The College of Chemistry

University of California, Berkeley

1948-1966

By Professor of Chemistry Rollie J. Myers

Preface

Several people have asked me to put down some history about the College of Chemistry. William Jolly has already done this in great detail, but this discourse will be more of a narrative and at times more of a worm's eye view of the college all from the viewpoint of a graduate student who arrived in 1948 and who then stayed on as a faculty member. Lewis Hall was first occupied in 1948, and by 1966 Latimer and Hildebrand Halls were finished. The Chemistry Plaza that we know today was then complete.

Rollie J. Myers (1924-2016)

By 1948 the College had fully recovered from G.N. Lewis's death and from World War II. It was an important year since Lewis Hall, the first substantial College building built since Gilman Hall, was made ready for use. After Lewis stepped down in 1941, the College was first led by two of Lewis' old associates, Wendell Latimer and Joel Hildebrand. Latimer came to Berkeley as a graduate student and as a young faculty member in 1921, and he built the first apparatus in the United States for the liquefaction of hydrogen. His interests were rather broad, and his book, "Oxidation States of the Elements and their Potentials in Aqueous Solutions", aka Ox-Pot, was very well known. He was the first to take over the Deanship and the future of the college was in his hands. Hildebrand was hired in 1912 by Lewis just after he arrived to become Dean. Hildebrand's job was to teach Chemistry 1A and 1B. He did this for 40 years, and his textbook, "Principles of Chemistry" went through many editions. He was very interested in education and was instrumental in the formation of the College of Letters and Science and served as one its Deans. He was very energetic: a pioneer skier and he helped found the Sierra Club. His long-term research interests were expressed in his book, "Regular Solutions", and he published over 100 papers with more published after the age of 70 than while teaching. His last two papers appeared in the year that he reached 100. Latimer and Hildebrand co-authored, "Reference Book of Inorganic Chemistry", which was a wonderful supplemental text for Chemistry 1B. Hildebrand took over the Deanship for two years starting in 1950, and it was he who gave me the title of Lecturer in Chemistry in 1951 with the princely nine months salary of $3,900.

These two guided the College of Chemistry away from Lewis' image as a "college of physical chemistry" into the modern diverse college we see today. For some thirty years Lewis' college was very important on the national scene. He attracted many talented graduate students who went on to do great things and to do research in many of the important chemistry departments in the United States. A few, of course, stayed in Berkeley and after his death they carried on the traditions which had made our college not only a great place to do research but which at the same time gave undergraduates a superior education. The author was a Caltech undergraduate and Linus Pauling gave our freshman chemistry lectures. The class once asked Pauling to name for us the most famous physical chemist. We all expected to him to say Pauling, but he said G.N. Lewis. This was the first time that I had heard his name.

College Buildings in 1948

The college footprint on campus was quite large. In the center was the Old Chemistry Building. This was a rambling red brick building which was built fifteen years before the 1906 earthquake, but with additions in 1900, 1902 and 1912. As we saw later it had no formal

foundation and in most places the bricks were simply placed on smooth soil. It was not badly damaged in the earthquake. The center section had glass paneling for roofing and this courtyard was the center of activity including afternoon pie sales organized by SACS. Upstairs was the chemistry storeroom with a grand collection of chemicals many dating back to pre-war Germany, and they were free for the taking. Undergraduate organic instruction centered in Old Chem and most of the organic faculty had offices there. If nothing else, it was a great occupier of ground and today's large plaza area is only possible because of rambling Old Chem. To the West was Gilman Hall and to the East was the new Lewis Hall. Lewis even added to the college footprint by blocking College Avenue so that it could no longer connect to Gayley Road. Slowly but surely College Avenue passed Bancroft became the university's own. On both sides of Old Chem was a wondrous collection of special buildings. On the South East side was an annex to Old Chem called the Rat House. It was a two-story wooden building which housed organic research labs. The name was said to be derived from Edward Chace Tolman, the behaviorist psychologist, having done rat maze experiments in this building, but this is probably not correct. The North side of Old Chem was very busy. After Hildebrand arrived, he needed a large lecture hall and a number of Chem 1A/1B labs. The large lecture hall was built attached to Old Chem, as was additional space called Chemistry Annex. The labs were in a two story plus basement North-South pointed wooden building. It was said to have been built for less than $30,000, and it was the University's best ever investment. It was used by up to 1,000 students every semester for 40 years. Its lab rooms could each hold 28 students with lockers for six sections. The replacement labs put in Latimer were a close copy, plumbing and all, to those in this Freshman Chemistry Building. But Latimer had hoods while the Chem 1 lab building had open balconies on the North end. They were commonly called "Berkeley hoods." Hydrogen sulfide was dispensed on these balconies for qualitative analysis. Much later on it was determined that the release of hydrogen sulfide, with or without hoods, could no longer be tolerated on campus.

The only concrete structure on the North side was the building housing the Crocker 60 Inch Cyclotron which was built in 1937. It stayed active and was still in operation when Latimer was first built. Its large magnet was moved to Davis and the cyclotron re-established there. Over a period of time the Crocker building was dismantled. Nearby was a one-story wooden building called the Old Radiation Laboratory. It was first built for the College of Engineering, but it was turned over to E. O. Lawrence for his early cyclotron experiments. In 1948 Melvin Calvin was using the labs in this building to investigate the use of C-14 as a tracer in photosynthesis. This building was quite spacious once an early cyclotron was removed. It was also equipped with a machine shop and a glass blowing shop. The history of C-14 will be discussed later. The strangest structure in the chemistry complex was a small concrete bunker between Lewis and Old Chem. It was called the Acid House and it was used to store solvents and bulk chemicals. It

was removed when Old Chem was torn down and it was replaced by a larger structure in Strawberry Canyon.

College Administration and Shops

Compared with today, the College administration in 1948 was very tiny, and it was housed in 110 Gilman. The Dean's administrative assistant was Mabel Kittredge, commonly call Miss K, although she was possibly married and had the married name Wilson even in 1948. She had taken over her job from her sister, Ester, who appears in that famous 1917 Gilman Hall front steps photo. Every graduate student, every faculty member and even most college undergraduates knew Miss Kittredge because of all of the power that she held. She dispensed the keys, did the teaching assignments, handled a College Loan Fund, typed many of the manuscripts and most likely influenced the Dean in personal matters. Getting along with Miss Kittredge was essential.

Latimer had hired a local chemist, Robert Anthonisen, as a business manager. He was assisted by only a part time bookkeeper. At that time the College received little federal government money, so "Tony's" job was to keep track of the 19900, or university money, accounts. Material was free and the shops did not recharge for work done. A few faculty members received money by doing atomic energy related work. That was handled elsewhere, but it resulted in Gilman Hall having one real secretary who was on the second floor and she did work for those few.

The Wood and Machine shops were installed in the basement of Gilman in two opposite rooms. The small sub-basement with an outside entrance was the Liquid Air Plant which made liquid oxygen and liquid nitrogen in excess of college use. Excess liquid oxygen was sometimes disposed of by pouring it into Strawberry Creek. The large Glass Shop was in Old Chem. Over time the number of workers in the Glass Shop went down while the other shops increased. The graduate students did not have legal access to the shops at night, but their door locks were very primitive and could be opened with a piece of sheet metal which was known as a "get-in-ski." Around 1947 the shops improved their security by installing metal plates covering the latch, but an inventive young faculty member simply put a nose on the sheet metal to get around the metal plates, and this was known as a "Gwinn-ski." It was stored in the pipes above a shop door. This illustrates the desire of the young researchers to steam full speed ahead, and an almost cooperative administration.

Most Chemistry Departments liked to have a small, but very useful library which held Chemical Abstracts and a few important journals. Keeping track of the synthetic chemistry recipes was not possible in big libraries in other buildings. Our small library was on the second floor of Gilman, but it became large enough to double as a study hall when it moved to the plaza level of Latimer Hall. It was enlarged even more when it moved into the plaza level of Hildebrand.

There were two young members of the support staff who represented the future. First there was Lin Chin who took care of the undergraduate physical chemistry storeroom. He moved up in administration and was finally in 410C Latimer. Second there was Curt Bowers, who came to the Bay Area after graduating in Chemistry from an all black college in the South. He told the story of leaving the state unemployment office, and being told, "they will never hire you," as he left the office. In 1948 racial discrimination in employment and housing was widespread in California, but Latimer and Hildebrand did hire him, and he assisted the Chem 1 lecturers with great demonstrations for many years. One of the biggest characters on the support staff was Al Carrol. He ran the Chem 1 storeroom and handled the Chem 1 laboratory admission process with an iron fist. Since the students had stood in line for at least one hour to register for the course they did not argue with Al. The women always found that they were in a far corner of a lab room which was some sort of tradition. He seemed to have a personal employee in the storeroom. We soon found that Al had founded a credit union and was running it out of his storeroom. This credit union is still in business, but it is in a different off-campus location.

The 1948 Faculty

By 1948 Latimer had left his footprint on the composition of the faculty. That is not to say that the people who were left over from the Lewis era were second class, for among those hired by Lewis were Giauque, Seaborg and Calvin who would all win Nobel Prizes. Latimer simply felt that the college needed serious chemical engineers, organic chemists and even what we now call biophysical chemists. The 1948 faculty was composed of Lewis's hires, war time Latimer hires and post-war Latimer hires. In those days faculty were directly hired by the Dean with no formal committee input.

Lewis Hires: Joel Hildebrand (1913), G. Earnest Gibson (1913), Gerald E. K. Branch (1915), Wendell M. Latimer (1917), T. Dale Stewart (1917), Axel R. Olson (1919), William Francis Giauque (1922), Gerald K. Rollefson (1923), Melvin Calvin (1937), Kenneth S. Pitzer (1937), Glen T. Seaborg (1939).

War-time Hires: Edwin F. Orleman (1941), Robert E. Connick (1942), William D. Gwinn (1942), James Cason (1945), William G. Dauben (1945).

Chemistry Post-War Hires: LeRoy Alton Bromley (1946), Leo Brewer (1946), Burris B. Cunningham (1946) George Jura (1946), Isadore Perlman (1946), Richard E. Powell (1946), Henry Rapoport (1946), Bruno H. Zimm (1946), Marshall Cronyn (1947), Thomas R. Simonson (1947), David H. Templeton (1947), Donald S. Noyce (1948), Joseph C. Guffy (1948), Donald S. McClure (1948), Chester Thomas O'Konski (1948).

Chemical Engineering Hires: While there was no formal Department of Chemical Engineering in the college, Latimer was collecting faculty for such a department within the college and he soon formed such a division within the College. Those hired to make a strong division were: Charles R. Wilke (1946), Donald Norman Hansen (1947), Charles William Tobias (1947), Theodore Vermeulen (1947), Campbell (Ford) Williams (1948), but Williams left before the department was formed. Bromley also joined this group to help found Chemical Engineering.

The Division was first formed in 1946, and the person chosen to lead that division was a 1933 Latimer PhD, Phillip William Schultz. Over the years he had held academic positions in several universities, had experience teaching chemical engineering, and had been active in the Manhattan Project during the war. He was clearly a Latimer favorite, but he died in March 1947 following his appointment in 1946. Ted Vermeulen, a person with strong Cal Tech connections, was hurriedly snatched from his position at Shell Research in Emeryville to be the division head in 1947. For many years there was a behind the scenes fight between the Colleges of Engineering and of Chemistry over who would have Chemical Engineering. It is said that our larger undergraduate enrollment and the quality of our faculty hires tipped the balance. The Department of Chemical Engineering was finally established in 1957 with Wilke as chairman.

A number of other Latimer hires, Connick, Gwinn, O'Konski, Brewer, Cunningham, Templeton and Bromley, were involved in war time work in Berkeley and elsewhere. The third floor of Gilman was fenced off for security and Seaborg received his Nobel Prize in chemistry for work done there. Cunningham developed microanalytical methods which were used in the Radiation Laboratory, and after the war he established the microanalytical laboratory in the lowest floor of Lewis. It also had an employee, Vazken Tashinian who was universally called Tash, to do CHN analyzes for the growing organic groups. Charles Koch (1946) was a long time lecturer in Chemistry 5. It was then a very popular analytical chemistry course whose labs took up most of the first Lewis floor lab rooms and with a stockroom next to the elevator. For many years Chem 5 was part of the chemistry major, and it was required by most medical schools. It was then a major chemistry course. Koch also supervised the microanalytical laboratory. The college lost two prominent faculty members, Zimm and McClure, to industry because of our lagging pay scale. They both later returned to academia at other institutions. As an important biophysical chemist Zimm was a great loss, but he was replaced later by Tinoco and Hearst.

Carbon -14

The major missing faculty member from our list is Samuel Ruben who was hired in 1939, and who soon became a star among the chemistry faculty by pioneering the use of radioactive

carbon isotopes to study biological chemistry. He teamed with the physicist Martin Kamen and they published many papers pioneering the production and use of isotopes. They first used stable O-18 and radioactive C-11, but its twenty minute half life made it difficult. Ruben and Kamen tried many times to make C-14 which was expected to have a longer half life. Finally, in early 1940 they formed C-14 by bombarding graphite with deuterons. It has an almost 6,000 year half life. Calvin was later picked by E. O. Lawrence to use C-14 as a tracer and this was done in the Old Radiation Laboratory. He went on to win a Nobel Prize for this work. Willard Libby who received his PhD in Berkeley in 1933 and was a faculty member until he left for the Manhattan Project in 1942 was Ruben's research director in Berkeley. Libby also won a Nobel Prize for C-14 dating while at the University of Chicago in 1960. Ruben's last paper was published in 1943 and the title was, "Photosynthesis and Phosphorylation." By this time, he had become involved in chemical warfare work in the Rat House. On September 27th of 1943, while working with two other people, Sam was exposed to phosgene gas. The others were exposed to less gas, but Sam died of pulmonary edema the next day. Ampoules of gas are often frozen and thawed again, it is a commonly done but some skill and luck is involved in whether an ampoule breaks in the process. He left a widow, Helena Ruben, and three children. She remained a friend of the college, and she later worked with Templeton in crystallography both in Lewis and on the hill for 30 years. Harold Johnston's book, "A Bridge not Attacked" has many pages about Sam Ruben, including letters and personal details. While they both worked on chemical warfare, Johnston spent most of his time overseas and they never met.

Martin Kamen had a far different fate. He first went to Oak Ridge but returned to Berkeley under a cloud of suspicion by the FBI. He was soon accused of giving away secrets to some Russians in San Francisco and he was dropped by Berkeley. He spent many years trying to clear his name, and this long effort is documented in his book, "Radiant Science, Dark Politics." In 1995 at age 82, Kamen was finally fully recognized, and he was given the prestigious Fermi Award by President Clinton for his and Ruben's discovery of C-14.

The Graduate Program

Students who were accepted to work on the PhD program were almost all assigned and supported as teaching assistants in Freshman Chemistry. A few were assigned to Chem 5, which was quite large. The organic labs were obviously manned by students who chose an organic research director. The Freshman TAs were assigned to be in lab rooms for two sections each of which required 6 hours of attendance in the lab. In addition, they were expected to attend the lectures, which in Chem 1A and 1B was two one hour lectures per week. We were told that G.N.Lewis did not believe in having lots of course work and the major job of the student was to choose a research project in the first semester, start research and then to pass the oral

qualifying exam in their second year. The oral exam in the late forties and early fifties called for the student to find a paper in the literature and try to correct it in some way, but the major part of the exam required the student to propose two new research experiments. One proposal was to be in physical or inorganic chemistry and the other in organic. Little time was spent on the student's own research topic. After a few years the proposals were to drop to one, and finally they were dropped altogether. It was a very challenging system.

The support as a teaching assistant only lasted for three years, and so students were expected to file a thesis at the end of their third year. This all changed when federal money became available. Theses were quite short, but still very difficult for the student to prepare with almost all the figures supplied as photographic prints which the student prepared in the college dark rooms. Carbon copies were the only copies. The graduate division not only accepted the thesis and checked it for durability, but they also had a few rules. The most troubling one was the language requirement. During most of our period this was a reading requirement in two foreign languages. These language exams were read by a chemistry faculty member, and so the standards were loose. For chemistry students it was largely French and German, but this was a great burden on some students. Over time it dropped to one language and finally it was abolished.

Chemistry's 1948 course requirements were quite simple. Everyone started in Chem 114H, which was advanced thermodynamics using "Thermodynamics and the Free Energy of Chemical Substances" by Lewis and Randall as a text. Those students who received a C grade in this course were in some trouble. The one organic course was really an early version of physical organic and used a text written by Branch and Calvin. The most interesting graduate course was given by Giauque. It traced some of his accomplishments including adiabatic demagnetization and the discovery of the oxygen isotopes. It was essentially a course in statistical thermodynamics as understood by Giauque but hearing from this master was a high point in the course requirements. If one wanted to learn more about quantum mechanics, spectroscopy, and the solid state one had to take or audit physics courses. Chemistry did soon establish a quantum mechanics course which used a textbook written by Pitzer, and this course slowly became more sophisticated as we hired young faculty members.

The major seminar, first established by Lewis, was in 102 Gilman on Tuesday afternoon. It was said that in Lewis' day the chairs were assigned, and Lewis would call directly on students to say what they were doing. By 1948 that had broken down and the students were starting to outnumber the chairs. It soon moved to 100 Lewis and for a time it switched from Tuesday at 4PM to Tuesday at 7PM. All the faculty and students were still expected to attend. As specialized seminars became very common, it finally evolved in what we call the GRC. It was however a thrill to meet in 102 Gilman and imagine the time when the dominating Lewis could

directly question every graduate student. Lewis indirectly controlled every PhD student in his day, but the dirty job of being the formal graduate advisor for the thesis was left to Latimer, Gibson and other faculty members. As a result, Lewis is not listed as the research director in any thesis.

Since almost all the students were teaching assistants and the use of the shops and most chemicals were supplied by the university, much of the research required no outside support. Before the federal government got into the business of supporting research there were only a few sources of equipment money. One important source was the Research Corporation. It was founded by Frederick G. Cottrell. He was born in Oakland and he received a BS from the College of Chemistry in 1896. After obtaining his PhD in Germany he returned to be a College faculty member in 1902. He was both a scientist and an inventor, but clearly, he was one of the most capable Chemistry faculty members at that time. His best known invention was the Cottrell Electrostatic Precipitator which he developed to clean up the emissions from several of our local industries. Instead of collecting its royalties, he used them to create the Research Corporation. It was designed to grant money for research in the physical sciences. Cottrell was rather restless and refused the position as Dean before Lewis came and left the faculty in 1911. He spent much of his professional life working in several federal laboratories. His non-profit ended up giving money to many important research workers including E.O. Lawrence for an early cyclotron. In return, Lawrence gave his patient for the cyclotron back to the corporation. In all, 35 Nobel Prize winners received funds from the Research Corporation in their early years before their prize was awarded. My research director, William D. Gwinn, received money from the Research Corporation for the purchase of klystrons which I used in my own PhD thesis work. We had just started work in Lewis in 1948, but on November 16th I happened to be walking past the lower door to 100 Lewis. I could see that someone had collapsed in the auditorium and that he was being taken away by an ambulance crew. I later learned that it was Cottrell and that he had suffered a fatal heart attack sitting next to Joel Hildebrand at a meeting of the National Academy of Science.

The 1950s graduate students were largely male, and many had been in the service during the war. A few women were present, but their real problem was not opposition from the faculty. A few had problems with their oral exam, but It was largely the newness of it all for women to be graduate students and this was followed by a cool reception from employers when they finished. I know of one woman who was told from by an interviewer from Chevron Research in Richmond that, “they did not have facilities for women.” We never knew exactly what he meant, but she did find an excellent job at Bell Telephone Laboratories. The campus was very full of returning service men, and one semester in 1949 we had two large laboratories in Lewis taken up by students enrolled in Chem 105, which would be unthinkable today. The university had just started to build the high-rise student dormitories and apartments were very hard to

find and relatively expensive. A sign saying that a place was for rent was not to be seen anywhere near campus. Rental listing places did a big business. For chemists a popular place to live was International House. It is close to the chemistry buildings. You had to be single, but many of us met our future spouses at I House. Another popular living arrangement for male students was Mrs. Randall's house. Her late husband Professor Merle Randall was brought to Berkeley by G. N. Lewis, but he was not always popular with the other faculty. In 1944 at age 56 he was forced to become professor emeritus. Clearly this was done after Lewis was no longer dean. It was said that the excuse was that he had asked his students to purchase a text which he had written but which was not appropriate to the course that he was teaching. He died in 1950 of heart trouble. After his death his wife Lillian turned her south campus home on Etna Street into a residence for chemistry graduate students. She did this for several years and she was universally loved by these students.

Freshman Chemistry

The college took this course very seriously. Unlike other schools we did not turn it over to postdoctoral lecturers and it was designed to involve almost all the faculty. In 1948 all the physical and inorganic faculty members were required to attend at least one Chem 1 lab room for the first hour and to lead a discussion of the current lecture subject. This meant that they had to be very experienced or they had to attend the lectures. About once a week a short quiz would be given at the start of the lab to quiz students about the current lecture topic. While the students took this quiz, the laboratory faculty members would wait in a small room in the building and exchange gossip or ideas about chemistry. These discussions, which could include future Nobel Prize winners, were a wonderful way for the young faculty to meet the old. After Hildebrand retired, the lectures were largely taken over by Richard E. Powell. He also helped modernize the final editions of Hildebrand's textbook and the laboratory manual.

The Chem 1A lab experiments went over the fundamentals of chemistry. This included the standard experiments in molecular formulas, equivalent weight and absolute temperature, for example. In Chem 1B most of the time was taken up by the qualitative analysis of some common metals. It used the then standard hydrogen sulfide precipitation scheme as perfected by the late William C. Bray. The lab text was by Latimer and Bray. All the chemicals necessary for these experiments were on the shelves in each lab room, and the students were not required to wear safety glasses. One would expect that many students would be injured by acid burns, but the most serious injuries were cuts and burns caused by the bending of soft glass tubing and the shoving of glass tubing into rubber stoppers. Fortunately, Cowell Hospital was quite close to the chemistry labs. The use of plastic ware removed this problem. If a mercury thermometer broke, we rolled right along. The used chemicals were all poured directly

down the drain. In 1948 most of the sewage probably went untreated into the bay. The 1B qualitative analysis lab also featured unknowns. Students had to first dissolve these solids, and the most infamous unknown would not dissolve in any laboratory chemical. Many serious students loved the challenge of solving the content of these unknowns by observation and conclusion, but it was very difficult for the slower student. The grades in the course were based on a combination of laboratory scores and midterms and the final exam. The grading standards were quite high with about 13% “A” grades and 25% “B” grades. The grades of D and F were not uncommon.

Nobel Prizes and New Buildings

In early October of 1949 the occupants of Gilman Hall were surprised to hear firecrackers. This was Wendell Latimer’s way of announcing that William F. Giauque had been awarded the Nobel Prize in Chemistry. This was the college’s first “in house” Nobel Prize, and everyone was very pleased. In 1954 the University built Giauque a building for low temperature research. It was situated between Gilman and the Old Chemistry Building, so that one could then smoothly walk between the two buildings. The top of Giauque’s building established the plaza level which was later utilized by Latimer and Hildebrand. This building was designed to house unusual apparatus in order to accomplish Giauque’s low temperature experiments which also involved very high magnetic fields. Inside of this building were two enormous direct current generators which were originally streetcar system generators. They were obtained “on loan”, and so the South wall of this building was made extra thin so that these DC generators and the motor which drove them could be removed in one piece. They were ultimately removed, but only in pieces. The major purpose of the low temperature building was to use these generators to energize copper wound magnets. These magnets formed from heavy copper bus bar took years to design and to build. The electromagnetic strain at 100,000 Gauss on the heavy copper windings was very high. In addition, in order to keep the magnetic field constant, the current from the generator had to be regulated to at least one part in a thousand. Fortunately, modern solid state devices had just become available to regulate and handle the very high current, but the design of this regulation system was almost as difficult as the construction and design of the copper coils. Much of the responsibility for these tasks rested on the shoulders of David N. Lyon. He obtained his PhD under Giauque in 1948 and ultimately became a faculty member in Chemical Engineering. The work on the magnets is summarized in a Review of Scientific Instruments publication by Giauque and Lyon in 1960. The motor driving the generators used so much electricity that its hours were limited to late night and the University had to warn the power suppliers before hand. Since this process generated a lot of heat the magnets were cooled with circulated kerosene, and then this was cooled with water. The top of the low temperature laboratory has a raised section with a soft roof which would allow exploding magnets and kerosene to reach for the sky and not injure the building or people on the plaza

level. Such an explosion never took place, but the copper magnets slowly became obsolete as high field superconductive magnets were developed. Giauque was very demanding of his students and the preparation of the large and very pure single crystal samples that he wanted proved to be very difficult for some of his students.

Glenn T. Seaborg's Nobel Prize was awarded in 1951. It was shared with Edward McMillan for their work on the chemistry of the transuranium elements done during the war. Much of the chemistry was done on the third floor of Gilman Hall. The establishment of the Atomic Energy Commission resulted in very stable funding for nuclear chemistry and nuclear physics both on campus and above the campus, "on the hill", where the large cyclotrons were located. McMillan was a faculty member in physics and he also headed what was ultimately designated as the Lawrence Berkeley Laboratory, LBL, or the Rad Lab, for several years. Seaborg was famous not only for his nuclear work, but he also served as the head of the AEC from 1961-71. Over the years he was called to Washington to advise many Presidents about scientific problems. He also served as the Chancellor on the Berkeley campus at a very important period of expansion from 1958-1961. He received many honorary awards, and his many honorary PhD robes have been displayed on very special occasions.

Melvin Calvin's Nobel Prize was awarded in 1961. His office was in Old Chem, but as we mentioned before the lab work was done in the Old Radiation Laboratory. As a result, when Latimer and Hildebrand were built, he became doubly homeless. For a short time he and his group moved into the sixth floor of Latimer. His own building, the Chemical Biodynamics Laboratory, later known as the Calvin Laboratory, was built shortly after Latimer in 1963. It was not funded by the University as were the few other specialized research buildings on campus. Calvin's old office in Old Chem had a fireplace and so one was installed in his new office in Latimer. It never worked properly, and so the occupants of Latimer could detect when he would light a fire. It was finally moved into his own building. Calvin published more papers and ran a larger group than any other Chemistry faculty member, but he still continued to teach organic chemistry to biological students in Chem 8. Towards the end of his career, he became very interested in the energy problem, and he proposed growing plants which were capable of directly producing liquid fuels.

In 1946 Wendell Meredith Stanley received the Nobel Prize in Chemistry for his work on the crystallization of the tobacco mosaic virus. This prize was shared with two other people who had been able to do similar work on proteins and enzymes. He was at the Rockefeller Institute at the time, but in 1948 he came to Berkeley with the promise of a building devoted to virus research and a modernized biochemistry department. It is said that Latimer was important in seeing that his building was not built down hill with the other biology buildings but was built near chemistry. It was completed in 1952 and looked very much like Lewis Hall. It had several

names such as the Virus Laboratory, but after Stanley died in 1971 it was named Stanley Hall. It was torn down in 2003 and replaced in 2007 with the grand building which you see today. Since it is close to our buildings it is very conveniently occupied by the research groups of a number of chemistry faculty members and it is the most recent expansion of chemistry's research space.

Our own most recent Nobel Prize was won by Yuan Lee in 1986, but more will be said about that later. Henry Taube's 1983 Nobel Prize can be partially clamed by us, although he just received his PhD in 1940 and was only an Instructor for one year. If the war had not interrupted his work, he might have stayed in Berkeley. While Kenneth Pitzer never won a Nobel Prize, he was the most likely physical chemist to inherit the mantle laid down by Lewis. His early research was in petroleum thermodynamics and was funded by the American Petroleum Research Institute. He left campus in 1949 to head the research division of the AEC, and as expected when he returned to the College in 1951 he was appointed the Dean. He was instrumental in seeing that the AEC, later the Department of Energy, awarded money that was used in the College for other than nuclear research. He obviously enjoyed heavy administration and in 1961 he became president of Rice University. In 1968 he jumped to Stanford. This was a difficult time for him and he returned to our department in 1971. He revised Lewis and Randall's old thermodynamics text, with the help of Leo Brewer, and did some famous work on the calculation of the activities of ions in concentrated aqueous solutions. He was a wonderful colleague.

Chemistry 4

The first year chemistry curriculum has evolved over time, but the creation of Chemistry 4 was an early revitalization of the first year course. In the 1950s many schools decided to include much more quantitative analysis into the first year course. This required a considerable investment in analytical balances and schools also had to provide the space for this equipment. This was not practical in our many Chem 1A/1B labs, and so it was decided to create a new small first year course which would be populated by the best first year students. The first professor selected to teach this course was the newly hired Bruce Mahan. He was an all Harvard physical chemistry graduate who was hired in 1956. He was followed by George Pimentel, but George quickly went on to do the lectures in Chem 1. He was very popular with the students in Chem 1 and he became the model for the modern Berkeley first year lecturer. The Physical Science Lecture Hall that replaced the old lecture hall attached to Old Chem was named for him shortly after he died in 1989.

Mahan took his notes for his Chem 4 lectures and turned them into an outstanding chemistry textbook, entitled "University Chemistry." It sold very well all around the world and we had the privilege of first using this text in Chem 4. About the time that he finished its 3rd edition Mahan came down with amyotrophic lateral sclerosis and he died a slow tragic death in 1982. The 4th edition was completed after his death by Rollie Myers.

Since Chem 4 had one more unit than Chem 1 and a higher level of instruction it took some skillful recruiting to gather its 120 some students. This was not too difficult for in those days the students who wanted to enroll in Chem 1 had to stand in line for at least an hour. So, we would move up and down this line until we had a few more than 120 students who were qualified and willing to take Chem 4 instead of Chem 1. The extra unit meant that they would be excused from ever taking Chem 5. Harold Johnston was the faculty representative for the planning of Hildebrand Hall. He gave Chem 4 one-half of the second floor of Hildebrand with a large storeroom and two large labs. This space lasted for several years, but the pressure to expand the lab space in biophysical chemistry forced Chem 4 to move into the second floor of Latimer. With the computerization of course enrollment it became increasing difficult to properly recruit the best students for Chem 4, and so It is now a required course for our Chemistry majors.

Further Course and Faculty Diversification

The biophysical faculty became fully established after Zimm left in 1952 by Ignacio Tinoco (1956), John E. Hearst (1962), and Kenneth Sauer (1963). They joined O'Konski who was more of a regular physical chemist, but he had organized a special section of the upper division physical chemistry course, then called 110, to contain biophysical material. After a few years this special section evolved into a course designated as 106. Tinoco, Sauer and James Wang (1966) wrote a textbook for this course in biophysical chemistry and it too was a successful text. It has had several editions including its current one with additional authors. Wang later left for Harvard in 1977.

The organic group branched out into full fledged physical organic by the addition of Andrew Streitwieser (1952). With the formation of a stronger organic group our attraction to graduate students who wanted to get an organic PhD greatly increased, and both upper division and graduate organic courses were created. The expansion of the inorganic faculty preceded more slowly, Norman Phillips (1955), did low temperature work on inorganic materials, but he was even more allied with physics than Giauque. Brewer worked closely with the spectroscopic group in Physics, but he could be best classified as an inorganic or even materials chemist. Connick was essentially the head of the inorganic group and worked in solution chemistry. He served as the second chairman of the Chemistry Department after that title was not also the

Dean of the College. The first Chairman was Isadora Perlman, but he did not like administration and only served from 1957-58. Connick, on the other hand, liked administration and after being the Department Chairman for one year he replaced the absent Pitzer as Dean from 1960-65. He then served as Berkeley's Vice-Chancellor-Academic Affairs for several years starting in 1965. Templeton did X-ray crystallography on inorganic salts, but he was more of a physical chemist than an inorganic one. William Lee Jolly (1952) had worked with Latimer and he worked in synthetic inorganic chemistry. He was the primary teacher of the one semester upper division inorganic course. Powell always had a very small but very diverse research group. Powell's most famous student was Gabor Arpad Somorjai. He received his PhD under Powell on small angle X-ray scattering of catalytic particles in 1960, but he was not added to our faculty until 1964.

Latimer could see the growing importance of instrumentation in chemistry, and Joseph C. Guffy was hired to set up a chemical instrumentation upper division course designated as Chem 125. The laboratory room was dominated by a large spectrograph which was designed for inorganic emission analysis. This laboratory was not successful and Guffy left after two years to join Chevron Research. The Chem 125 course lived on for several years as a lecture course on chemical instrumentation. The lesson learned is that fancy instrumentation has to be first introduced as a research service, and only when the instruments come down in price and become more reliable can they be placed in undergraduate laboratories.

Physical chemistry remained as the dominate group in Chemistry. George Pimentel was a natural leader in research with a specialization in the infrared spectra of frozen films containing interesting species in a low temperature matrix. He used solid nitrogen for the matrix, but he could only cool it to liquid hydrogen temperatures in order to get good infrared transparency which was presumably the result of slower freezing. Safety considerations would make that much use of liquid hydrogen very difficult today. In about 1960 he discovered that the photolysis of methyl iodide in a frozen matrix produced iodine atoms in the upper of the two ^2P states. This resulted in an infrared laser, even without mirrors, and this was the invention of the chemical laser. Later he became very interested in building a spectrograph which NASA would use in a Mars fly-by. Like Lewis and Pitzer before him George had little respect for physical chemists who only did theory. He served as Chemistry Chairman from 1966-68 and was succeeded by Bruce Mahan 1968-71. Bruce was more Harvard than old Berkeley, and he hired two physical chemists who only did theory, Robert A. Harris in 1968 and William Hughes Miller in 1969. The Dean at the time was Harold Johnston, and so he must have supported hiring theoreticians. They became the foundation of our current theoretical group.

One of the major appoints in physical chemistry was Dudley Robert Herschbach (1959). He had received his PhD from Harvard working with E. B. Wilson in microwave spectroscopy, but as an undergraduate at Stanford he had worked with Harold Johnston. Until he left Berkeley for

Harvard in 1963, he had set up a large molecular beam laboratory which was made possible because of the large scale machine work done at LBL. Herschbach was able to take some of this equipment to Harvard, but enough remained for Bruce Mahan to carry on molecular beam work. When Pitzer was on a trip to Taiwan he met a prospective graduate student by the name of Yuan Tseh Lee. Lee did come to Berkeley and worked with Mahan on molecular beams receiving his PhD under Mahan in 1965. Lee then did post doctoral work with Mahan for one year and with Herschbach at Harvard for second year. He then he joined the faculty at Chicago, but he returned to our faculty in 1974. In 1986 he shared the Nobel Prize with Herschbach and John Polanyl.

After 1952 the Department of Chemical Engineering continued to grow. Eugene E. Petersen was hired in 1953, and in 1954 and 1955 there were two particular distinguished appointments, Andreas Acrivos and John Prausnitz. They were followed by Donald R. Olander in 1958 and a senior appointment of Michael Boudart in 1961. Acrivos jumped to Stanford in 1963 and Boudart followed in 1964. By the 1960s Stanford had arisen from a long sleep for in 1956 when Johnston first left Stanford for Cal Tech in 1956 he reported that he had little faith that Stanford's Chemistry Department would ever be first class.

Faculty Growing Pains

In the old college a young Instructor was often picked as a possible replacement for a soon to retire senior faculty member. This concept still was active in the early 1950s, and one of the soon to retire faculty member was Axel Olsen who retired in 1954. At one time George Pimentel and I were in a small race to fill the position of teaching Chem 5, which was Olsen's course assignment. By the middle 1950s things changed. Seaborg had become Chancellor and the University was in a position to expand its faculty. For several years after that time the College had many more faculty positions, FTEs, than it had space or energy to fill. Money was not a problem for in those days a new faculty member was supposed get by largely with existing equipment. As a result, "set-up" money was not an important factor in hiring, but space was always a problem.

As we have indicated before, the post war growth of the faculty in physical chemistry went much more smoothly than it did in organic and inorganic. While physical chemistry may have missed adding some potentially important faculty by their bias against people who did theory, the organic and inorganic groups did rather badly in adding faculty. I was only directly involved in two such cases. In 1958 I was attending a meeting at Caltech, and I had been told to contact John Paul Schaefer there and assure him that his appointment in organic chemistry was coming along. The next year he came as a new assistant professor. He stayed exactly one year and jumped to the University of Arizona. Clearly, he had great talent for at Arizona he became their Chairman in Chemistry in 1968 and then in 1971 he was appointed as President of the

University of Arizona. He held this job for 11 years and then afterwards he became CEO of the Research Corporation for six years. He even moved the Corporation from New York to Tucson. He is presently best known for his skill in photography and his connection with Ansel Adams. Three other organic faculty were also hired, George Alvin Wiley in 1959 and in 1960 William C. Agosta and Phillip E. Eaton. Agosta and Eaton both left after one or two years and went on to distinguished careers in other major research institutions. Clearly, the organic group could not retain first class scholars in the 1960s. George Wiley was a special case. He was an African-American and he was very interested in being active in the civil rights struggle and the intense emphasis on research in Berkeley was not right for him. He left after two years and went to Syracuse University where he was more able to do activities such as founding the National Welfare Rights Organization. In 1973 he was reported as missing while sailing in Chesapeake Bay, and he presumably drowned. The George Wiley Award in Organic Chemistry at Syracuse is named in his honor.

The reason for the poor retention of assistant professors in organic chemistry was explained to me recently. It was not poor personal interaction with the senior organic faculty members, it was their poor support of the junior faculty. It seems that the supply of incoming organic graduate students was very limited, and so the synthetic organic assistant professors who were hired before 1970 were told that they could not take on graduate students. As a result, the most talented ones left for other schools. This was not true for the physical chemistry and inorganic assistant professors, and so several of them stayed on for several years but were not finally promoted. Most had graduate students who either left with their research director or had to be accommodated by tenure faculty.

My major contact with hiring in Inorganic was when I was handed the CV of James Ibers. He was at the fine research laboratories of the Shell Oil Company in Emeryville. He did X-ray crystallography and had obtained his PhD and X-ray training at Caltech working with Pauling's associates. I was instructed with the task of determining whether he was "another Pauling." The answer to that question had to be no, for that was an impossible standard for a new faculty member. Ibers left Shell, long before they shut down the labs, and went to Northwestern where he has had a very distinguished career. This was clearly recognized by us when we hired Kenneth Raymond in 1968 who had obtained his PhD under Ibers. Charles Harris was hired as an inorganic chemist since he had obtained his PhD under Albert Cotton in 1966, but he rapidly turned into a physical chemist. Neil Bartlett was hired as a senior inorganic chemist in 1969, but some would say that the hiring of Earl Muetterties in 1978 was the turning point for inorganic chemistry in Berkeley.

The nuclear group's hiring was handled by Seaborg. Kenneth Street received his PhD under Seaborg and was a co-author of the early 1950 paper about the making of the new element

Californium, but he first went to the new National Laboratories in Livermore. He returned as a faculty member in 1959, and for personal reasons he returned to Livermore in 1974. John Rasmussen, another Seaborg student, was appointed as a faculty member in 1952, but in 1969 he jumped to Yale. After three years at Yale, he returned to our faculty. Another Berkeley nuclear student, Joseph Cerny, was hired in 1961 and he became very active in university administration.

There is a relatively long list of assistant professors in physical chemistry who did not receive tenure, but Bradley Moore (1963) who worked under Pimentel was an exception and he has even served as Dean of the College. Herbert Strauss (1961) along with Bruce Mahan (1956) and Harold Johnston (1957) helped break the mold of hiring only our own PhDs in physical chemistry.

The Bad or the Funny

The College suffered from a few dramatic thefts. The first ones involved metal from a storage area in the low temperature building. These thefts were not widely discussed, but a large amount of war-surplus mercury was carried away one night. In hindsight this was probably a blessing for after 1970 one had to pay people to take mercury away and after 1990 no one would touch it. The platinum theft was another matter. Over the years the college had collected a relatively large amount of platinum ware including crucibles and dishes. They were collected for use by analytical chemists for the dissolution of rock samples with hydrogen fluoride or even molten NaOH. A heated platinum crucible also has a very stable weight. Today we might use Teflon plastic ware and a platinum evaporation dish is not to be found. This platinum was stored in a four to five foot high well-built steel safe weighing perhaps 2000 pounds. The safe was in room 19 Lewis. At the time this room was part of the Chem 5 storeroom. Very few people knew about the contents of this safe, but anyone who went into room 19 on business would have seen the beast. One Monday morning the storeroom manager discovered that the entire safe was missing. The safe did have wheels, but its removal required a heavy duty truck and a multi-person crew.

The funny was really a scandal in the middle 1950s. A quiet divorce was accepted by that time, but a messy one was considered a scandal and this one was outstanding for its time. The elements were a young assistant professor with a wife and a young graduate student whose wife was very talented with her own PhD and could be considered as the "*femme fatale*." To make things messier the assistant professor's wife was pregnant and she was also good friends with the wife of a senior faculty member. For the other young faculty members our job was to act ignorant and to keep a low profile. As one could imagine, the assistant professor quickly departed for another chemistry department as did the *femme fatale*. The graduate student survived and also lived to be a distinguished faculty member in several chemistry departments.