially in mathematical sciences and the computer oriented areas. Yet, the need for trained technician personnel, such as engineering technicians, chemical technicians, and laboratory assistants, has not decreased. Also the review of literature revealed that many companies have discovered that the two-year college-trained technician can fill the career position between the craftsman or operator and the four-year college graduate. The

review of literature and responses to the questionnaire revealed that related paraprofessional shortages cannot be attributed to any one specific cause but rather to a multitude of factors. A partial solution to the problem is revision and expansion of existing programs and the addition of new programs where demand is sufficiently high.

The third basic purpose of this study was to determine the attitudes of science and chemistry department chairmen and/or instructors in two-year associate degree level programs and their concept toward a model program that would include related careers. Recommendations of the respondents with regard to a model program were that the institution should have a well-equipped laboratory. In addition to a good supply of chemicals and materials, instrumentation must be reasonably up-to-date and appropriate for many types of laboratory activities. The absolute minimum costly instrumentation includes infra-red spectrophotometers, gas chromatographs, atomic absorption spectrophotometers, and other spectrometers such as nuclear magnetic resonance spectrophotometers and mass spectrophotometers. The respondents further recommended that at least two, and preferably more, instructors be substantially involved in a model program.

The concensus of the respondents was that the single most important recommendation for a successful model program is that the faculty must be fully aware and sympathetic to the fact that such a program is unique and not an abbreviated chemistry program. They further indicated that each faculty member should recognize the program is fully legitimate, different from a four-year chemistry program rather than a "haven for also-rans." Unless the faculty members are able to project and create a "high status" image which happens to fully justified when one sees the

value of well-trained technicians to their employers, a successful model program cannot be established.

The findings were as follows. Twenty respondents (58 percent) were favorable toward the implementation of some type of a two-year associate degree program, paraprofessional in nature and including training for related careers. The findings incidentally reflected that the majority of the 58 percent suggested that some type of a study or program evaluation was needed to help eliminate some courses and strengthen others to provide the proper level of training for employment requirements. Seven respondents (21 percent) indicated that due to the wide variation of curriculums in chemical technician education, they felt that one inflexible program could not be established and still meet their school's program objectives. They indicated that they would be very receptive toward the implementation of a model program. Six repondents (17 percent) indicated that there was not any need for a model program and revisions were unnecessary in existing programs since current curriculums could handle the emergence of similar or related careers. Two respondents (5 percent) did not respond with remarks or comments about current or future programs and revisions.

The respondents stated that a curriculum directly based upon one of the three basic areas (biology, chemistry, and physics) does provide important components in the related chemical programs. Also, they stated, that in the broad sense, related and health career programs are involved with chemical systems and chemistry is an important component in health career and related career programs. According to their responses, chemistry should be of a practical nature which is

also complementary to the practical nature of other courses in that curriculum. Their responses indicate that chemistry courses, in a model chemical technology program, would be more satisfying to health and related career students than theory-oriented courses. Further, a model chemical technology chemistry course would involve appropriate analytical techniques at a very early point in the program. They further suggested that a model chemical technology program could provide a cluster core for some health and related career programs.

Other Recommendations

1. It is recommended that a viable chemical technician education curriculum be developed.
2. It is recommended that schools give serious attention to the further development of their chemical technology programs which meet the emerging needs of the health and other related career programs.
3. It is recommended that efforts in the different technical divisions of schools be commonly coordinated in the planning and development of emerging programs dealing with chemical oriented systems.
4. It is recommended that more schools offering chemical technology programs adopt the American Chemical Society's CHEM-TEC curriculum guide.

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APPENDIX A

LIST OF SCHOOLS

Contained in this section is a list of one hundred (100) various types of schools offering a two-year associate degree in chemical technology and related programs. The writer wishes to thank the American Chemical Society for their assistance and for the following list. The numbers at the left of each school correspond to the computerized print-out list utilized to make the random selection.

1. Agriculture & Technical College
   Alfred, New York

2. Agriculture & Technical College
   Canton, New York

3. Agriculture & Technical College
   Cobbleskill, New York

4. Allegany Community College
   Cumberland, Maryland

5. Alpena Community College
   Alpena, Michigan

6. Amarillo College
   Amarillo, Texas

7. Anchorage Community College
   Anchorage, Alaska

8. Arapahoe Junior College
   Littleton, Colorado

9. Arizona Western College
   Yuma, Arizona

10. Asheville-Buncombe Technical Institute
    Asherville, North Carolina

11. Auburn Community College
    Auburn, New York

12. Barstow College
    Barstow, California

13. Bergen Community College
    Paramus, New Jersey

14. Bessemer State Technical Institute
    Bessemer, Alabama

15. Brigham Young University
Provo, Utah

16. Bronx Community College, CUNY
Bronx, New York

17. Brunswick Junior College
Brunswick, Georgia

18. Burlington County College
Pemberton, New Jersey

19. Camden County College
Blackwood, New Jersey

20. Catonsville Community College
Catonsville, Maryland

21. Central Piedmont Community College
Charlotte, North Carolina

22. Chaffey College
Alta Loma, California

23. Charles Stewart Mott Community College
Flint, Michigan

24. Cattanooga State Technical College
Chattanooga, Tennessee

25. City College of San Francisco
San Franciso, California

26. College of Lake County
Grayslake, Illinois

27. Community College of Philadelphia
Philadelphia, Pennsylvania

28. Community and Technical College University of Akron
Akron, Ohio

29. Conners State College
Warner, Oklahoma

30. Copiah-Lincoln Junior College
Wesson, Mississippi

31. County College of Morris
Randolph, New Jersey

32. Delaware Technical & Community College
Georgetown Branch, Georgetown, Delaware

33. DeKalb Community College
Clarkston, Georgia

34. Eastern Oklahoma State College
Wilberton, Oklahoma

35. Ferris State College
Big Rapids, Michigan

36. Florissant Valley Community College
St. Louis, Missouri

37. Fox Valley Technical Institute
Appleton, Wisconsin

38. Franklin Institute of Boston
Boston, Massachusetts

39. Fullerton Junior College
Fullerton, California

40. Gloucester County College
Sewell, New Jersey

41. Greenville Technical Education Center
Greenville, South Carolina

42. Holyoke Community College
Holyoke, Massachusetts

43. Jefferson County Technical Institute
Steubenville, Ohio

44. John Tyler Community College
Chester, Virginia

45. Kellogg Community College
Battle Creek, Michigan

46. Lawrence Institute of Technology
Southfield, Michigan

47. Lehigh County Community College
Schnecksville, Pennsylvania

48. Loop College, City College of Chicago
Chicago, Illinois

49. Lorain County Community College
Elyria, Ohio

50. Long Beach City College
Long Beach, California

51. Los Angeles Trade Technical College
Los Angeles, California

52. Lowell Technological Institute
Lowell, Massachusetts

53. Mary Holmes College
West Point, Mississippi

54. Mercer County Community College
Trenton, New Jersey

55. Merritt College
Oakland, California

56. Mesa Community College
Mesa, Arizona

57. Milwaukee Area Technical College
Milwaukee, Wisconsin

58. Morris Harvey College
Charleston, West Virginia

59. Muscatine Community College
Muscatine, Iowa

60. Muskegon Community College
Muskegon, Michigan

61. New York Community College
Brooklyn, New York

62. Niagara County Community College
Niagara Falls, New York

63. Northwestern State University
Natchitoches, Louisiana

64. Olive-Harvey College, City College of Chicago
Chicago, Illinois

65. Onondaga Community College
Syracuse, New York

66. Orange Coast College
Costa Mesa, California

67. Owens State Technical College
Perrysburg, Ohio

68. Phillips County Community College
Helena, Arkansas

69. Phoenix College
Phoenix, Arizona

70. Pima College
Tucson, Arizona

71. Polk Community College
Winterhaven, Florida

72. Purdue University, Calumet Campus
Hammond, Indiana

73. Purdue University, Indianapolis Campus
Indianapolis, Indiana

74. Raymond Walter General & Technical College
University of Cincinnati, Cincinnati, Ohio

75. Rhode Island Junior College
Providence, Rhode Island

76. Rockland Community College
Suffern, New York

77. Salem County Technical Institute
Penns Groves, New Jersey

78. San Bernardino Valley College
San Bernardino, California

79. San Jacinto College
Pasadena, Texas

80. Seattle Central Community College
Seattle, Washington

81. Shoreline Community College
Seattle, Washington

82. Skagit Valley College
Mt. Vernon, Washington

83. State Technical Institute at Memphis
Memphis, Tennessee

84. Staten Island Community College, CUNY
New York, New York

85. Sullivan County Community College
Loch Sheldrake, New York

86. Technical Institute of Alamance
Burlington, North Carolina

87. Technical Institute of San Juan
Hato Rey, Puerto Rico

88. Texas State Technical Institute
James Connally Campus, Waco, Texas

89. Thomas Moore College
Covington, Kentucky

90. Union County Technical Institute
Scotch Plains, New Jersey

91. University of Evansville
Evansville, Indiana

92. Vermillon State Junior College
Ely, Minnesota

93. Victor Valley College
Victorville, California

94. W.W. Holding Technical Institute
Raleigh, North Carolina

95. Washington Technical Institute
Washington, D.C.

96. West Hills College
Coalinga, California

97. West Shore Community College
Scottville, Michigan

98. West Virginia State College
Institute, West Virginia

99. William Rainey Harper College
Palatine, Illinois

100. World University
Puerto Rico

APPENDIX B

THE QUESTIONNAIRE

Gentlemen:

Would you please take a few moments to complete the attached questionnaire? I am currently involved with a research study of post secondary chemical technician education programs.

I would appreciate any additional remarks and comments on your ideas of your school's current chemical technology program needs in the area of evaluation and revisions, due to the level of training, employment requirements, and the implementation of a model program that would include the emergence of similar and related careers particularly in the paraprofessional health field.

I would be very happy to mail you a copy of this study when it is completed.

Most Respectfully,

Herschel L. Deibel

CHEMICAL TECHNICIAN EDUCATION PROGRAM

The following questions regarding your institution's plans for and interest in Chemical Technician Education. Chemical Technician Program (CTP) fully prepares an individual for immediate entry into a career as a chemical technician in health, industry or for transfer to a baccalaureate program with credit towards a degree in chemistry, biochemistry, pharmacy, medicine, engineering, or environmental health sciences. The graduates of a CTP have found employment as chemical and research technicians in the following and related fields: health, petroleum, pharmaceuticals, foods, plastics, nuclear, paints, petrochemical, textiles, sales, analysis, and production.

1. If there is someone, other than the person completing this questionnaire who should be receiving it, please identify him or her in the space provided:

   Name:_____

   Title:_____ Dept.:_____

   Address:_____ City:_____

   State:_____ Zip:_____

   School:_____

   Telephone Number:_____ Ext:_____

2. What is the current status of a CTP program at your school?

   (please check one)

   _____ Have a CTP program

   _____ Planning a CTP program to begin (date)_____

   _____ Considering starting a CTP program

   _____ Our school curriculum is not compatible with a CTP unit

_____ Never heard of a CTP program before receiving this questionnaire

_____ Other (please specify)_____

_____ Discontinued our CTP program in (year)_____

3. Which of the following CTP-related programs are offered in your school? (please check all that apply)

_____ Medical Laboratory Technology

_____ Medical Technologists

_____ Medical Laboratory Technician

_____ Certified Technician

_____ Registered Medical Technologists

_____ Other (please specify)_____

4. Of the training programs in technologies introduced on your campus since 1970, which one, in your opinion,

(a) recruits the greatest number of students_____

(b) why do you think this training program attracts the most students?_____

_____

5. What kind of contacts and communications does your school have with hospitals, industry, and other potential employers in your locale? (please check all that apply)

_____ They provide training

_____ They have requested that we begin a CTP program

_____ They have provided employment for our graduates and students

_____ They are on advisory committee(s) for school training programs

_____ Other (please specify)_____

_____ None

6. In your opinion, what are the employment opportunities for your gradutes in local industry, hospitals, etc. (please check one)

_____ Excellent

_____ Good

_____ Fair

_____ Poor

_____ Does not apply

_____ Other (please specify)_____

7. Are there any current new areas of technological training that you feel are being overemphasized and in which students will have difficulties securing employment?

_____ Yes

_____ No

_____ Not sure

If yes, please identify the occupation(s):_____

_____

_____

8. Your institution is: (please check all that apply)

_____ Public

_____ Private

_____ Other

_____ Community College

_____ Junior College

_____ University of Four-Year College

9. Approximately how many students are enrolled this semester in your institution?

_____ Number of full-time students

_____ Number of part-time students

Completed by:_____

Title(s):_____

Please use this space for additional remarks and comments.

VITA

Herschel Louis Deibel

Candidate for the Degree of

Master of Science

Thesis: A STUDY OF POST SECONDARY CHEMICAL TECHNICIAN EDUCATION PROGRAMS

Major Field: Technical Education

Biographical:

Personal Data: Born in Ponca City, Oklahoma, July 25, 1938, the son of Mr. and Mrs. Louis C. Deibel.

Education: Graduated from Ponca City Senior High School, Ponca City, Oklahoma, in May, 1957; received Junior College Certificate from Northern Oklahoma College in 1960; attended Oklahoma State University, 1960-61; received Bachelor of Science degree in Chemistry from Central State University in 1969; enrolled in graduate school at Central State University, 1971; enrolled in graduate school at Kansas State University, 1972; completed requirements for the Master of Science at Oklahoma State University in July, 1976.

Professional Experience: Technical Representative, Champlin Oil Company, 1969; Instructor, Foster Estes Vocational-Technical Center, Oklahoma City school system, 1969-present; Core Analyst, Core Lab Inc., 1969-present; adult evening instructor, Oklahoma City school system, 1975; adult evening supervisor, Foster Estes Vocational-Technical Center, 1975; adjunct instructor, Oklahoma State University Technical Institute, 1976-present; member of President's Honor Roll, Central State University, 1971; Phi Delta Kappa, American Vocational Association, National Educational Association, Oklahoma Vocational Association, Oklahoma Educational Association, Association of Classroom Teachers, and Society of Automotive Engineers.