THE SCHOOL OF CHEMISTRY

BY BETA OF ALPHA CHI SIGMA

The School of Chemistry

BY THE BETA CHAPTER

of the

Alpha Chi Sigma Professional Chemical Fraternity

1945-1946

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INSTITUTE OF TECHNOLOGY
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINN.

FOREWORD

It can be said without reservation that a man's approach to a new task is made easier when he is aware of the background of that which he is about to encounter. In past years there was a dormant demand for consolidated information in a general sort of way concerning the School of Chemistry.

Most men after graduating from college look back on their college days and retain a firm and fond interest in the institution at which they were trained for their professions. As we reminisce on our collegiate training we often think of things that we missed or felt the need of as undergraduates. Such thoughts have prompted the publication of this booklet. The booklet was prepared in order to acquaint new students with the School of Chemistry, and to aid them in deciding the path they wish to follow throughout their college work.

The material is arranged in what we deem the appropriate order: first, that dealing with the School, the various departments, and the faculty; second, the articles on chemists and chemical engineers, the differences in their curricula, and what each type of training will prepare a man to do; third, the value of a liberal education and the different types of extra-curricular activities open to the student; fourth, the articles on how a student can obtain a job on graduation and what to expect in the way of employment; fifth, developments in post-war education in the Institute of Technology. It might be added that in certain cases the authors who wrote on the various departments were too modest, so additions have been made by the editors.

We wish to extend special thanks to those whose names are appended to the various articles, and in particular to Dean Lind for his contributions and suggestions. For their work in assembling and editing we are indebted to R. T. Arnold, P. J. Riley, C. M. Huggett, and A. J. Madden of the School of Chemistry; F. P. Parkin, L. V. Anderson of the Minnesota Linseed Oil and Paint Company; D. W. Johnson of Plymouth Laboratories (Chicago); L. M. Schaller of the New England Mutual Life Insurance Company; C. V. Firth of the Bureau of Mines; G. Ray Higgins, Manager of Coffman Memorial Union; D. M. Taylor of the Minnesota Department of Health; and any others who have made contributions.

The Beta Chapter of the Alpha Chi Sigma fraternity sincerely hopes that this booklet will serve as an informal introduction to the School of Chemistry.

BETA CHAPTER OF THE ALPHA CHI SIGMA FRATERNITY.

INTRODUCTION

The School of Chemistry has long felt the need of a publication of informal character which would give new students or prospective students a picture of the fields of chemistry and chemical engineering both within and outside the University. This need has now been well filled by the present booklet of the Beta Chapter of Alpha Chi Sigma chemical fraternity. While written primarily for students it will be of interest also to parents and alumni. It gives an insight into the kind of work which chemists and chemical engineers do while in college and after graduation.

Official information about courses and curricula will be found in the Bulletin of the Institute of Technology. Information about living costs, employment opportunities, etc., is contained in the General Information Bulletin and in the Bulletin for Freshman Week. All of these publications may be obtained by writing to the Office of Admissions and Records.

It is expected that this booklet will be revised each year by the Beta Chapter. It gives me a great deal of pleasure to welcome this contribution to student life, to congratulate the Beta Chapter on its loyal spirit, and to thank its members and alumni for the fine service it is thus rendering to the School of Chemistry.

S. C. LIND

Dean of the Institute of Technology.

JAMES LEWIS MORRILL, LL.D.

President of the University of Minnesota

Dr. James Lewis Morrill assumed his duties as the newly elected president of the University of Minnesota on July 1, 1945. From 1942 until that date, Dr. Morrill held the presidency of the University of Wyoming.

The problem of finding a new president had concerned the Board of Regents since the death of President Coffman in the fall of 1938. Since that time, the presidency has been held by two of the University's best-known veteran deans, Dr. Guy Stanton Ford and Dr. Walter C. Coffey. Dr. Coffey reached retirement age in the spring of 1944. At the request of the Regents, he agreed to carry on for another year until final action had been taken on securing a new man for the office. The long search ended when Dr. Morrill accepted the presidency in the winter of 1944-1945.

"It has been our endeavor," said an announcement by the Board of Regents, "to find a president who is not only a true gentleman of high standing in the educational world but who has had experience both in university administration and in the field of public relations. Dr. Morrill admirably meets these qualifications. Not only has he the highest recommendations, but the members of the committee have met him and know him for a fine and able man of temperate judgment, one who will get along with people."

President Morrill was born Sept. 24, 1891, in Marion, Ohio. He was graduated from Ohio State University in 1913, and was married in 1915. Dr. Morrill got his start in the newspaper business with the Cleveland Press shortly after graduation from Ohio State University. He did reporting and copy reading, was editorial assistant, later became political and legislative correspondent, and in 1919 became city editor and acting managing editor.

From 1917 to 1919, Dr. Morrill served as executive secretary of the United States Food Administration in Ohio and of the Ohio Branch Council of National Defense. During the years 1919 to 1928 he held the position of alumni secretary and editor at Ohio State. From 1925 to 1929, he taught in the departments of journalism and education; he did graduate work and was junior dean of the College of Education from 1928 to 1932. In 1932 he became vice-president of Ohio State University in which position he continued until going to the University of Wyoming as president in 1942.

President Morrill holds the LL.D. degree from Miami (Ohio) University and from Ohio State University. He is a member of the Ohio State University Research Foundation, of the advisory board, Geological Survey of Wyoming, is chairman of the Committee on institutional organization and policy of the Association of Land-Grant Colleges and Universities, and is active in the North Central Association of Colleges and Secondary Schools.

He is a member of the Newcomen Society, Phi Beta Kappa, Phi Delta Kappa, Alpha Psi Delta, Sigma Delta Chi, Alpha Sigma Phi, Phi Eta Sigma, and Phi Delta Epsilon. His clubs are the University Club of Denver and the Rotary Club.

It is quite evident that Dr. Morrill is indeed a busy man. But it is rumored that he is an avid sports fan, especially for football. Minnesota is indeed fortunate in obtaining the services of Dr. James Lewis Morrill, and we are certain that all students at the University will join in wishing our new president a fruitful and lasting association with the University of Minnesota.

SAMUEL COLVILLE LIND, Ph.D.

Dean of the Institute of Technology

Dean Lind was born in McMinnville, Tennessee. Whether the "Minn" in McMinnville had anything to do with his coming to the University is hard to say. But it can be said that the University of Minnesota and the Institute of Technology, of which the School of Chemistry is a part, is indeed fortunate in having Dean Lind as a member of its staff. He received the Bachelor of Arts Degree at Washington and Lee University in 1899, the Bachelor of Science degree from Massachusetts Institute of Technology in 1902, and the Doctor of Philosophy degree from Leipzig in 1905. Dean Lind did further work and study in Paris and at the Radium Institute in Vienna during 1910 and 1911. He was assistant chemist at Massachusetts Institute of Technology in 1902-03, and taught at the University of Michigan from 1905 to 1915. He worked with the U. S. Bureau of Mines in various capacities and became chief chemist in 1923. He was associate director of the fixed nitrogen research laboratory of the U. S. Department of Agriculture in 1925 and 1926. He became director of the School of Chemistry at Minnesota in 1926, in which capacity he served until becoming Dean of the newly formed Institute of Technology, which includes chemistry, mines and all branches of engineering, in 1935. He served as a member of the Division of Chemistry of the National Research Council in 1931, is a member of the editorial staff of many publications, and at present is editor of the Journal of Physical Chemistry. He has served on committees of various chemical and physical societies and is a past national president of the Electrochemical Society (1927) and the American Chemical Society (1940). He was a delegate of the United States to the International Congress of Chemistry held in Rome in 1938. In short, he is a national and international figure in the field of chemistry and chemical education. His scientific interests have been along the lines of radio activity and related subjects, kinetics of chemical reactions, photochemistry and various other studies in physical chemistry. His administrative and other duties on various national committees make him one of the busiest men on the campus.

A HISTORY OF THE SCHOOL OF CHEMISTRY

LILLIAN COHEN

Associate Professor of Inorganic Chemistry

Period I. The Early Development

In 1869, college training was first offered by the University of Minnesota, even though it functioned as an educational institution in 1867. Chemistry was taught in an inadequate laboratory in a damp basement by a professor, who was also instructor in French. In 1875, chemistry was housed in five rooms in a new agricultural building (on the main campus). In 1880, Chemistry was sufficiently important to have several instructors, and James Dodge, who had just received his Ph.D. under the famous Bunsen in Germany, became the director. (This is the Bunsen of the famous Bunsen burner). Dodge with his broad and splendid chemical background brought new life to the chemistry department. Organic chemistry was introduced, and new apparatus was purchased. As the University grew, the department also grew, and soon was in need of larger quarters. In 1890 a building for housing both Chemistry and Physics was erected, and in 1902, this was remodeled. Physics moved into a new building, and Chemistry stayed here until 1915. The old building became the Minnesota Union and then acquired fame when it became "The Ship" for the Naval Training Unit.

The first complete course in Chemistry was offered by the College of Engineering in 1891; few students enrolled in it, but in 1897 four men graduated from this course, receiving the degree of Ch.E. None of these four, two of whom were outstanding in their profession, are now living. These four men are considered as the first graduates from the School of Chemistry, even if the School was not established at that time. Even though Professor Dodge had his doctorate, no graduate work was given at that time.

Period II. Foundation and Expansion of the School of Chemistry

In 1893, Dodge went to California, and Dr. George B. Frankforter, a Ph.D. fresh from Berlin, became head of the Chemistry Department. He was very enthusiastic and ambitious. Chemistry became one of the popular courses on the campus. Through the doctor's efforts, on June 4, 1902, the Board of Regents voted that a course of study in Chemistry and Engineering be given thereafter in the School of Chemistry. Dr. Frankforter was made Director. However the School was still connected with the Arts College. This was a very unsatisfactory situation, but fortunately, on May 17, 1904, the Regents made the school an independent unit with Dr. Frankforter as Dean. The contents and the names of the curricula given varied with the demand; although one curriculum was called Engineering Chemistry, no chemical engineering as such was given. There were courses in Industrial Chemistry, Photographic and Electro-Chemistry. In 1902 there were all told about 30 students in the School,

but the School taught all the elementary Chemistry given at the University, and all the advanced courses except those given at the Farm Campus and Physiological Chemistry in the Medical School. Though Dr. Frankforter was successful in gathering much of the chemistry under one direction, he never succeeded in getting the exceptions mentioned,

Physical Chemistry was first introduced in 1904-05. In 1907, the faculty of the School was composed of seven members, with thirteen assistants. Some of the assistants were undergraduates. One of the instructors in this period was Dr. Francis Frary, who is now director of research of the Aluminum Company of America. In 1905, the Minnesota branch of the American Chemical Society was organized, and in 1910, the American Chemical Society held its meeting at the University. Over two hundred and seventy-five members and guests were present. This was the first national recognition of Chemistry at Minnesota. Research was recognized as essential to the growth of the School.

At this time about six hundred students in the University were taking some Chemistry and about eighty-three students were in the school proper. There were eighty-one men, and two women students. By 1915, a new building was erected, to meet the growing needs of the School, and in 1917, eighteen men graduated from the School.

Period III. The Recent Years

During the first World War, the School of Chemistry fared badly with nothing important being accomplished. At the close of the war, the School of Chemistry was reorganized under a new dean, Lauder Jones. Graduate courses were given and were well attended, the semester system was replaced by the quarter system. Complete changes were made in the curriculum.

In 1919, the Institute of Technology was established. The School of Chemistry became a unit in the Institute, but retained its own status, with its own faculty. By 1919, there were 34 graduate students in the school, and all assistants had bachelor degrees and were working for their doctorates. In the years immediately preceding World War II, the number of students enrolled in the different Chemistry courses offered by the School increased to over 2500, with a registration in the School itself in excess of six hundred. At present, the war has made most serious inroads in the number of our students. Many inroads have been made in the faculty, who have contributed their services for the welfare of the nation.

THE INORGANIC DIVISION

HAROLD P. KLUG
Associate Professor of Inorganic Chemistry

The career of every chemist may be said to begin with the course in general inorganic chemistry. In this course, the embryonic chemist gets his first introduction to the subject, and learns many of the fundamentals. It is the foundation on which all specialized training in other branches of chemistry must be built. Its importance, then cannot be too strongly emphasized.

The Inorganic Division is thus charged with the important work of introducing the student to chemistry through the course in General Inorganic Chemistry. In addition the Division presents the first work of an analytical nature, qualitative analysis, the determination of the elements present in a sample of unknown composition. Another of its duties is to offer advanced work in the chemistry of metals and the non-metals, with the exception of the element carbon. Finally, it promotes original investigation, research, in the domains of inorganic chemistry and related fields.

Since chemistry is fundamental not only in engineering, but also in medicine, agriculture, metallurgy, geology, and many other sciences, some 1800 to 1900 students take courses in the Division each year. This instruction requires a staff of nine full-time teachers and a corps of two dozen assistants. Meet the inorganic staff!

PERSONALITIES

M. CANNON SNEED, Ph.D.
Professor of Inorganic Chemistry and Chief of the Division

Dr. Sneed was born in Nashville, Tennessee, and received his education at the University of Chicago and the University of Cincinnati. He came to Minnesota in 1918 as associate professor, and became professor in 1924. Besides his stimulating and very able administration of the Division, he has made notable contributions to the textbook field in inorganic chemistry. His *General Inorganic Chemistry* (with J. Lewis Maynard) is the most comprehensive and up-to-the-minute text in general chemistry. He is an expert hunter and fisherman, and has a fine collection of guns which he really knows how to shoot.

LLOYD H. REYERSON, Ph.D.
Professor of Inorganic Chemistry and Administrative Assistant

Professor Reyerson is a native Minnesotan and a graduate of Carleton College, with graduate training from the University of Illinois and Johns Hopkins. During 1927-28 he was a fellow of the John Simon Guggenheim Memorial Foundation at the University of Berlin. He has been director of the Northwest Research Institute since its founding in 1935. The Institute has made important contributions toward the utilization of Minnesota popple wood, South Dakota Lignite, and the low grade manganese ores of this region. Governor Stassen appointed him chairman of the Scientific and Technical Advisory Committee to Minnesota war industries. Dr. Reyerson is now assistant dean of chemistry. Research interest: colloid chemistry.

LILLIAN COHEN, Ph.D.
Associate Professor of Inorganic Chemistry

Dr. Cohen calls Minneapolis and Minnesota her home. After completing her Masters degree she became a member of the School of Chemistry staff. Later she studied abroad at Zurich Polytechnic, and following this finished her Ph.D. at Minnesota. The Bulletin and Schedule of classes for the School of Chemistry are her hobby, and she is the final

authority on all such matters. Recently she has written a history of the Minnesota School of Chemistry. She retires in June, 1946.

GLADSTONE B. HEISIG, Ph.D.
Associate Professor of Inorganic Chemistry

Dr. Heisig was born in the state of Texas. He received his graduate training at the University of Texas, Rice Institute, and Princeton University, and came to Minnesota in 1919. His laboratory manual in general chemistry for engineers, and his text in qualitative analysis (with M. C. Sneed) are important texts in these fields. Research interest: psysico-organic chemistry and coordination compounds. Dr. Heisig is now (1945) in Europe giving instruction in chemistry to veterans.

Hobby: his cabin on Woman Lake and canoeing.

HERVEY H. BARBER, Ph.D.
Associate Professor of Inorganic Chemistry

Professor Barber claims New York as his home state. He came to Minnesota for the Ph.D. and remained to teach general chemistry. He is an analytical chemist extraordinary, and his services are sought all over the state when tough problems come up. You'd be surprised at some of the questions he has been asked to answer. Recently with Dr. Ivan Taylor he has published a book on semimicro qualitative analysis which is revolutionizing the technique and teaching of qualitative analysis.

HAROLD P. KLUG, Ph.D.
Associate Professor of Inorganic Chemistry

Dr. Klug claims Ohio as his home state and Minnesota by adoption, having taught at Carleton from 1927 to 1930. After graduate training at Ohio State University he was a fellow in physical chemistry at California Institute of Technology in the laboratory of Dr. Linus Pauling. Coming to Minnesota in 1937 he brought a new research technique, x-ray diffraction, to the School of Chemistry. Crystal structure analysis and crystal chemistry are his special research interests. In the spring of 1941 the local section of the American Chemical Society elected him chairman of the Section for the following year.

J. LEWIS MAYNARD, Ph.D.
Associate Professor of Inorganic Chemistry

Dr. Maynard lists Cincinnati, Ohio, as his birthplace. Graduate trained at the University of Minnesota, he joined the School of Chemistry staff in 1923. With M. C. Sneed, he is the author of a new textbook of general chemistry, and he and Dr. Ivan Taylor are the authors of the accompanying laboratory manual. The chemistry of the coordination compounds is his special interest. Hobby: hunting.

NORVILLE C. PERVIER, Ph.D.
Associate Professor of Inorganic Chemistry

Dr. Pervier is a native of Iowa where he obtained part of his graduate training at Iowa State College. After joining the staff of the School of

Chemistry at Minnesota, he completed his work here. As chairman of the Students' Work Committee he receives all student petitions and other requests for favors. His textbook of chemistry for students of embalming is the only one in the field, and has been widely used. Hobby: playing the pipe organ which he himself installed in his home.

T. IVAN TAYLOR, Ph.D.
Associate Professor of Inorganic Chemistry

Dr. Taylor was born in Idaho and trained at Columbia University, and is the most recent addition to the staff of the Division. With H. H. Barber he is the coauthor of a recent text on semimicro qualitative analysis, and with J. L. Maynard, a laboratory manual in general chemistry. Professor Taylor's special research interest is the study of isotopes with the mass spectrograph, and he fills the stairways with apparatus to track down the elusive isotope. He is now on leave doing defense research at the U. S. Bureau of Standards in Washington.

THE ANALYTICAL DIVISION

I. M. KOLTHOFF

Chief of the Division and Professor of Analytical Chemistry

Quantitative Analysis is one of the fundamental branches of chemistry. As a matter of fact, before physical chemistry ever could become a separate branch of chemistry, it was necessary to know the qualitative and quantitative composition of substances. The fundamental laws are only discovered when enough facts are available. The basic facts dealing with stoichiometry, composition of molecules, combining weights, are all analytical. Even at the present advanced stage of physical chemistry, an adequate understanding of the theoretical and practical fundamentals of analytical chemistry is essential in the further experimental development of theoretical chemistry.

The debt which physical chemistry in its infant stage owed analytical chemistry has been amply repaid. Physical chemistry has provided us with many methods of analysis. It is one of the accomplishments of the division of analytical chemistry to have included in its educational program several advanced courses dealing with physico-chemical methods of analysis.

In the above we have stressed only the relation between analytical and physical chemistry. This relation is emphasized by Professor I. W. Geiger in his courses on gravimetric and volumetric analysis. He does not provide an education for analysts, but for analytical chemists. The relation between analytical chemistry and industrial developments is so self-evident that we do not have to elaborate on it.

For advanced work in quantitative analysis the division is unique and one of the outstanding departments in the country. Dr. Sandell covers all phases of qualitative and quantitative micro-chemistry. Dr. Meehan offers a course in spectroscopy and spectrophotometry. Dr. Kolthoff together with Dr. Matsuyama cover the application of electrochemistry to analytical chemistry.

PERSONALITIES

I. M. KOLTHOFF, Ph.D.
Chief of Division and Professor of Analytical Chemistry

Dr. Kolthoff was born in Almelo, Holland. His college work was done in Europe, and he received his Ph.D. degree in 1918 from the University of Utrecht. He taught at Utrecht until 1927 when he came to Minnesota to take over his present position. He is a world renowned chemist and has received many honors from the various American and foreign societies including the Dutch government. His textbooks on general analytical chemistry and on various specialized subjects are widely used. The work he has done is voluminous and includes much work on co-precipitation and the dropping mercury electrode. Since January of 1943 Dr. Kolthoff has been in charge full time of a government research program on synthetic rubber. Recently Dr. Kolthoff was knighted with the Order of Orange-Nassau by Queen Wilhelmina of the Netherlands. In July of 1945 he was one of the United Nations scientists who attended the two hundred and twentieth anniversary jubilee of the Soviet Union Academy of Sciences at Moscow. Dr. Kolthoff has many non-scientific interests including horseback riding, music and the arts, and a strong liking for Laurel and Hardy. He is known as "Pete" to his many friends.

I. W. GEIGER, Ph.D.
Associate Professor of Analytical Chemistry

Dr. Geiger was born in Bluffton, Ohio. All of his college work was taken at Ohio State, where he received the bachelor's degree in 1913, the master's degree in 1914, and the Ph.D. in 1916. Dr. Geiger is the old-timer of the department, having come to Minnesota in 1916. He has done work on various analytical methods, and has charge of the course in general analytical chemistry. He imparts many of his philosophies to his students. He has wide interests outside of his major field in the education of students, fishing, hunting, and many other aspects of life.

E. B. SANDELL, Ph.D.
Associate Professor of Analytical Chemistry

Dr. Sandell is what might be called a true Minnesotan, since he was born in Minneapolis and took all his college work at the University of Minnesota. He received the bachelor's degree in 1928, the master's degree in 1929, and the Ph.D. in 1932. He was a duPont fellow in 1931-32, and became an instructor in 1932. He is now an associate professor of analytical chemistry. He has done work on co-precipitation and is very much interested in microchemistry. His course in microchemistry is unique in embracing both the qualitative and quantitative aspects of the field. His book in quantitative chemistry with Dr. Kolthoff is widely used. According to Dr. Kolthoff, a student may swear a little when he takes Dr. Sandell's course in the polarizing microscope, but later will have forgotten the many headaches and be grateful for the course. Dr. Sandell is the author of a book on colorimetric methods for traces of metals which has found wide acclaim in this country and abroad.

E. J. MEEHAN, Ph.D.
Associate Professor of Analytical Chemistry

Dr. Meehan is a native Californian, having been born in Oakland and educated at the University of California in Berkeley. He received his bachelor's degree in 1933, and the Ph.D. in 1936. He taught at the University of California until 1939, when he came to Minnesota as the youngest man of the analytical staff. During the war he was connected with the government research program on synthetic rubber. He is not only a star bowler but distinguishes himself as a teacher of beginning and advanced subjects. He is a married man; his attractive wife is a former student of his.

THE ORGANIC DIVISION

W. M. LAUER
Professor of Organic Chemistry

It is impossible to view the development of chemistry in this country since the first world war without some pride. Organic chemical industry was practically non-existent in the United States thirty years ago; almost all of our organic chemical products were imported from Germany. We did make soaps, refine petroleum, and compound rubber, but these processes at that time were rudimentary. The host of new detergents, high octane gasoline, automobile tires capable of furnishing high mileage, synthetic rubber, plastics and countless other products which are required for the present war machine were unknown to the veteran of the first world war. Before the first world war, organic chemistry might with some justification have been stamped with the label "Made in Germany." Most of the purely scientific and industrial developments originated on the other side of the Atlantic. However, the period between the two world wars has witnessed a change, the importance of which the American public still does not fully appreciate, but which will, in the not distant future, be recognized with justifiable pride. The results of the scientific and industrial growth of chemistry are no longer brought to us; we in America now occupy the central position. This transformation has not been accidental, but has been the result of the untiring efforts of a large number of well-trained chemists and chemical engineers.

The training of young men for this army, which functions not only in time of war, but also in peace time, is one of the functions of the University, and the University of Minnesota can well be proud of its accomplishments along this line. Counter-attacks challenging America's position in chemistry are taking place constantly, and constant hard and intelligent effort is necessary in order to maintain our position. This applies not only to those who are at present employed in chemical industries, but with equal force to those undergoing training for this interesting and important task. The undergraduate who puts forth his maximum effort in order to acquire the best training possible contributes his share to this end.

The work in organic chemistry at Minnesota is designed to furnish

the student with the background upon which to build. The field of organic chemistry is too broad to attempt instruction in all of the many applications of this science; rather, an effort is made to supply the student with a thorough training in the principles, techniques, etc., which, if mastered, will enable him to successfully apply this fundamental knowledge to the problems as they arise. Such students find places in the rubber, petroleum, plastics, dye, sugar, cellulose, pharmaceutical, chemical, paint and oil, and food industries, to mention only a few of the types of industries requiring the services of men well-trained in organic chemistry.

PERSONALITIES

LEE IRVIN SMITH, Ph.D.
Chief of Division, and Professor of Organic Chemistry

Dr. Smith was born in Indianapolis, Indiana. He received his bachelor's degree at Ohio State University in 1913 and his Ph.D. at Harvard in 1920. Dr. Smith came to Minnesota in 1920 and became chief of the division in 1932. He is a world renowned chemist for his work in reaction mechanisms, quinones, methylated benzenes and vitamin E. He has been in charge of an NDRC project for several years during the war. Dr. Smith is a snappy dresser, with a weakness for red neckties, and is a most excellent lecturer.

W. M. LAUER, Ph.D.
Professor of Organic Chemistry

Professor Lauer was born in Thomasville, Pennsylvania. He received his bachelor's degree at Ursinus College in 1913 and his Ph.D. at Minnesota in 1924. He came to Minnesota in 1920. During the war he has been in charge of an anti-malarial project. Dr. Lauer is very congenial and well-liked. He has been known to reminisce on his experiences as a student in Germany. His chief interests in organic chemistry are structure and reaction mechanisms.

C. F. KOELSCH, Ph.D.
Associate Professor of Organic Chemistry

Professor Koelsch was born in Boise, Idaho. He received his bachelor's degree at the University of Wisconsin in 1928 and his Ph.D. in 1931. He came to Minnesota in 1933. He was a fellow of the National Research Council at Harvard University and a winner of the American Chemical Society Award in pure chemistry. Dr. Koelsch spends much time in his laboratory working out organic problems in which he has a justly famous facility. He has worked on an NDRC project during the war.

R. T. ARNOLD, Ph.D.
Assistant Professor of Organic Chemistry

Dr. Arnold is the youngest member of the organic staff. He was born in Indianapolis, Indiana. He received his B.S. at the Southern Illinois Teachers College in 1934, and his Ph.D. at the University of Illinois in 1937. He came to Minnesota in 1937, and specializes in theoretical organic chemistry. He worked on an anti-malarial project during the war. He is always a kind and generous giver of advice and help, and is justly proud of his home in St. Anthony Park.

DIVISION OF PHYSICAL CHEMISTRY

F. H. MacDougall
Chief of the Division, and Professor of Physical Chemistry

An important task of the members of the Division of Physical Chemistry is to make our students acquainted with the generalizations and theories of chemistry. As a foundation for these studies, the students should have acquired, in their courses in inorganic, analytical, and organic chemistry, a sufficiently wide knowledge of the numerous facts on which the laws and theories of chemistry are based. This statement does not imply that in inorganic, analytical, and organic chemistry the student does not meet with generalizations and theories. Far from it! But in physical chemistry, the principal object in view is a systematic study of these laws and theories, and this systematic treatment can only be given to students who have already a good acquaintance with the observed facts.

A thorough knowledge of the generalizations of our science, including the use of thermodynamic principles, and a thorough acquaintance with the theories of atomic and molecular structure and behavior will put the chemistry student in a good position to carve out for himself a successful and useful career as a teacher, as a research chemist, or as a worker in any of the important fields of Chemical Engineering.

PERSONALITIES

F. H. MacDOUGALL, Ph.D.
Chief of Division, and Professor of Physical Chemistry

Dr. MacDougall was born some time ago in Canada, received his bachelor's and master's degrees at Queen's University, Kingston, and his Ph.D. in Leipsig. He is interested in most phases of physical science and mathematics, but chiefly in the application of thermodynamics to chemical problems. His books on physical chemistry and thermodynamics are widely used. From July, 1943 to January 1, 1945 he was in charge of a National Defense Research Council project carried out in the School of Chemistry. He is very fond of symphonic music and likes to play contract bridge, usually with Dr. Sneed as a partner. Dr. MacDougall is a true scholar and has a rare wit.

ROBERT S. LIVINGSTON, Ph.D.
Professor of Physical Chemistry

Dr. Livingston was born in San Francisco and received his bachelor's, master's and doctor's degrees from the University of California. He spent a year of study and research in Copenhagen and more recently a year in Chicago on a Lalor fellowship. He has done much research in reaction kinetics and more recently in the field of photochemistry. He is director of the physical chemistry laboratory at Minnesota. From 1942 to 1945 he was on leave of absence, first in Chicago and then in Washington, working on important war projects. Dr. Livingston finds recreation in hiking and in calculations of a statistical nature, especially if these are of no use to anybody.

BRYCE L. CRAWFORD, JR., Ph.D.
Associate Professor of Physical Chemistry

Dr. Crawford first saw the light in New Orleans but learned about atoms at Stanford, where he received his A.B., A.M., and Ph.D. degrees. He spent two years at Harvard as National Research Fellow and one year at Yale as instructor in chemistry. He came to us in September, 1940. His interests lie in the field of molecular structure and particularly in the use of quantum mechanics in solving molecular problems. He prides himself on his skill at bowling; at any rate, he has been on a winning team from the School of Chemistry. He also likes to sing, but since he lives in a duplex, an angry and aroused public opinion compels him to be mute. From 1942 to the present time Dr. Crawford has directed important war research at the University.

DIVISION OF CHEMICAL ENGINEERING

C. A. MANN
Chief of the Division, and Professor of Chemical Engineering

The function and operations of the Division of Chemical Engineering are completely discussed by Dr. Montonna in his article "The Professional Aspects of Chemistry and Chemical Engineering," which appears later in this booklet; hence it is not necessary at this time to discuss the courses in the Chemical Engineering department. So, without further hesitation, we will give you a word picture of the members of the teaching staff.

PERSONALITIES

CHARLES A. MANN, Ph.D.
Chief of the Division, and Professor of Chemical Engineering

Professor Mann was born in Milwaukee, Wisconsin, and received his Ph.D. degree in 1916. He was instructor of chemical engineering at the University of Wisconsin from 1909-1916, and served as head of the chemical engineering department of the Iowa State College before coming to the University of Minnesota in the same capacity. Besides handling the administrative work of the Department, he teaches undergraduate and graduate courses, directs research and has charge of the Placement Service for Chemical Engineers. His research interests are along various lines: zeolites, corrosion and organic inhibitors of corrosion, electro-chemistry, unit operations and industrial chemical products. Golf, gardening and billiards are his hobbies. He enjoys a good story and has his files full of stories for all occasions.

GEORGE H. MONTILLON, Ph.D.
Professor of Chemical Engineering

Professor Montillon was born in Cedar Rapids, Iowa. He took his undergraduate work in mechanical engineering and for several years was connected with the gas industry. He received his master's degree in

chemical engineering at Iowa State College and the Ph.D. degree from the University of Michigan in 1926. In 1918 he worked on the Muscle Shoals project until the close of the first World war. He became instructor of chemical engineering at the University of Wisconsin in 1919, and came to the University of Minnesota in 1920. His special interests lie in electrochemistry and chemical engineering unit operations and design. During the last three years and again this year he will be on leave of absence doing some special investigations for the T.V.A. He has two fine boys, one in the Navy department, and the younger one graduating from Annapolis. He likes to play bridge and work around his yard.

RALPH E. MONTANNA, Ph.D.
Professor of Chemical Engineering

Professor Montonna was born in Cape Vincent, New York. He did his undergraduate work at Syracuse University and received the Ph.D. degree in chemical engineering at Yale in 1924. He came to the University of Minnesota in 1924, and teaches or has taught Chemical Engineering Materials of Construction, Chemical Engineering Economics, Design in Chemical Engineering and advanced courses in Explosives, Cellulose, and Intermediate Dyestuffs. He has been very active with the Northwest Research Foundation and has developed a process for producing alpha cellulose from aspen wood and low cost hydrogen from North Dakota lignite, and linen from Minnesota flax straw. Recently he was appointed assistant dean of the Graduate School. He retains his professorship in Chemical Engineering and the directorship of the Institute of Research. His researches include work on filtration, distillation, and on cellulose. His main hobby is travel, although he enjoys a game of bridge or golf.

ARTHUR E. STOPPEL, Ph.D.
Associate Professor of Chemical Engineering

Professor Stoppel was born in Rochester, Minn., and received his college training at the University of Minnesota. He received the Professional Chemical Engineer's degree in 1921 and the Ph.D. in 1924. He began teaching in the Division of Technological Chemistry in 1923. When this division was abolished, he became a member of the Chemical Engineering Division. He is especially interested in fuels and combustion. On a number of occasions he has done special work in this field for national organizations. Dr. Stoppel is known for his droll humor and his ever-fuming pipe. He has two very fine children, a boy and a girl.

EDGAR L. PIRET, Ph.D.
Professor of Chemical Engineering

Dr. Piret was born in Winnipeg, Canada. He did his undergraduate and most of his graduate work at the University of Minnesota. After completing most of his graduate work he spent a little more than a year in France on a Franco-American scholarship at the University of Lyon, and received a doctor's degree from that institution in 1936. After completing his work at the University of Minnesota for his Ph.D. in 1937, he began teaching in the Department of Chemical Engineering. His research work has been on the unit operations and design as well as food

technology. He has done consulting work for a number of companies in Minnesota. He has an excellent training in industrial bacteriology. He enjoys music and athletics and likes to attend national scientific meetings. He was married Sept. 4, 1945.

FREDERICK PHILIPS PIKE, M.S.
Instructor in Chemical Engineering

Mr. Pike was born in Tarbaro, North Carolina. He did his undergraduate work in chemical engineering at the University of Virginia. He worked in the Gold Division of the Treasury Department in Washington for one year, and then attended Massachusetts Institute of Technology where he received the M.S. degree in chemical engineering in 1936. He is an instructor of unit operations, and is at present doing research work toward his doctor's degree. It is interesting to note that he originally intended to become a doctor of medicine, but after one year chose chemical engineering. He is very proud of his dog and is trying to train her for hunting, though he finds little time to do any hunting himself.

ARTHUR J. MADDEN, JR.
Instructor in Chemical Engineering

Mr. Arthur J. Madden, Jr., received the B.S. in Chemical Engineering from the University of New Hampshire in June 1940. He came to the University of Minnesota immediately as a teaching assistant in the Department of Chemical Engineering. Because of the increased teaching load due to the service men, he was made an instructor in Chemical Engineering in June 1942. He taught the Unit Operations, Applied Electrochemistry and Chemical Engineering Thermodynamics until he accepted an appointment with the N.D.R.C. at Cumberland, Maryland. His intention in coming to Minnesota was to work for his Ph.D. degree. In December 1943, he married Miss Boucher and now has a nice daughter. Mr. Madden will return in the fall to assume his instructorship in Chemical Engineering and to continue his graduate work.

MELBOURNE L. JACKSON
Instructor in Chemical Engineering

Mr. Jackson was born in Wisdom, Montana. His undergraduate training was taken at the University of Minnesota and Montana State College. He has worked for the Salmon By-Products Company, Ketchikan, Alaska and the West Virginia Pulp and Paper Company. One year of graduate work was taken at the Institute of Paper Chemistry with Lawrence College. He was an instructor at Montana State College for two years prior to coming to Minnesota in 1944. He is an instructor of unit operations and chemical engineering equipment design and is also doing graduate work toward the Ph. D. degree. Hobbies include music and photography and he claims the youngest son of the staff of Chemical Engineering.

THE PROFESSIONAL ASPECTS OF CHEMISTRY AND CHEMICAL ENGINEERING

By Ralph E. Montonna
Professor of Chemical Engineering

The science of chemistry leads, in practice, to two groups of professional activities. The first of these is based upon the more scientific aspects of the field and leads to the profession of chemist and, in combination with other sciences, to the allied professions of biochemist, physiological chemist, pharmaceutical chemist, etc. The second group of activities is based upon the more commercial or applied aspects of the field and leads to the profession of chemical engineer. The differentiation between the two groups of professional activity is largely one of point of view and is fostered by differentiation of the professional training in its later stages.

The professional chemist is one who is trained in the science of chemistry and the allied sciences of physics and mathematics. He seeks to extend both the science and its applications by discovering new facts, relationships, or reactions and defining or limiting their scope. He usually works in the laboratory with small quantities of materials which are as pure as can be obtained. He works in test tubes and beakers of glass or materials not affected by the reaction. He is concerned only with measuring the energy changes involved and not with the efficiency or speed of the transfer. He measures the rate of the reaction or the energy changes but is little concerned with the time actually required. In other words, the chemist concerns himself with discovering the scientific facts about a given reaction but not with the economics of the process.

The chemical engineer is one who is trained in the physical sciences and their application to those unit operations common to chemical processes so that those processes may be both technically sound and economically feasible. The unit operations such as filtration, distillation, evaporation, drying, etc. are the tools of the chemical engineer. There are about fifteen or twenty of these operations. But, applied to different reactions, and arranged in different combination, they constitute the thousands of industrial chemical processes. The chemist does these things without thought as to their speed, efficiency, or cost. But to make a successful business enterprise, the chemical engineer must know how to do them easily, quickly, efficiently and above all, cheaply. He must find out how to carry out the reactions on a large scale from some abundant source of available raw material of whatever degree of purity Nature provides. He must construct his apparatus of cheap easily available engineering materials which will neither be corroded by the reaction nor contaminate the product. He must force the reactions to attain reasonable speed and he must provide efficient and adequate means for the transfer of energy involved in the reactions, and finally above all, he must do all these things as cheaply as possible. The business of the chemical engineer, then, is to arrange the unit operations in proper coordination so as to produce processes which will result in products that can be sold at a profit.

In training for both professions, therefore, there must be a thorough grounding in the fundamental sciences of chemistry, physics, and mathematics. Thus the first two years of academic training are the same for both chemists and chemical engineers. In the last two years there is differentiation and specialization according to the objects of each profession as outlined above. The chemist takes advanced chemistry courses specializing in various fields such as inorganic, organic or analytical chemistry and in the more theoretical aspects of the science. He may also branch out into other allied scientific fields by taking courses in biology, metallurgy, geology, pharmacy, etc. He thus lays the foundation for specialization in biochemistry, metallography, pharmaceutical or physiological chemistry, or bacteriology. The chemical engineer, however, specializes in his subject by an intensive study of the unit operations and broadens his knowledge of engineering by acquiring the fundamentals of mechanical, civil and electrical engineering with such courses as heat engines, hydraulics, strength of materials, machine designs and electric power. Both curricula include further *fundamental* study of chemistry in the last two years in such courses as organic chemistry, physical chemistry, and chemical technology and both lead to the bachelor's degree at the end of four years.

To really complete his chemical engineering training, however, the superior student should pursue his studies for a fifth year which is taken in the Graduate School and leads to the Master's degree. Those who intend to engage in research and development as a career should take further graduate work leading to the Doctor's degree. Among the chemists, graduate work is even more common since the undergraduate curriculum opens only a limited number of functional opportunities of a routine character such as control work in chemical plants. Few chemists of ambition stop there and few seem to take the Master's degree, although the author believes there would be opportunity for more men of this amount of training. Most of those who go on continue to the Ph.D. degree with a view of entering upon the research function.

There are five groups of functions which technical men may perform in the process industries, and a sixth group of miscellaneous functions which may or may not be connected with industry. These groups follow the logical development of an idea or reaction into a practical, workable, economic chemical process. They are:

1. The Research or Design functions
2. Construction
3. Plant operation and Management functions
4. Maintenance
5. Sales and Business functions
6. Miscellaneous

Before a chemical process or a piece of equipment or a chemical plant comes into being, an idea must first be conceived and so isolated and developed that it can be translated from its abstract sense into a practicable working concrete plan ready for artisans to build something out of it. These are the functions of the first group. The idea of a new machine or piece of equipment or the conception of a plant layout must be designed and set down into a working set of blue prints from which mechanics can build it. These are functions of the chemical engineer and are called

design or plant layout. The chemical reaction must be studied and the optimum conditions determined in test tube or beaker stages. This is the work of the research chemist or to a more limited extent of the research chemical engineer. The principal work of the latter, however, in this group consists in the determination of optimum design and materials of construction in a semi-commercial or pilot plant which is known as development. All of these functions are concerned with the translation of abstract ideas into concrete workable plans. It is work which requires abstract thinking, initiative, imagination and originality; a restless, unsatisfied, curious mind; courage to pioneer into the unknown; and, above all, optimism and perseverance in the face of ridicule and discouragement.

After the abstract idea has been isolated and defined, and reduced to a concrete working plan, the machine or a plant to carry out the process must be constructed. Most of this work is carried out by civil and mechanical engineers but there are a limited number of jobs for both chemists and chemical engineers. The former are needed to test materials of construction to see that they meet specifications and sometimes to set up specifications, often in conjunction with chemical engineers. The latter are needed, also, for consultation with the other engineers with regard to the specific chemical problems that may arise during construction.

After the plant is constructed it must be operated so as to produce the products at a profit. It is in operation and plant management that the majority of chemical engineers find their eventual job. Many chemists are also employed for analytical work in process control which is the eyes and ears of the production management both as to quality of product and efficiency of process. Plant management which may include any job from foreman up to general management and even executive positions is a fertile field of employment for chemical engineers. Positions in this category require a very different temperament from the first type of function. Here the man must be calm, even of temperament, and like to have things maintain their status quo. He must have tact and executive ability but, since the main objective is a smoothly functioning machine which will continue to produce, he usually prefers to have things continue as they are and he resists changes which disturb production routines. Chemists in this functional category are likewise of a routine type of mind as contrasted to the research type.

Paralleling the operational functions are another group of functions constituting the maintenance group. Plants and equipment wear out and break down and must be repaired. This field offers a limited opportunity for chemical engineers, being carried out, generally, by mechanical engineers. But since processes may fail in efficiency of operation or quality of product, there is another type of process maintenance known as "trouble shooting." This is largely a field for chemical engineers. It consists of correcting troubles arising from low efficiency or poor quality in various departments of the process or in attempting to anticipate trouble by studies tending to increase either the efficiency or the quality of the operation. For such jobs, since the problems are varied in nature, a type of mind somewhat similar to the research group is required but it must be coupled with an abundance of optimism, judgment, and tact, since the "trouble shooter" always has to impose his ideas, however good, on a reluctant operating personnel.

A fifth group of functions open to professional workers in chemical

industry is economic in nature. Ordinarily in business, these functions are performed by people trained in business administration but these industries are so highly technical that it is desirable to have them handled by personnel trained also in the technical aspects of the field. They consist of such jobs as sales, technical sales service, purchasing, cost accounting, production control, market and economic surveys, etc. Experience has shown that it is easier to give technically trained people the necessary economic training than for business administration graduates to acquire the necessary technical understanding. To provide for this, the University of Minnesota offers combined curricula in chemistry or chemical engineering and business administration. These curricula contain the complete basic training in both business and the technical fields. They are five years in length and, upon completion, lead to two degrees, bachelor of business administration and either bachelor of chemistry or of chemical engineering. Because this is a sort of educational bargain, since the students, in five years, can acquire two degrees which separately would require eight years of study, they are expected to maintain a somewhat higher scholastic average to remain in the course. These students ordinarily obtain jobs equivalent in pay and responsibility to those technically trained people with a Master's degree. They should not, however, be entered upon unless the prospective student has a real interest in the business side of chemistry in contrast to the technical.

There is a sixth group of functions which must be called miscellaneous because of their varied character but which are open to graduates of the chemical or chemical engineering curricula because they are the most broadly trained of all technical students. Each one usually requires some special aptitude together with the technical training. Some examples are patent work in the chemical field; personnel work, particularly with technically trained personnel; technical writing; technical advisor to banks, investment houses and insurance companies; teaching of chemistry or chemical engineering, both at the university level and in secondary schools; research or development both in the government civil service and in private or public research institutes and other miscellaneous functions too numerous to mention.

In conclusion, however, the author wishes to urge that, however attractive a field may sound or however "crowded" or "open" it may appear at the moment, the prospective student bases his choice of a vocational field upon a careful survey of his aptitudes and his liking for it. All vocational fields are crowded at times and the present condition is no indication of what will be true four or five years hence at graduation time. Also, the trite old saying, "There is always room at the top," is always true in the sense that there is always a demand for the best men in any field. Therefore, choice of a vocation should be based on liking and aptitude for the work because with these qualities likelihood of success is always greater.

VALUE OF A LIBERAL EDUCATION*

By Richard T. Arnold
Assistant Professor of Organic Chemistry

Many students at the opening of their college careers believe that in order to be a success one simply has to choose a highly specific field and study it thoroughly. Before many months have passed the student is well aware of the fact that these specific fields are so large and are expanding at such a rapid rate that to acquire all of the known facts in a specified field is in most cases out of the question. These thoughts often lead individuals to accept the philosophy of learning more and more about less and less. No well informed person will argue that this is not an age of specialization. A well educated man must be a specialist in some branch of knowledge, but this same specialist should expose himself as a diligent student to the elements of a liberal education.

Education may be considered from the point of view of the individual or from that of the community. The word community here is used in its broadest sense to describe a city, a state, a nation, or all of mankind. In a large community there are thousands of diverse activities engaged in daily by its citizens and the community expects these services to be performed with as much efficiency as possible. The community needs doctors, lawyers, business men, street car conductors, teachers, masons, big business executives and a host of others. The community knows that agricultural research has increased the productivity of farms and thereby supports such researches that are designed to increase the wealth, health, comfort, and general well-being of its members. The community also knows that research carried on without any definite utilitarian end in view has frequently led to striking benefits for all mankind. Who does not appreciate electric lighting, electric elevators, synthetic rubber, high test gasoline, and a whole host of other products of present-day technology? Yet it is generally recognized that none of these would exist if some individuals had not been permitted or encouraged to make entirely "useless" experiments with magnets, galvanic currents, or the chemistry of polymerization processes. In addition to all that has just been mentioned the community wants the activities of its members to be governed by a moral code. This moral code finds expression in the laws and ordinances of the community but owes some of its features to the religious history of the community. The community does not want thieves and racketeers; it wants moral and law-abiding citizens.

The community is not perfect. Even in a democratic community such as the United States there are social, economic, and legal inequalities which must in time be removed. How can this be effected? Only by the persistent urging and preaching of exceptional members of the community, members who have exceptional powers of imagination, of will, of determination and in other moral or spiritual qualities.

You are aware of many means by which the intellectual life of our country can affect that of another. There is an exchange of books, magazines, literary and scientific journals; there is an exchange of scientists,

* A number of the views expressed here have been taken from the Sigma Xi Annual Lecture for 1942, presented by Professor F. H. MacDougall.

statesmen and tourists; there is an exchange of students. Furthermore, in our intercourse with foreign countries, through personal contacts in commercial transactions or by journeys to other lands, through books, news item reaching us by press services or by radio we have an opportunity to study the social, religious, economic and political structure of other countries. A scientist, no matter how profound his knowledge of the structure of an atom may be, does not belong to the group of leaders unless he has and uses other abilities in writing or in speech or in action to promote the interests of the community.

If our specialist has the right intellectual equipment he should through his formal college courses, through his own reading and daily experiences be able to acquire a just appreciation of the important role played by the various sciences and applied sciences—physical, biological, social, and political—in the development of our civilization. He should have a sympathetic understanding of the scientific spirit. This does not mean that he must have a profound or detailed knowledge of every science. It does not even mean that he must have taken courses in economics or political science at the University, although such courses would be valuable. If he is intelligent he may acquire an adequate knowledge of economic laws and political organization, to some extent from experience, to a greater degree by reading. It seems almost self-evident that an intelligent study of the history of political organizations in the past should enable one to suggest lines along which our present political structure can be improved and should also enable one to oppose convincingly proposed changes which might be harmful or disastrous. History must, accordingly, be a prominent part of a leader's education.

By a continuation of the same kind of reasoning it can be shown that a general study and appreciation of economics, foreign languages, psychology, and a host of other studies all aid an individual to play a prominent and desirable role both in his chosen profession and as a member of his respective community.

Democratic forms of government depend upon and are stabilized by people with broad liberal educations.

At times it is difficult for a student to outline a good program for outside reading and study which will adequately serve his desires for acquiring a broad background. Nevertheless this is the only route open to an engineer whose time in college is taken up almost entirely with formal specialized courses in technological fields.

When a student registers at Minnesota he is assigned to an advisor. Now it is understood that the advisor-advisee relationship should be of a perfectly friendly and personal variety. The student should consult his advisor at the earliest possible moment, and as the weeks and months ensue, the student should lean heavily upon this academic friend for all kinds of advice. What better person could be found to assist a student in formulating a program for outside general reading? This duty should be one of the outstanding tasks of an advisor, and the student must not be reluctant in making frequent visits for information.

It must not be assumed, however, that the working out of a program for general reading is the only duty of an advisor. Any question, personal or academic, can be asked of an advisor. He is the student's friend and official consultant.

EXTRACURRICULAR ACTIVITIES AND UNIVERSITY ORGANIZATIONS

By Louis Schaller,[1] Loyd Anderson,[2] Dale W. Johnson[3] and Clayton Huggett[4]

The real purpose of a higher education is the development of the whole individual. This development is the objective of the School of Chemistry and the University of Minnesota. A man cannot possibly succeed in the business or professional world unless he is equipped and able to do something besides just earn a living. This development program requires a judicious combination of study and leisure, or in other words, work and play.

Extracurricular activities in the Institute of Technology, of which the School of Chemistry is an integral part, are many (and varied) and afford opportunities for each man enrolled. The various organizations and societies in the school that sponsor this work have been founded, organized, and developed by innumerable undergraduates and graduates of the School of Chemistry who have gone out to become leaders in our country.

The professional chemistry fraternity, Alpha Chi Sigma, the student chapters of the American Chemical Society, the American Institute of Chemical Engineers, the honor societies, and all the related organizations have but one common goal—that of assisting the undergraduate to have contact with the pertinent problems and opportunities in the field of chemistry. The future in this field is practically unlimited, but it is fast becoming a certainty that a young man must have a broader education and experience to succeed in the profession. Every young man admitted to the College is determined to succeed in his chosen profession. In this process he must make friends and contacts with fellow students and develop his own individual personality. The associations made in this process help to round out his complete education. The ability to write, speak, and clearly express himself is enlarged and exhibited through this association with the men who are equally ambitious to succeed in the field of chemistry. The following material is prepared to describe briefly the organizations and associations that can be made in the School of Chemistry. They command the support and respect of the University officials and afford unlimited opportunities to broaden and equip the chemist and chemical engineer in whatever branch of the field he chooses. Become acquainted with them.

Alpha Chi Sigma

Alpha Chi Sigma, a professional chemical fraternity, was founded at the University of Wisconsin in 1902 by a group of undergraduate chemists to bind together men devoting their lives to the science and the profession of chemistry. At the present time there are fifty-three collegiate chapters located at the leading colleges and universities in the United States. There are seventeen chapters and eight groups in the professional

[1] With New England Mutual Life Insurance Co.
[2] With Minnesota Linseed Oil & Paint Co. Laboratory.
[3] With Plymouth Laboratories (Chicago).
[4] With The School of Chemistry—National Defense Research Council.

branch. Since Alpha Chi Sigma is a professional chemical fraternity, it is founded on the basic premise of lifelong activity and interest in the chemical profession and in the fraternity. More than sixteen thousand members have been initiated into the fraternity during its existence. There is no organization quite comparable to a professional fraternity. Socially it presents a member with the opportunity of meeting those interested in his work. Fraternal bonds are ever so much stronger than purely professional ones; but there are no bonds equal to those of combined fraternal and professional interests.

Beta chapter was founded at the University of Minnesota in 1904. Since that time it has initiated more than 500 undergraduate and graduate students into membership. To help insure that the students elected to Alpha Chi Sigma are those that will continue in chemistry, men are not eligible for full membership before their sophomore year.

American Chemical Society Affiliate, Minnesota Chapter

The American Chemical Society now has over twenty-five thousand members. Chemical knowledge and industry are fostered in all possible ways, and members are afforded every opportunity to keep abreast of the advancement of chemical science. The Society's periodicals are the best in the field. Its publications include the News Edition, The Journal of the American Chemical Society, Chemical Abstracts, and Industrial and Engineering Chemistry. Full membership is open to any reputable person who has an adequate collegiate training in chemistry or in chemical engineering. Several universities have student affiliates of the American Chemical Society. At Minnesota we have the American Chemical Society Affiliate, Minnesota Chapter. Students may belong to the above organization and are given junior memberships in the American Chemical Society. The Chapter holds meetings at regular intervals and has lectures and discussions on chemical subjects.

The American Institute of Chemical Engineers

The American Institute of Chemical Engineers is an organization for chemical engineers. It is similar in its setup to the American Chemical Society. Membership is open to any person with an adequate training in chemical engineering. The Institute publishes the Transactions of the American Institute of Chemical Engineers, a very excellent technical publication. Several universities, including Minnesota, have student chapters of the AIChE where the students hold junior memberships in the national organization. The Minnesota Chapter holds monthly business meetings with lectures and movies on technical subjects. The Chapter also sponsors inspection trips to various industrial plants in the Twin City area.

Phi Lambda Upsilon

This is an honorary society for chemists. Its membership consists of over 9,000 chemists critically selected on the basis of their meritorious achievements. Each year the local chapter of Phi Lambda Upsilon elects to membership outstanding juniors, seniors, and graduate students who are majoring in chemistry, chemical engineering, biochemistry, psysiological chemistry, or pharmacy. An active program is maintained throughout the year with its purpose to promote a close social and intellectual companionship between men with the same interest—chemistry.

Iota Sigma Pi

Iota Sigma Pi is the women's chemical sorority at the University. While this organization is not strictly an honorary society, its members are chosen on the basis of scholarship. To be eligible for membership, a woman must be a chemistry major as an undergraduate but may be a chemistry minor as a graduate student. The purpose of this organization is to give women chemists an opportunity to become better acquainted with one another in their mutual field.

Besides the strictly chemical organizations, there are some others to which the chemist might belong.

Gamma Alpha

Gamma Alpha is a graduate fraternity which is made up of men working in the laboratory sciences whose purpose is to acquaint men with all fields of science.

Phi Beta Kappa

Phi Beta Kappa is an honorary society for students in the College of Science, Literature and Arts, in which college, as the name indicates, the field of study may be greatly varied.

Sigma Xi

Sigma Xi is an honorary scientific society primarily for people who have completed their undergraduate work and who have shown promise in various fields of research. Each year the Society selects a limited number of seniors who have done an undergraduate research problem and have shown promise in their chosen field. These students are given a cash prize for their efforts and membership in the organization which is made up of the top-ranking scientists in all fields.

Tau Beta Pi

Tau Beta Pi is an honorary engineering fraternity in the Institute of Technology. Chemical engineers who have made a good scholastic record are eligible for membership in this organization.

While the University officials make up the regulations and rules which govern University policies and functions, the student body also has a governing body which works in cooperation with the officials. Any student who has a passable scholastic record and who may be interested in school politics has an opportunity to take part in such activities. The elections and platforms are handled in much the same manner as any city political machine with its various parties and campaigns.

All-University Council

The All-University Council is the student governing body which deals with general problems concerning the University and its students.

Union Board of Governors

The Union Board of Governors handles the affairs of the Minnesota Union, provides entertainment programs for the students and handles all-university social functions.

Technolog Board

The Technolog Board is an organization in the Institute of Technology, of which the School of Chemistry is a part, which has charge of the publication and business operations of the engineering journal "Technolog." This journal is one of the finest college technical journals in the United States and is prepared and edited almost entirely by students in the Institute. Any student who has a journalistic tendency may have the opportunity of writing technical articles or working on the business end of this publication.

Engineers' Day

Once each year the Institute of Technology sponsors an "open house" which is designated as Engineers' Day. This day is devoted to a display of the activities of the Institute with each school putting on demonstrations of interest to the public. The program is arranged from both a technical and entertainment standpoint. The entire show is handled by the students of the Institute and affords opportunities for the student to show his initiative as a leader and organizer. One member of the student body of the Institute is chosen as St. Patrick, who, with the Engineers' Day Queen, has charge of the festivities of the day. The festivities begin with the famous Engineers' Day parade in which individuals and groups of the Institute take part, and ends with the Engineers' Day dance. The School of Chemistry sponsors a show on Engineers' Day with many displays dealing with the role of chemistry and how it benefits mankind.

Veterans' Club

In addition to the usual activities open to all students, former service men and women will find the Veterans' Club an organization devoted to their interests and will have much in common with its members.

THE PLACEMENT SERVICE

F. W. Johnson

Assistant Dean and Head of the Placement Service of the Institute of Technology

The Placement Service in the Institute of Technology was organized to help juniors, seniors and graduate students to find the type of employment for which they are best fitted. Representatives of industrial concerns from all over the country are encouraged to send representatives here for interviews with students. Through these interviews students obtain a direct knowledge of the companies represented and the companies obtain direct information about the students and make a direct contact with them. Thus both are aided in making a wise selection. For several years before the war, practically all of the graduates from the Institute of Technology secured their positions by contacts made through the Placement Service. During the war the number of graduates available for industrial employment was much reduced; however, many companies continued to send representatives and all graduates were placed. Now that the war is over, the companies are returning to their pre-war methods and the same procedures may be expected as prevailed before the war.

The functions of the Placement Service are carried out by a director and a secretary. Contacts are made with the various industrial concerns and a time for interview arranged that fits into their program as well as ours. A schedule of appointments is arranged for each representative several days before his arrival in order that the students to be interviewed may be notified of their appointments.

In the selection of students for interviews, the first procedure is to find those students who have followed a course of study which has prepared them for the type of work the company has to offer.

Companies designate the men in whom they are interested not only according to major fields of technology, but also according to the various branches of each field such as research, development, design, application, sales and service. It is well for each student to give some thought as to which of these branches of his chosen field he likes the best, to which branch he feels he is best adapted, and in which branch he will be the most successful.

Information about the companies which come to interview students is available at the placement office. Students are urged to study this information so as to help them in knowing the companies in which they will find the opportunities they desire.

The impression that the student makes in the interview is very important. A good appearance is valuable, as is a pleasant and courteous manner.

The representatives depend not only on the interview, but upon the scholastic rating, and upon the recommendation of members of the faculty. It is helpful, therefore, if the student knows some members of the faculty so that they may bring out his strong points to the company representatives, because it is in the branch where his strong characteristics are of special advantage that success will be found.

The function of the Placement Service does not terminate when the student graduates. If an alumnus finds that a change of position is necessary or desirable, the Placement Service is available and help will be extended to find the best available position.

EMPLOYMENT

By Lee Irwin Smith
Chief of the Division and Professor of Organic Chemistry

Many—in fact most—students of the University of Minnesota find it necessary to work part time in order to support themselves while in school. The jobs which are filled by these students are many and varied, but because of the scarcity of chemical industries in the Twin Cities, not many of these jobs are chemical in nature. Besides this, a student could not hope to obtain a chemical job until he had completed enough of his training to become qualified, which means that chemical jobs, for the most part, would be limited to juniors and seniors. The School of Chemistry does not employ undergraduates as assistants; these positions are given to graduate students only. Hence the problem of getting a job while in school as an undergraduate generally involves the practical use of some hobby or avocation which the student already has, and by virtue of which he possesses special knowledge or skills. A complete list of such jobs that have been, and are held by students on a part time basis would be a very long one. It must be remembered, however, that the student is primarily a student. Any job that he takes must therefore be one in which the hours are not too numerous and are flexible, for time must be available for attending classes and laboratories, and the schedules of these classes are quite rigid. So the flexibility must come in the work hours.

The actual problem of getting a job, therefore, resolves itself into one which is based upon the student's own special aptitudes and skills, which he alone knows, and so he usually has to get his part time job by his own efforts. Having secured a job at which he can earn enough to support himself, the question arises, what adjustments must a student make in his program in order to compensate for those hours when he has to work, and which are in reality taken away from his school time? The University evaluates the credit hour as three clock hours — that is, every credit hour is supposed, on the average, to require three hours of the student's time per week *in* and *out* of class. The normal load is traditionally fixed at fifteen or sixteen credits, which means an hour load of forty-five to forty-eight per week. In the School of Chemistry, this tradition of a fifteen credit load has never been much in evidence, it may be that wind of it has never been able to push by the odors coming out of the front door—but in any event, credit loads of eighteen are quite common. This means an hour load of fifty-four per week.

Now it stands to reason that a student cannot shoulder any such load as this and do outside work too—yet many of our students attempt it. It must always be remembered that the undergraduate record becomes a part of a student, as much as his birth certificate does. The transcript

follows him wherever he goes, and a poor transcript is indeed difficult to live down. So the student should make it his cardinal principle never to do anything which may mar his transcript, and to do everything which will keep his honor average as high as possible. Two things follow from this: (a) one should not earn money while going to school, if he does not have to do so, and (b) if one has to do so, one should work the minimum time necessary to earn his living, and he should adjust his school program so that his total hours of outside work and school work do not ever exceed about fifty. That is, if a man has to work twenty hours a week in order to support himself, he should never register for more than ten credits of school work per quarter. Even this is too much, for it neglects completely one of the intangibles which are so important while a man is learning and acquiring the background for his later professional work. Remember always that true learning is a leisurely process; it cannot be put on a production line. One must have time to think, and one frequently does his best thinking when to all appearances he is just sitting. (I could describe this in much more picturesque terms, but this article is going to be printed and so I dare go no further. But I know, and many others have told me the same, that often one's best ideas come when he is just sitting around, apparently doing nothing at all.) And so the man who has to rush from class to class and from class to work—who is always rushing around because he has too big a load—seldom gets anything really worth while done and he certainly does not indulge in mental digestion of the material he gets in his courses. In fact, he is usually a mental dyspeptic. So if you must work outside, be sure to cut down on your school work, for it is ever so much better to take five years to get your degree, and to get it with a nice record, than it is to push yourself through in four years and come out with a wretched record.

When a chemist becomes a junior, if he has a good record, there is a distinct possibility that a first-rate chemical concern will offer him a summer job. These jobs are offered with a view to permanent employment after the student graduates, if everything is mutually satisfactory. These jobs pay from $125 to $150 per month, and for the Company, they represent the very cheapest and surest way there is to discover whether or not any given man has the knowledge, skill and personality necessary for a permanent position. For the student, these jobs usually constitute a stepping stone to a permanent job, or at the very least, they give the student an idea as to what industrial chemistry, as represented by this particular company, is like. These jobs make very valuable contacts and are very much worth while. They are not open to all students; usually only to those within a year of graduation and who have good records.

You will, no doubt, have noticed that several times in this discussion the term "good record" has been used. What is a good record? Different standards can, of course, be set up, and it is true also that circumstances alter cases a great deal. But for the most part, it can be taken as the consensus of personnel officers and faculty alike that an honor average of 2.5 or better is very outstanding; one of 2.0 to 2.5 is outstanding; one of 1.5 to 2.0 is good, and 1.0 to 1.5 is "run-of-the-mine." Anything less than 1.0 is poor. It is true that some men with mediocre college records have achieved considerable in the way of success in later life, but these successes are practically always due to some other qualities which these men possessed. The undergraduate record in many cases may be the most

important single thing in evaluating the worth of a student to a prospective employer.

Having become a senior, and well on the way to the degree, what then? By the time a man reaches his senior year, he should have done some thinking about his future work and he should have a pretty good idea as to what sort of work he would like to do. Two main courses are open, and it is usually quite easy to choose one of these. They are (a) graduate work and (b) immediate entrance into professional work. Graduate work is very exacting in its requirements, both as to scholastic ability and temperament. If the honor average is 2.0 or better, it promises well for graduate work as far as the scholastic side is concerned. On the side of temperament, a man will usually know of his own accord, for there must be a keen desire to learn and to know, and a desire (as well as an ability) to solve problems which have never been solved before. Graduate work is very different from undergraduate work, for one does not just go on taking courses. There is an entirely new philosophy of learning which must be acquired, and unless it is acquired, true graduate work simply cannot be done. One will pass his course work with little or no trouble, but unless he acquires the proper point of view and the proper philosophy, the graduate student remains a "course passer" and he never, never gets a Ph.D. degree. But suppose the student has the requisite good record, and he is convinced that he should enter graduate work. How will he support himself? If the student has an honor average of 2.2 or better, his chances of being appointed an assistant in a first class graduate school are very good. These student assistantships pay salaries of $750 and usually most of the fees are remitted. The service required is usually twelve hours per week of teaching in elementary courses. On this a single man can live comfortably—a married man cannot. With an assistantship, the rest is up to the student; whether or not he can become a successful candidate for the Ph.D. degree will depend entirely on himself.

If the senior student wishes to enter graduate work, and is not successful in obtaining an assistantship, then he must choose one of two plans. He may get together, in whatever way he can, enough money to see him through one year of graduate work, and then enter the school of his choice, depending upon his record as a first year graduate student to get him an appointment as an assistant for the second year. If the student adopts this plan, he should not do any outside work during his first year of graduate work, for if anything happens to mar his record this first year, the student might just as well give up the idea of graduate work once and for all. The other course open to a man who wishes to enter graduate work, and who has not been successful in obtaining an assistantship, is to take a job, work for a couple of years and save his money, and then enter the school of his choice. He may even apply again for an assistantship, and with better chances for success in view of the time spent in professional work. This course—working for a couple of years to earn money for graduate work—is not easy, however, for as one goes along, with a larger income, his desires increase and one never does save as much as one has figured in advance that he will. Moreover, responsibilities are also likely to increase, for there may be a very pretty stenographer in the office. So while this course has been known to lead

to success, it is hazardous, and it requires great determination and perseverance in order to follow it through as planned.

All of the above remarks apply equally well to those who wish to spend only one year in graduate work, then take the M.S. degree and enter their professional work. Assistantships are generally not given to those who wish only the M.S. degree, the theory being that if a man is good enough to hold an assistantship, he should be good enough to obtain the Ph.D. degree. Besides that, if assistantships are given to men who will hold them for only one year, the turn-over in personnel is so great that it raises very undesirable administrative problems. So, in general, if the student wishes only the M.S. degree, he must be able to support himself for a *calendar* year, since it is very rare that the M.S. degree can be earned in one academic year. The prerequisites for graduate work for the M.S. degree are not quite so high as they are for those who wish the doctorate. In general, students who have undergraduate honor averages of 1.5 or better may reasonably expect to be able to earn the M.S. degree. The M.S. degree is very much worth while for those who can earn it, and who are definitely planning to terminate their academic work at this point. There is a great demand for real M.S. men, and the starting salary is around $225 with salaries of $250 or even more being offered to particularly desirable men. With the increased salaries go increased responsibilities and increased authority. But the companies do not want M.S. men who are really Ph.D. candidates; men who have to interrupt their work in order to earn some money on which they can finish, nor do the companies want M.S. men who take the M.S. degree because they cannot make the grade for the Ph.D. degree. What they want are bona fide M.S. men, good men, who will plan to remain permanently, and very good jobs are available for such men.

Turning to the second main course open to a senior, what can be said about immediate entrance into professional work? What do chemists do; what salaries do they get; how rapidly may one expect to advance in salary and responsibility, etc.? The chemist with the B.S. degree usually takes his place in the research laboratory of a large company as an "assistant" to an independent worker, a man who holds the doctorate. Or, he may enter what is frequently called the "Research and Development Division," again as an assistant to a Ph.D. chemist. Or, he may enter the "Control Laboratory." In these jobs, it is the duty of the young chemist to carry out the orders of his immediate superior as skillfully as he can. As he progresses in skill and learns to do many operations with less and less supervision, his responsibilities are increased and the time may come (though it usually does not) when he will be working on his own, and even perhaps have "assistants" under him. The types of work which a young chemist may be called upon to perform are as numerous as the operations of chemistry. He may be asked to distill this; to crystallize that (and, incidentally, to discover for himself, by experiment, what is the best solvent to use); to prepare a kilo of this or that (he must look up the directions himself, or if they do not exist he must devise a set of directions and submit them to his superior for approval). In the Control Laboratory, the young man will be asked to filter this; to precipitate that; and very soon, merely "to analyze this." Here again, he may have to look up the directions for himself, or to devise directions and methods, and this phase of his work can be very fascinating indeed, for the "trick"

analytical methods which have been devised in the Control Laboratories of the large Companies are very numerous and many of them are very ingenious indeed. For the most part, these operations will be supervised at first, but later on, as the young man demonstrates his knowledge, skill, and aptitude, and as mutual confidence grows between the young man and his superior, the supervision will be much less in evidence, and the orders given will leave more and more to the discretion of the young fellow himself. There may be a certain amount of routine work to be done, especially in those laboratories which do not have a separate Analytical Division, and certainly if the job is in the Control Laboratory itself, the younger men almost invariably will be called upon to do this. But the work is rarely ever entirely routine; often the routine work can be finished in the morning, and thus the afternoons may be left free for the more exciting new things. There is plenty of variety in any job with a large Company, and one never becomes bored by having to do the same things days after day. Usually, the smaller the Company, the smaller the staff, and hence the greater variety of the work which must be done. But to offset this, it is usually true that the smaller the Company, the more routine work there is and the less time there is for the newer things.

Besides the chemical companies, there are the Government Bureaus. The work to be done by the young chemist in these jobs is much the same as that done in the laboratories of the large companies—perhaps a bit more routine work, but not necessarily so. These positions are generally under the Civil Service Commission, and one must pass competitive examinations and be rated for them.

The average starting salary for a B.S. chemist today is around $200 per month. Starting at $200, the average salary, a young man may reasonably expect a raise to $225 at the end of his first year, provided that his performance has been a meritorious one. From then on, the salary will rise slowly, so that a B.S. man, five years after leaving school, will have done very well indeed if his salary has reached $300. After it reaches that figure, little can be expected in the way of increases in salary, unless the man is very outstanding indeed. The rate of promotion is about the same in the Government Laboratories; after serving for specified lengths of time in the lower grades, with modest but stipulated annual increases in salary, the chemist becomes eligible for the next higher grade. His salary then cannot be increased until he has been appointed to the next higher grade or rank.

The whole question of the young chemist and his job has recently been discussed in the Journal of Chemical Education, for 1940, in a series of articles entitled "The Chemist at Work." In "The Chemist," the official publication of the American Institute of Chemists, there appeared during 1941 a series of articles entitled "The Young Chemist in the Government Service."

Finally, the young chemist must remember always that he is a member of a profession, and he should uphold the ideals of the profession and assume an individual responsibility for the common weal. He should be a member of his professional societies—The American Chemical Society and The American Institute of Chemists, and he should become as active in the affairs of these societies as his time and ability will permit. The article "Licensing the Chemist," in "The Chemist" for March, 1942, is a very timely one. It discusses the differences between professions and trades or crafts, and deals with the responsibilities and privileges of a professional man. This article and the questions discussed in it are well worth the attention and thought of every young chemist.

POST-WAR EDUCATION

S. C. Lind
Dean of the Institute of Technology

With the close of the war civilian student enrollment will increase while the number of Army and Navy students may be expected to drop. Already the Engineering, Science, Management War Training courses have been terminated. Government loans to students pursuing accelerated courses are no longer available. Acceleration in the School of Chemistry will probably not be continued after the close of the 1945 Summer Session which happens to coincide with the regular program beginning in the fall quarter.

Many changes in curriculum, however, have been made or are under consideration. Some of them are planned to benefit the returning veterans.

Several two-year terminal curricula have been adopted in the Institute of Technology for sub-professional training of technical aides, one of them in the field of chemical analysis. These courses will be open both to veterans and other students who want a course of short term.

A curriculum leading to the degree Bachelor of Naval Technology has been adopted especially for NROTC students who have a good general training in technology but do not meet the special requirements of any professional engineering curriculum.

Much attention has been given to a five-year curriculum in science and technology designed to include a year of humanities evenly distributed over the five years. The faculty has voted in favor of such a curriculum in principle. A special committee has worked with the cooperation of the College of Science, Literature and the Arts in arranging a program. This fall (1945) the faculty will vote on its adoption and decide whether it shall immediately be made mandatory or left optional. If made mandatory, students who had already begun the four-year courses (and probably entering veterans who do not want the longer course) could follow the four-year curricula.