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HERMAN SAMUEL BLOCH
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A Biographical Memoir by

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HERMAN BLOCH WAS BORN in Chicago to Aaron and Esther Bloch, who were immigrants from the Ukraine. He attended Senn High School on Chicago's north side, graduating in 1929 with high honors. According to his principal, his grade point average of 97.41 was the highest ever achieved by a Senn graduate. On the basis of this outstanding record he was granted a full-tuition scholarship to the University of Chicago, where he graduated Phi Beta Kappa in 1933, with a degree in chemistry and physics. He continued at the University of Chicago for graduate school, receiving his doctorate in organic chemistry in 1936, with Prof. Julius Stieglitz as his thesis advisor.

After receiving his doctorate he joined Universal Oil Products Co., a research company specializing in the development of refining processes and products for the petroleum industry. In 1940 he married Elaine Judith Kahn, also a University of Chicago graduate. Herman and Judith had three children, Aaron, Janet L., and Merry D., of whom I will say more later.

Herman joined Universal Oil Products (UOP) during a period when the petroleum industry—while not exactly in its infancy—certainly was not that far advanced technologically. Most of its products were developed by thermal cracking of crude petroleum to produce straight-run gasoline, with tetraethyl lead being added to boost the octane number to a value suitable for smooth running in the internal combustion engines of that period. The petrochemicals industry was virtually nonexistent. The company's R&D activities were carried out in a Chicago suburb, at the Riverside laboratory, which had been established in 1921 for the purpose of applying the latest developments in science and technology toward the manufacture of gasoline to serve the growing automobile market. To that end a staff of outstanding scientists and engineers had been assembled at Riverside. Herman joined this group as a young research chemist in 1936, immediately after receiving his doctorate.

The research laboratories were moved to Des Plaines, another Chicago suburb, in 1956. After going through a period of diversifications and acquisitions in the 1960s and 1970s, UOP was subsequently acquired by Signal Companies, which merged in the early 1980s with Allied Company to form Allied Signal. In 1988 the refining and petrochemicals process unit was spun off and combined with the catalysts and absorbents unit of Union Carbide to form a new "UOP," jointly owned by Allied Signal and Union Carbide. In 1999, with the purchase of Union Carbide by Dow Chemical and the merger of Allied Signal and Honeywell, UOP became a joint venture between Honeywell and Dow Chemical. With all of these changes it is amazing how little has changed in terms of the UOP mission and core business. Processes developed by Herman and his colleagues are still very important to the business and survive, with modifications and updates to keep pace with current technology, to the present day.

Much of the history of both the Riverside and Des Plaines labs is given in a historical account of UOP published in 1994, the eightieth anniversary of the company's founding.[1]

The Riverside lab was designated as a National Historic Chemical Landmark by the American Chemical Society in 1995.[2] Bloch's research contributions are highlighted in the history as well as the commemorative brochure that accompanied the landmark designation.[3]

It gives me great pleasure to author this biographical memoir of Herman, who was my mentor, friend, and fellow chemist.

RESEARCH AT UNIVERSAL OIL PRODUCTS COMPANY

When Herman joined UOP, the study of reaction mechanisms as a subfield of organic chemistry was underway. In their attempt to make better gasoline and improve the yield of gasoline from a barrel of crude oil, UOP chemists were at the forefront of studies on fundamental hydrocarbon chemistry. There was a rather general consensus among traditional organic chemists that while the chemistry of olefins and aromatic hydrocarbons was interesting and important, the chemistry of paraffins was not, and hardly worthy of much effort. Indeed, the very name "paraffin" means "little affinity," or unreactive. When Herman arrived at UOP, he became a part of an effort to modify paraffinic hydrocarbons to make better gasoline using catalytic chemistry rather than the predominantly thermal processes prevalent at that time.

A fundamental achievement of UOP research scientists was their understanding of the role of acid catalysis in initiating the full range of hydrocarbon reactions leading to the formation of a higher grade and yield of gasoline. This represented one of the first examples of the use of what was then called carbonium ion chemistry—now called carbocation chemistry—in a practical way to form useful products. This was extremely important during World War II, when the use of acid-catalyzed reactions of hydrocarbons led to gasolines having a much higher octane number. The gasolines obtained from these processes were far superior to those being produced by the Axis powers and resulted in Allied pilots having a substantial performance advantage over their German counterparts. This achievement has been cited by some observers as one of the keys to victory during the Battle of Britain.

Herman carried out fundamental research studies on the full range of reactions of hydrocarbons that could be used to make a higher quality and quantity of gasoline, conducting research on classic organic reactions, such as isomerization, polymerization, cyclization, dehydrocyclization, and dehydrogenation—all of which can be initiated by formation of a carbocation, or in some cases a carbocation radical.

A further development that arose from these studies was an appreciation of the fact that surface acidity could catalyze reactions in a similar manner to solution acidity. Among UOP scientists who carried out critical work on solution acidity that supported this analogy were Louis Schmerling and Herman Pines, both of whom went on to receive American Chemical Society awards for their work. UOP scientists pioneered in the development of catalysts whose surfaces had been modified to increase acidity by the addition of trace amounts of noble metals. This understanding eventually led Bloch's colleague, Vladimir Haensel, to develop a catalyst that contained a relatively small amount of platinum on alumina as a reforming catalyst. The term "reform" refers to those processes by which the structures of hydrocarbon molecules are rearranged to form new molecules that are more highly branched and more aromatic. The reformed molecules give gasoline that has a much higher octane number and runs much smoother in internal combustion engines. The use of the platinum-on-alumina catalyst, further modified by halide ions, gave significant improvements in gasoline yield, as well as higher octane gasoline. This process was patented, trademarked, and licensed as "platforming," or platinum reforming.

Even more important, from the standpoint of basic organic chemistry and process chemistry, platforming led to the formation of large amounts of aromatic hydrocarbons. Prior to this development the main source of these basic organic chemicals was the coal tar that was a by-product of the coke and natural gas industry. The products from coal tar were of uncertain quantity and quality. Herman Bloch led the way in the development of a separation process for separating aromatics from nonaromatics by selective solvent extraction, which was trademarked as Udex. A single platforming unit, attached to a Udex unit, produced more aromatics during a relatively short period of time than were obtained from coal during the entire period of World War II. If left in the gasoline fraction, the aromatics led to significant improvements in the overall octane ratings, as mentioned earlier. When separated from nonaromatics into the individual C6-C9 aromatics, they became intermediates for the plastics, textile, and synthetic fibers industries. These industries were virtually nonexistent before the advent of a reliable source of chemical intermediates from petroleum. It should also be noted that the significance and importance of the entire petrochemicals industry was greatly enhanced by the operation of the platforming process and the separation processes. Herman's role in the development of a process for this separation was crucial to the utilization of aromatic hydrocarbons as commodity chemicals and the establishment of robust petrochemical and polymer-based industries.

Immediately after World War II there was significant growth in the synthetic detergents industry. Most of these detergents were based on sulfonated alkybenzene derivatives. The problem with these detergents resided in the nature of the alkyl chain(s). Because these alkyl chains were highly branched, the detergents could not be completely degraded by bacteria. Thus, when laundry wash water was discharged into streams, the detergent molecules were not degraded and retained their detergent properties. The resulting buildup of these waste detergent molecules caused severe foaming in lakes and streams. The solution to this problem seemed obvious: Use linear alkyl benzensulfonates as detergents instead of the branched-chain derivatives. The problem was that the long-chain linear olefins necessary for the formation of the desired alkylbenzenes were not readily available.

Although the process leading to the appropriate alkylbenzene derivatives seems straightforward in retrospect, it was anything but that in execution. There was no readily available stock of linear olefins for benzene alkylation. Fortunately, the UOP Molex process that was developed to separate low-octane-number linear paraffins from naphtha in order to increase the octane number of the paraffinic components of gasoline could be modified to work with higher-molecular-weight alkyl mixtures. Using this modified process, linear paraffins were separated from branched paraffins. The naphtha remaining could be further isomerized to give more linear paraffins and the separation cycle repeated to give more linear paraffins. Eventually the total hydrocarbon feedstock could be converted to a mixture rich in linear paraffins of the desired chain length.

The linear paraffins could be selectively dehydrogenated by a process, developed by Bloch and his associates, called the Pacol process, to give the desired straight chain primary olefins. Herman was also involved in the development of the process by which benzene was alkylated with linear olefins to produce alkylbenzenes. The alkylbenzenes were then sulfonated to produce biodegradable detergents. The process was described and illustrated with a full-page story in the Technology section of the American Chemical Society's weekly newsmagazine, *Chemical & Engineering News.*[4]

Although the LAB (linear alkyl benzene) process was introduced nearly 40 years ago, it is still one of the major UOP technologies. Even though the process has been continuously updated and improved—they are now on the fifth generation of catalysts—the essential details of the original process are still in place. As it is described today in UOP trade literature, it still consists of the basic steps as listed below.

1. Hydrotreated kerosene or other paraffinic feedstocks are fed to a molecular sieve unit for separation of normal from branched paraffins (UOP Molex Process). The naphthas and branched paraffins are eventually all converted to normal paraffins by a combination of isomerization/separation steps.
2. The normal paraffins in the C-10–C-14 range are dehydrogenated to give the corresponding linear olefins. This step is known as the Pacol Process.
3. The linear olefins are then used to alkylate benzene in an acid-catalyzed process to form the LAB. This process now uses a solid acid catalyst.

As of today 85 percent of the world's supply of LAB detergents are made using this technology. There are 25 to 30 plants located all over the world. Since its development as a UOP process, it is estimated to have contributed more than $500 million to UOP revenues.

It seems that for much of his professional career Herman was focused on finding a solution to a serious environmental problem. For the most part this was coincidental, and an observation can now be made retrospectively. It just so happened that because the petroleum and petrochemicals industries produced such a large proportion of widely used consumer products, it was inevitable that waste products and by-products would also be produced in significant quantities. It is one of the characteristics of technology that problems caused by its use can usually be solved most effectively by the application of additional technology. But I also have absolutely no doubt that working on solutions to these problems had a powerful appeal to Herman's sense of stewardship for the world in which we live and all who live in it. He truly did believe that we ought to work to make the world a better place and that chemists have a special role to play in bringing this about.

So, when the exhaust gas from automobile engines was found to be a major contributor to smog and that a major component of exhaust gas was unburned hydrocarbons, it was natural that Herman would consider the possibility of using UOP catalysts in a post-engine device for the cleanup of engine exhaust. Herman led the team that focused on the development of such a catalytic device. Of course, this involved much more than the technical aspects of using science and technology to develop a product. The automobile industry had to be convinced that it would have to take this step. In order to meet exhaust emission standards of the Clean Air Act, the industry finally accepted the idea that it had to accept a retrofit developed by someone else for their automobiles. Today every automobile produced throughout the world has to have a catalytic exhaust device in order to meet clean-air standards. Without these devices, life would be a whole lot more uncomfortable and unhealthy for the world's citizens.

Herman received many awards for his research achievements. He was honored with the Eugene Houdry Award in Applied Catalysis from the Catalysis Society in 1973; Kokes Lecturer, Johns Hopkins University in 1975; E. V. Murphee Award in Industrial and Engineering Chemistry from the

American Chemical Society in 1975; the IR-100 Award from Industrial Research Magazine; the Robert A. Welch Lecturer in Chemistry in 1975; and elected to National Academy of Sciences in 1975.

Earlier I mentioned that when Herman came to Universal Oil Products, he joined a research group at the Riverside laboratory that was conducting fundamental research on the chemistry of hydrocarbons. On November 15, 1995, the laboratory was designated as a National Historic Chemical Landmark by the American Chemical Society. Bloch and his accomplishments were cited among those responsible for the landmark designation.

It is important to note that in addition to his achievements and contributions as an outstanding research scientist, Herman was also a very skilled and dedicated manager and leader of research groups. Most of his career predated the time of dual career ladders. Under the dual career system it was possible to choose between being a research manager or research investigator as a career path. Herman was very productive in both roles and progressed steadily after joining UOP as research chemist in 1936. He subsequently became research group leader (in 1939), coordinator (in 1945), deputy director of refining research (in 1955), associate director of process research (in 1961), associate director of research (in 1964), and director of catalysis research (in 1973), a position from which he retired in 1977.

AMERICAN CHEMICAL SOCIETY

Throughout Herman's career he was actively engaged in and involved with the American Chemical Society. He supported the society through membership in the Chicago Section and the Division of Petroleum Chemistry, subscribing to its major journals and abstracts, attending society meetings and serving as an officer, and presenting papers at meetings and in journals. To be more specific, he served as chair of the Chicago Section, councilor from the section, member of the board of the society for nine years, chair of the board for five years (the only person ever to do so for that length of time), and chair of several local and national committees.

He led the board of directors during a time of significant change in the public affairs focus of the American Chemical Society, as well as that of other scientific and professional societies. Historically, the only involvement of these societies with governmental bodies and public agencies had occurred when the government was in some kind of crisis and needed the special scientific and technical knowledge that society members could contribute. They would then be invited to give their expertise during the period of the emergency. Most often this occurred during wartime. This posture began to change in the 1960s and 1970s. Herman was a leader in this change of direction. One result was that Herman, as board chair, presented testimony that represented the ACS position on pending toxic substances legislation before the Subcommittee on Consumer Protection and Finance of the Committee on Interstate and Foreign Commerce of the U.S. House of Representative. He presented testimony in 1975, and the landmark toxic substances control legislation was passed in 1976. The legislation has been critical ever since to the nation's environmental protection program.

While Herman was a member of the ACS Council in the 1950s, he became very troubled by the fact that when meetings of the society were held in Southern cities, the society abided by the laws and customs of the region, and minority members were not allowed to stay in hotels or meet in function rooms where committee meetings were held. He, with other like-minded councilors, presented a resolution that attempted to prohibit the society from holding meetings in cities that required the society to enforce segregated practices. Although the motion was tabled, the message was heard and no future meetings were scheduled in Southern cities until civil rights laws were passed to eliminate segregation in public accommodations.

It is not surprising that Herman took a stand for what was a very unfair and insensitive practice toward the society's minority members. Not only did it go against the very strong grounding of his faith in the tenets of Judaism, it violated his sense of fair play. In addition, the practice of such acts of discrimination directly affected friends and colleagues with whom Herman had strong personal relationships. They were members with him in the Chicago Section, the society, as well as other professional organizations. I remember vividly when Herman told me this story many years later. You just knew he felt it was one of his finest hours as a professional and as a human being. As he shared it with me, I could feel the sense of pride that he felt, and I, too, felt the same pride. I was elated that he shared the moment with me.

As a dedicated and committed chemist, he gave a significant amount of time and effort to the American Chemical Society, first and foremost. But he also was a member of the American Institute of Chemists, the Catalysis Society, the Chicago Chemists Club, American Association for the Advancement of Science, Society of Chemical Industry, and the Illinois and New York academies of science. He was a founding member of the Chicago Chemists Club and was also very active in the local chapter of the American Institute of Chemists.

CIVIC AND COMMUNITY CONTRIBUTIONS

During his entire life Herman felt a strong obligation and duty to be involved in the support and uplift of his community. This led to his answering the call to serve in those organizations that are the heart and soul of any community. For example, during a lifetime of commitment he served as a member of the Cook County Housing Authority for many years, serving as chair in 1971. (Chicago is located in Cook County.) During his tenure he fought for fair housing for all citizens of the county, without regards to race, ethnicity, or religion. This was a period during which adequate housing for all citizens was an issue that was hotly debated, and certainly not universally accepted. He served on the Human Relations Commission of the city of Skokie, Illinois—where he made his home—for six years. During his tenure he authored the first fair housing legislation for Skokie. He also served as a trustee of the library board for many years. For his civic work he received many community service awards, including the University of Chicago's Distinguished Alumni Award for Public Service. For the State of Illinois he served as chair of the physical sciences section of the Illinois Board of Higher Education.

HUSBAND, FATHER, MENTOR

Herman was much beloved by all who knew him. He and his wife, Judith, were married for 50 years, from 1940 until his death in 1990. With each of his children he had very special relationships. His son, Aaron N., received his B.S. from Yale before going on to get his Ph.D. in chemical physics from the University of Chicago, working with Prof. Stuart Rice. Aaron went on to have a very distinguished career in industry, serving as a principal scientist with the Exxon Corporation for many years, followed by an academic career as vice-provost for Columbia University for three years. He served for four years as provost for the University of Buffalo until his untimely death in 1995.

His daughter Janet also attended the University of Chicago as an undergraduate. She went on to do graduate work at

Harvard, where she received an M.S., and returned to the University of Chicago for her Ph.D. in Russian history. She is presently a professor of history at the University of Miami (Florida). His daughter Merry Bloch Jones did her undergraduate work at Cornell and received an M.A. from the Annenberg School for Communication at the University of Pennsylvania. She is a popular author with many books to her credit.

Given the special relationship that the Bloch family has with the University of Chicago, it was not surprising that Mrs. Bloch chose to offer the chemistry department at the university the opportunity to host an annual lecture in Herman's memory that would honor an industrial scientist. Thanks to a generous contribution from UOP and contributions from his many friends, the lectureship was established, with the first presentation being made in 1992. In addition to honoring Herman's memory, the award has a two-fold purpose. First, the award is intended to recognize the achievements of chemists and chemical engineers who made outstanding contributions to science while working in industry, as did Herman Bloch; second, the award is meant to promote creative dialog between academic and industrial researchers. There is no doubt that the lecture has succeeded in achieving its stated purposes. As a result of the award, outstanding industrial researchers have the opportunity to visit the University of Chicago annually and share their research with faculty, students, and invited guests.

Herman was a father figure and mentor for all who worked for him and for other young men and women whom he met outside of work in his professional and civic duties. He was first and foremost a very gentle man, with a great sense of humor. I can remember going to him on many occasions with a problem—sometimes technical, sometimes about life. His approach was always the same. He would lean back, reflect for a while, perhaps ask a question for clarity, and then he would give advice that was not necessarily a direct answer to the question you had asked, but he had put you on the path that would lead you to your own understanding and solution. He always would make sure that you did the critical thinking so that you could claim ownership of whatever the outcome might be.

There is another term, used frequently today, that also can be applied to what Herman meant to many who knew him: role model. People observe you and want to be "like you." In his professional capacity as a research leader at UOP, as chair of the board of the American Chemical Society, and as a community leader, he was much admired and emulated. He touched and affected lives far beyond those with whom he worked on a daily basis, and his legacy will live on in his technical achievements, in the lives of those who admired and were inspired by him, and the life of service that he gave to his society, community, profession, and nation.

THIS BIOGRAPHICAL MEMOIR for Herman Bloch would not have been possible without help and encouragement from Mrs. Judith Bloch, who shared many personal documents and information about her beloved husband and family life. I have truly admired her spirit and dedication in establishing the Herman Bloch Lectureship, which continues to contribute to Herman's legacy as an industrial scientist. Thanks very much to Bipin Vora for the information on biogradable detergents, Tamo Imai for general information about the period during which he worked for Bloch, and to George Lester for assembling much of the material that served as the basis for this memoir, as well as continued consultation and encouragement. Finally, I would be remiss if I failed to mention Shirley Cornelious, Jo Ann Boston, and Kay Kim of the UOP Technical Information Center. Their help and support in locating information was crucial to bringing this effort to a successful conclusion.

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