1983

Chemistry

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DEPARTMENTAL HISTORIES

PUBLISHED ON THE OCCASION OF THE CENTENNIAL OF
THE UNIVERSITY OF NORTH DAKOTA, GRAND FORKS

UND
1883·1983

CHEMISTRY

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Ever since its establishment, the chemistry department has had a central role in fulfilling the goals of the university. According to university bulletins from the first decades, it was thought that the study of chemistry was an important component of a liberal education since it "so accustomed the student to the inductive and deductive methods of science that he can successfully interrogate nature". Instruction in chemistry was also considered important in preparing students for the medical professions as well as for professions associated with the industrial-technological society that was then being developed. Another component in the activity of chemists at UND that becomes evident in the 1895 bulletin is the advancement of knowledge by research which was carried on by both faculty and students.

The history of the department can most clearly be presented in terms of three phases with the first extending from the establishment of the university until the arrival of Professor George A. Abbott in 1910. At the beginning of this first period there was a combined department of chemistry and geology, which in turn was a constituent of the School of Mines. However, in 1901 geology and mineralogy became a separate department and for the next decade chemistry and metallurgy were in the same department. The arrival of Professor Abbott coincided with the establishment of a chemical engineering department in the School of Mines and a chemistry department in the Arts and Science Division. Under Dr. Abbott's guidance as Chairman of the new department of chemistry a major growth and reorganization in faculty, facilities and curriculum took place. This phase ends with the retirement of Professor Abbott as Chairman following the end of World War II. The third phase, which continues to the present also has been a time in which the department experienced a rapid growth in the three areas mentioned above, as well as in the areas of research and graduate work.

At the beginning of the first of these phases, the staff of the university was small and there was no professor of chemistry listed in the bulletins. However, it might be surmised that the required two-hour course in the principles of inorganic chemistry was taught by Professor Montgomery, professor of Natural Sciences. In 1890 Earl J. Babcock became professor of chemistry and geology and the course work offered in chemistry was expanded to three years. The freshman year now included the principles of inorganic chemistry, qualitative analysis (primarily of the metallic elements) and applied chemistry. In the applied chemistry section, ideas and reactions that were important in both natural and industrial processes were discussed. In the sophomore year mineralogy was taught while the junior year involved quantitative analysis, concentrating on gravimetric and volumetric analysis of compounds, mixtures and ores. By 1895 the organization of the work in the sophomore and junior years had changed. The first half of the second year was now devoted to organic chemistry. This involved the study of the constitution and properties of homologous series of compounds. The second part of the sophomore year was spent on quantitative analysis and applied chemistry. Much attention was paid to analytical processes that could be applied to foods, waters, ores and

soils. Students were allowed some choice of course work in the third year and could take either physiological and hygienic chemistry and toxicology or sanitary and industrial chemistry. The bulletin for 1895 is the first one to mention research. It states that "special research is available for qualified students". During this time other courses were offered which were primarily chemical engineering and will not be described here. Over the next few years this curriculum would evolve until by 1905 the sequence after the freshman year was the following: qualitative and quantitative analysis in the second year, organic chemistry and qualitative analysis of organic compounds and acids in the third year. A separate course in medicinal chemistry was now offered. This course involved studies in physiological chemistry and "uses and economy of fats, carbohydrates, and proteins". Urine analysis and toxicology were also included. In 1908 a specific course in industrial and applied chemistry was introduced. It should also be mentioned that the second-year course in qualitative and quantitative analysis had supplementary materials in methods of instruction for students who intended to become teachers.

As can be seen, the offerings in chemistry were expanded during this period and correspondingly the number of faculty expanded from one to three. Apparently, from the beginning, student assistants were used in the laboratories. In 1899 Marcia Bisbee received a MA degree from UND and became an instructor in chemistry. She had been a student assistant in 1898 and remained in the department as an instructor through 1911, when she moved to the ceramics department. The third faculty member, W. B. Snyder, joined the department as an instructor in 1903 and appears to have been concerned primarily with the chemical engineering courses.

Most of the courses offered by the department included practical experience in the laboratory. These laboratories were first set up in the basement of "Old Main". However, in 1901 Science Hall was opened and chemistry laboratories and classes occupied the second floor. From the descriptions, it would appear that the facilities in these laboratories were quite adequate for the teaching goals of the department and included up-to-date equipment.

As stated previously, a new phase in the history of the department started in 1910 when Dr. Abbott became Chairman and professor of chemistry. His career with the university was both long and illustrious. He was chairman until 1947 and continued part-time teaching through 1953. In addition to his teaching and administrative duties he had many other activities that were of benefit to the university and the state. Since he was intensely interested in making science and scientists understandable to the non-scientist, he gave for many years "popular lectures" on scientific topics that appealed to such audiences. For many years he symbolized the scientist to the citizens of the city and state. He also continued to carry out research and direct student research. This research involved topics in areas of pure chemistry, such as investigations concerning ionic activities and colloidal behavior, as well as areas of more direct practical interest to the state, such as the chemical utilization of agricultural wastes and the analysis of natural ground waters at different sites in the state. For an appreciable length of time he also served as state toxicologist and frequently appeared in court as an expert witness.

The curriculum offered to both undergraduate and graduate students underwent major revision in the period 1910-1925. Since Professor Abbott was the first member of the department who had received his training in the relatively new

field of physical chemistry (Ph.D from MIT), it was natural for him to start in 1910 a four-credit physical chemistry course. This was probably an early date for such a course to be offered in a university in this section of the country. By 1917 this course had been expanded to a two-semester, eight-credit sequence containing both laboratory and lecture material. At this time the organic chemistry course was also expanded to eight credits. A course in photochemistry was also started in 1912. This course involved a discussion of general principles and their applications to photography. Although research had been available for students in the past, in 1915 course credit was given to both undergraduate and graduate students in a formal research course. A course in glass blowing was offered first in 1917.

Most of the curriculum developments discussed above were aimed at students interested in chemistry as a profession. However, the department also had the function of providing instruction in chemistry for students whose main interests lay in other fields. Thus, by the middle of the twenties several courses had been developed which served this purpose. At the freshman level there was a course emphasizing the relationship of chemistry and engineering and at the upper level an 8-credit sequence in industrial chemistry was offered. For pre-medical students a special organic chemistry course and a physiological chemistry course were available and there was a biochemistry course for home economics students. For prospective high school teachers there was also a special course.

At the time that these changes were occurring in the undergraduate programs, corresponding developments were taking place in graduate work in the department. As mentioned earlier, Marcia Bisbee received a M.A. degree in chemistry in 1899 and graduate work was available in the department. However, from lists of graduate assistants it appears that until 1919 there was only one graduate student in residence per year. In the early twenties the number of graduate students started to grow until by 1929 there were two or three per year. In 1925 the first formal graduate course was offered. This was a four-credit two-semester course in "Modern Theories of Organic Chemistry" in which emphasis was placed on theories of valence, molecular structure and reaction mechanisms. At this time formal departmental seminars and research courses were also added to the graduate program.

This curriculum remained fairly constant in both the graduate and undergraduate programs until 1947.

The growth in programs that has been outlined required a corresponding increase in faculty. In 1910 when Professor Abbott became chairman there were three faculty members. The faculty had grown to four by 1920 and five by 1930. The complete list of faculty members who have served in the department, their highest degrees and their dates of service in the department is given in Table 1.

Table 1
List of Chemistry Faculty and Dates of Service

Earl J. Babcock	B.S. D.Sci., University of North Dakota	1890-1910
Marcia Bisbee	M.A., University of North Dakota	1899-1912
William B. Snyder		1908-1910
Herbert W. Daudt	M.S., Harvard University	1910-1913
George A. Abbott	Ph.D., Massachusetts Institute of Technology	1910-1953
Fredrick G. Jackson	M.A., Harvard University	1912-1913

Fredrick H. Heath	Ph.D., University of Iowa	1913-1914
Edward X. Anderson	Ph.D., University of Iowa	1914-1944
Elmer Daniels	M.S., University of Minnesota	1914-1917
Willard W. Hodge	M.S., University of North Dakota	1918-1919
Harry C. Trimble	Ph.D., University of Chicago	1918-1922
Ben W. Rowland	Ph.D., University of Wisconsin	1920-1921
Ernest D. Coon	Ph.D., University of Wisconsin	1920-1960
Edwin E. Harris	Ph.D., University of Minnesota	1923-1930
James A. Burrows	Ph.D., Iowa State University	1926-1929
Edward O. North	Ph.D., University of Illinois	1930-1944
Walter H. Moran	Ph.D., Ohio State University	1930-1960
Ben G. Gustafson	M.S., University of North Dakota	1941-1974
Herbert E. Frier	Ph.D., University of Illinois	1947-1950
Grant W. Smith	Ph.D., University of Minnesota	1947-1950
Richard E. Frank	Ph.D., University of Freiburg	1948-1967
Harry J. Christophers	M.S., University of Washington	1948-1950
Lawrence T. Edwards	Ph.D., University of Michigan	1949-1950
Richard K. Pearson	B.S., Jamestown College	1949-1951
Walter Kelsch	B.S., University of Montana	1950-1951
Lawrence Summers	Ph.D., Iowa State University	1950-1980
Morton E. Millberg	Ph.D., Cornell University	1950-1952
Roland G. Severson	Ph.D., Purdue University	1950-present
Leonard E. Miller	Ph.D., University of Michigan	1951-1952
Richard R. Holmes	Ph.D., University of Minnesota	1952-1957
Horst W. Hoyer	Ph.D., University of Southern California	1953-1955
Edward J. O'Reilly	Ph.D., University of Connecticut	1955-present
Robert G. Splies	Ph.D., University of Wisconsin	1957-1959
Carl Arthur Wardner	Ph.D., University of Pittsburgh	1958-1971
Edward H. House	Ph.D., University of Rochester	1959-1961
Pramod Sarma	Ph.D., Louisiana State University	1959-1967
James A. Stewart	Ph.D., University of Ottawa	1959-present
Gerd H. Dahl	Ph.D., Iowa State University	1960-1962
A. William Johnson	Ph.D., Cornell University	1960-present
Virgil I. Stenberg	Ph.D., Iowa State University	1960-present
Norman Kulevsky	Ph.D., University of Michigan	1962-present
Howard Haight	Ph.D., University of Iowa	1963-1968
J. George Brushmiller	Ph.D., University of Pittsburgh	1965-present
Roy G. Miller	Ph.D., University of Michigan	1965-1982
Neil F. Woolsey	Ph.D., University of Wisconsin	1965-present
Simon Wong	Ph.D., University of North Dakota	1966-1967
Lynn Salisbury	Ph.D., University of Michigan	1967-1969
William G. Svetich	Ph.D., Montana State University	1968-1972
Lawrence E. Cook	Ph.D., University of Iowa	1968-1973
Jerry E. Dobson	Ph.D., Indiana University	1968-1973
Richard J. Baltisberger	Ph.D., University of Wisconsin	1968-present
George F. Vesley, Jr.	Ph.D., California Institute of Technology	1969-1973
Kenneth Klabunde	Ph.D., University of Iowa	1970-1979
Lewis J. Radonovich	Ph.D., Wayne State University	1973-present
Duane E. Bartak	Ph.D., Kansas State University	1974-present
Thomas A. Ballintine	Ph.D., Southern Illinois University	1975-present
Donald E. Bergstrom	Ph.D., University of California at Berkeley	1980-present
Martin B. Jones	Ph.D., University of New Mexico	1980-present
James Maxwell	Ph.D., University of North Dakota	1982-1983
Alex Kotch	Ph.D., University of Illinois	1982-present

Among those who spent any appreciable time at UND we have already discussed Dr. Abbott. Dr. E. X. Anderson was an analytical chemist who was on the faculty for thirty years. From comments made by those who remember him, he was very strict in his teaching and was a bit of a martinet in running his classes and laboratories. It should be mentioned that he was the research mentor for the graduate student who received the first Ph.D. degree granted by the department in 1921 (J. Fromeke). The next one was not awarded until 32 years later. His field of interest was in the physical chemistry of the condensation of vapors. Dr. E. D. Coon had a very long career at UND starting as a student at the undergraduate level. He received an M.S. degree in 1922, writing a thesis under the guidance of Professor Abbott, and a Ph.D. in physical chemistry from the University of Wisconsin in 1932 while on leave from UND. He was chairman of the department from 1957 to 1960. His main professional interests were in the physical chemistry of nitrogen oxide and teaching colloidal chemistry. By reputation he excelled in his teaching. Another person in the department for several years was Dr. E. E. Harris who was an organic chemist. He apparently did a good bit of research and published several articles on lignite and organic chemistry. Professor W. H. Moran, an organic chemist, also was on the staff for 30 years. His main concern was with the medical aspects of chemistry and he spent a good amount of time on the pre-medical courses in physiolocial and organic chemistry.

As the department developed it soon outgrew the facilities that were originally located in Science Hall. In 1919 a separate building for chemistry was completed at a cost of $62,500. This was a four-story building especially constructed for service as a chemistry facility. It had separate laboratories fitted out for use in general, analytical, organic, physical and physiological chemistry as well as individual laboratories for instructors and graduate students. Due to a shortage of space on campus the biology department was moved into the basement floor of this building and the building was used jointly until 1961.

The third phase in the history of the department starts with retirement of Professor Abbott as Chairman in 1947. This period is characterized as one of rapid expansion. The chairman's position was filled by several people after Professor Abbott with Grant Smith serving in the position from 1947 to 1951, Leonard Miller from 1951 to 1952, Richard Holmes from 1952 to 1957, Ernest Coon from 1957 to 1960 and Roland Severson from 1960 to the present time. Over this period there was an initial rapid increase in faculty numbers and then a leveling off; i.e., in 1945 there were five chemistry faculty members, in 1950 there were seven, in 1960 there were 11 and by 1970 there were 14. Over the same period the number of graduate teaching assistants increased from two in 1945 to 17 in 1982. It should be pointed out that examination of the departmental faculty lists in university bulletins might indicate that there were more faculty in some years than are indicated above. This arises because some members of the department have served in administrative positions. Thus, Professor Johnson has been Dean of the Graduate School since 1968, Professor Summers was for many years Coordinator of the Honors Program, Professor Gustafson was Director of the Division of Continuing Education from 1957 until his retirement and Professor Wardner was Director of the Science Institute for High School Teachers for a number of years.

Since the field of chemistry has undergone great and revolutionary changes over the last several decades, the material taught has also undergone vast changes. However, all of these changes in content proceeded without drasti-

cally changing the formal structure of courses that had been erected for the undergraduate curriculum in the twenties and thirties. For example, while a year of organic chemistry is still in the curriculum, the material covered now contains the fundamentals that would have been covered in the thirties plus many topics such as electronic structure, spectroscopy and thermodynamics that were not taught to undergraduates at all in the preceding decades. One of the changes in course structure that did occur in the early fifties was the addition of a course in instrumental analysis as the second course in analytical chemistry. Another development was that in all courses modern instrumental techniques were used wherever possible. During the latter part of the sixties the curriculum for chemistry majors was revised so that starting as a freshman the student would receive more practice in sophisticated laboratory techniques and instrumental methods. The lecture material given over the four-year period was reorganized so as not only to point up more of the descriptive chemistry but also to make the conceptual framework of chemistry more pertinent to understanding this descriptive chemistry and to enable the student to apply these principles in solving problems in chemistry. These revisions took several years to be fully developed and were partially supported by a $210,500 grant from the National Science Foundation (NSF).

Another change in the curriculum occurred in courses aimed at the non-majors or service courses. This involved dropping some of the specialized courses that had been developed in the thirties and forties for particular groups of students. For example, in the late fifties the freshman chemistry for engineers was dropped. These students are still being served but are now in classes that have a wider range of students.

The biggest changes in curriculum that occurred over this period involved the graduate level. As late as 1947 the only graduate course was the six-credit two-semester sequence in organic chemistry. In 1948 this was changed by adding courses in each of the other fields of chemistry. Thus, three-credit courses in analytical and inorganic chemistry that involved both laboratory and lecture work were added. In physical chemistry two three-credit courses were added; these courses involved the topics of thermodynamics, kinetics and atomic and molecular structure.

Doctoral programs in analytical, inorganic, organic and physical chemistry were formally approved in July, 1959. This, or course, necessitated more advanced courses being initiated. Formal courses were offered in quantum chemistry, spectroscopy, structural chemistry, physical-organic and physical-inorganic chemistry.

Perhaps the biggest change that came with the fifties was in the research and graduate components of the department. The older members of the department such as Abbott, Coon and Moran, while interested in research and scholarly activities, did not have the facilities, money or students that started to become available in the fifties and grew to such large dimensions in the sixties and seventies. Almost all of the new faculty that came in the fifties and thereafter were interested in and carried out research either alone or in conjunction with graduate students. The increased numbers of graduate degrees awarded in those decades is indicative of this growth. From the lists of graduate assistants and their theses, we can establish the approximate number of Masters degrees awarded in the twenties and thirties. These numbers are collected in Table 2 along with the numbers of degrees awarded in the succeeding decades.

Table 2
Number of Degrees Awarded

Decade	BS	MS	Ph.D.
1920-1929	?	8	0
1930-1939	?	8	1
1950-1959	44	27	0
1960-1969	91	28	16
1970-1979	92	21	32
1980-Present	17	5	9

Another indication of the growth of research interest is the number of research grants obtained from external sources. There were, of course, few sources of such funds in the twenties and thirties. These funds started to become available nationwide in the forties and fifties. The records on these are fragmentary but, as an example, departmental records indicate that in 1954 there were five research grants to five different faculty members. The faculty involved were Coon, Frank, Holmes, Summers and Severson. The agencies that made these grants were the National Science Foundation, Research Corporation, the Office of Naval Research and the Army Ordinance Department. In the years since then the department has continued to obtain grants from various sources and the total over the period 1960 to the present is $4,400,000. Again, it is the growth in the funds over the decades that is interesting: in the fifties grants amounted to $151,000; in the sixties, $1,211,000; in the seventies, $2,252,000; and $786,000 for the first three years of the eighties. Since 1950, the research interests of the department have ranged over the whole field of modern chemistry from basic academic research to efforts involving attempts to understand the structure of lignite and the products of coal liquefaction. Since 1974 a group of faculty has been strongly interested in research on coal liquefaction and various aspects of the chemistry of coal conversion. This has included the efforts of Baltisberger, Bartak, Jones, Klabunde, Stenberg and Woolsey. This group has over the years obtained research grants totalling $1.7 million and their efforts have resulted in 24 publications on this subject. The results of all of the research efforts in the past few decades may again be indicated by numbers, this time those on publications in national and internationally recognized journals. In the fifties, members of the department published 14 papers with this number increasing to 51 in the sixties, 190 in the seventies, and 45 in the first three years of the eighties.

As the preceding discussion indicates the department grew considerably in the fifties and thereafter. This growth strained the resources of the chemistry building constructed in 1919. The growth in the number of students involved may also be seen in the numbers of BS degrees awarded that are listed in Table 2. In 1961 a new chemistry building named in honor of Dr. Abbott was completed. This building was constructed and equipped at a cost of $950,000. This building, still in use today, is now crowded but was very spacious when first built. One reason for the crowding is, of course, the large number of students taking courses in chemistry but another reason is the large amount of equipment that is now necessary to do chemistry in today's world. Illustrative of this is the current insured value of the equipment in the building which is about $1,250,000. Another feature that should be mentioned is the chemistry library situated in the building. Currently this library subscribes to about 170 periodicals and has 3,385 books and involves one of the large expenses of the department.

It is clear from the foregoing that after a modest beginning the department has accomplished much. It has succeeded in giving a good education in both the undergraduate and graduate levels. The undergraduate students have been well prepared to work as professional chemists or go on to medicine and other specialties. Other students have gone on to graduate school in some of the most prestigious universities in the nation. The department is confident of continuing this admirable record in the future.