George W. Parshall

1929–2019

BIOGRAPHICAL *Memoirs*

A Biographical Memoir by
Robert H. Crabtree

NATIONAL ACADEMY OF SCIENCES

GEORGE WILLIAM **PARSHALL**

September 19, 1929–July 28, 2019

Elected to the NAS, 1984

By Robert H. Crabtree

From Depression-era poverty, George Parshall rose to lead chemical research at DuPont Central Research and in so doing had influence far beyond his company. His support greatly enhanced the status and development of the field of homogeneous catalysis—indeed, he wrote the best book on the field as early as 1980. In particular, he attracted a world-class group of collaborators and, with his instinct for what would be most promising to pursue, was a key influence in their scientific development, with the result that many of them went on to have stellar careers of their own. His generosity, energy, and kindness were also evident in the onerous task he took on after retirement: working with colleagues to bring about the destruction of the vast stockpiles of chemical weapons that had built up over decades in remote locations both at home and abroad.

Early Life

George Parshall was born on September 29, 1929, on the Minnesota family farm, the son of George Clarence Parshall Sr. and Frances Parshall (née Virnig). He was baptized in the Catholic faith of his mother. George Sr. briefly served in the Army during the Great War but survived both it and the subsequent 1918 flu pandemic. Frances grew up as a farmer's daughter in a German-speaking family, but the war made her family, along with many other German Americans, adopt Anglo culture and language. The family was badly hit by the Great Depression: not only did the economics of farming gravely deteriorate, but the Parshall family side business of tourist cottage rentals also slumped and the family had to move to a smaller farm. By 1936, George Sr. had obtained a job with the forest service, allowing the family to leave farming and move into the small town of Hackensack, Minnesota, where electricity was available to them, allowing George junior to read conveniently in the evening for the first time.

In an early indication of his scientific talent, George helped his father in fire spotting. This required climbing the lookout towers, identifying the type of smoke seen, whether from a forest fire or not, and triangulating the location of any suspected fire. In 1937, George Sr. temporarily lost his job, with the result that the family became squatters in the Forest Service cabin associated with a tower, with the tacit permission of the sympathetic Forest Service area superintendent. George Sr. was even reduced to poaching a deer from the forest to provide food for the family. Back in employment, George Sr. assisted the Weather Bureau by taking daily readings of temperature, humidity, wind, and precipitation. George showed his scientific inclinations in this area, too. When his father was out of town, he recorded the data.

George was a great reader, obtaining books by mail from the Minnesota State Lending Library. He later recalled: "The high point of the week was going to the post office and finding a brown paper parcel containing our reading matter for the next few days." At a recent high school reunion, one of his classmates commented, "he was always reading the *Encyclopedia*." Not just a reader, he also wrote articles for the local paper on basketball games he attended. As a member of the high school basketball team, he recalled that he made full use of his physics principles: the angle of incidence equals the angle of reflection. He was soon recognized as an exceptional student, was able to benefit from advanced courses given on an individual basis, and graduated at the top of the class. Far more than that, though, he gained the best score in the state on the college aptitude tests. His high school chemistry teacher was a big influence on his choice of chemistry in college.

Student Days

At the University of Minnesota, he signed up for a challenging double major in chemistry and chemical engineering which would normally take five years. As a required English course, he chose engineering English, which he later considered to have prepared him well for a life in the world of written words. Indeed, today's science students would do well to take more notice of this point. The draft having been reinstated in 1948, George preferred the more palatable option of joining the ROTC program, which he took seriously.

In his sophomore year, the precarious financial situation of his parents clashed with the heavy cost of his major—he even considered a switch to the cheapest one: mortuary science. Fortunately, he won a raise for his job at a local bicycle store that allowed him to stay with chemistry. The financial problem was only finally resolved by the award of a $600 scholarship for his senior year. A scientific highlight of these years was the visit to the department by Linus Pauling, whose talk there on his efforts to understand the structure of DNA was a source of inspiration to the budding chemist.

The job at the bicycle store honed his practical engineering skills, always helpful for a chemist, especially in the early days when much of the required apparatus had to be built on a do-it-yourself basis. It also helped when he bought his first car, a 1933 black Chevrolet, for less than $300. Its appearance was so poor, however, that his uncle forbade him to park in front of his house. When it finally died permanently, he was lucky to get $50 for it from a local dealer.

George had not really considered graduate school, so although two of his professors, Bryce Crawford and William Parham, urged him to reconsider, funding remained a worry. On graduation, he was therefore about to accept a paying job with the Pure Food and Drug Administration when chance intervened in the form of a research fellowship at the University of Illinois Urbana-Champaign (UI), where he joined Professor Bob Fuson's organic chemistry lab on an organometallic chemistry problem involving the reactivity of Grignard reagents. His initial fellowship ended after a year, and it was only his success in gaining a National Science Foundation (NSF) Fellowship that allowed him to continue in the Ph.D. program.

Farwell's Cafeteria, conveniently located across the street from Noyes Chemistry Lab, was a popular hangout where chemistry students and faculty gathered at mid-morning for coffee and conversation. Students could count on meeting such regular attendees as "Speed" Marvel, John Bailar, Therald Moeller, Ted Brown, Russ Drago, and Bob Fuson. This attractive aspect of academic life seems far less common in today's rushed times.

At that time, there was a "pipeline" between UI and DuPont, so George decided to take on a summer job with the company to sound out the possibility of a career there. It also gave him the opportunity to participate in the newly emerging area of transition metal organometallic chemistry. Future Nobelists Geoffrey Wilkinson and E. O. Fischer had just published their prize-winning work on ferrocene and its analogues and DuPont had assigned a team to explore the chemistry of these new "aromatic compounds." He made ferrocene analogs of phenylacetic acid and although these only had only trivial biological and chemical significance, the work kindled his interest in transition metal chemistry.

Once again financial pressures mounted in his third year at UI with the lapse of his NSF Fellowship. He always believed that this was because he had slacked off in his biochemistry minor, obtaining his only "B" in graduate school in an entomology course. Speed Marvel, whom he regarded as a second supervisor, intervened to find him funds from Allied Chemical Co. for what turned out to be his final year.

Work and Marriage

On graduation he received an offer from DuPont to work in their Chemical Department, later named Central Research and Development. During this time, he married a fellow student, Naomi Simpson, in spite of her strict Methodist family's resistance to her marrying a Catholic. As a result, the couple compromised by becoming Episcopalians, a faith in which they both became fully involved. Three sons followed in quick succession, Bill, Jonathan, and David.

His start as a research chemist at DuPont Central Research Division was inauspicious. He had to devise a catalyst to reductively dimerize acrylonitrile to give adiponitrile, the key intermediate in the manufacture of nylon, but he was not well prepared to work in heterogeneous catalysis and found the assignment frustrating. He soon transitioned to more productive lines, however, with a success in producing polymers allied to nylon but having improved properties.

In the early days the climate in the Chemical Department strongly encouraged exploration of new areas. Many took full advantage with the result that numerous DuPonters, including of course George himself, were later elected to the National Academy of Sciences (NAS), including Ted Cairns, Howard Simmons, and Bill Phillips; others spent only the formative part of their careers there were Earl Muetterties and Dick Schrock.

George with Dick Shrock, who worked for him in 1972-75, and Dick's wife, Nancy, at a 2005 Nobel reception at MIT. (Photo: Parshall family.)

Indeed, it was in George's group at DuPont that Schrock made the key discovery of the carbenes that now bear his name.[1]

George next decided to explore some new ideas in phosphorus chemistry. The foul smells he generated worked to his advantage in getting him expelled from the crowded building he at first occupied and instead being moved to splendid new pure research facilities with better air handling, where he spent the rest of his career. The move also brought him into contact with Dick Lindsey and Earl Muetterties, whom he regarded as exercising a decisive influence on his scientific development. His phosphorus work was published in the open literature and soon brought him recognition in the field.

Not only was George able to publish his work openly but he also obtained a ten-month industrial sabbatical in 1960–61 with Geoffrey Wilkinson at Imperial College London. These privileges were and remain highly unusual for an industrial chemist, but DuPont was perhaps the most advanced in their thinking on this. The air trip to London took 23 hours with refueling stops in Nova Scotia, Iceland, and Scotland.

At the new lab, graduate student Malcolm Green, later to become a major figure in the field, took George under his wing and gave much practical advice both about the laboratory and about living in London. George worked on a wide variety of organometallic problems using their brand new, top of the line NMR spectrometer just acquired by the lab. Even though this was ridiculously small by today's standards, being merely a 60 MHz model, it greatly speeded the work.

George in his early years at DuPont.
(Photo: Parshall family.)

Returning to Central Research, George embarked on a variety of problems, such as catalytic dinitrogen reduction to ammonia, in which he was unfortunately "scooped" by Vol'pin in Russia. By 1965, he had assembled a group to work on homogeneous (soluble) catalysts both for their industrial applications and for what they could teach about the fundamental organometallic chemistry underlying their catalytic activity. DuPont was a good place for this because they operated more chemical processes based on homogeneous catalysts than any other company. This activity became the central focus of his scientific career for the rest of his time at DuPont.

T. V. "Babu" RajanBabu, now a Distinguished Professor at the Ohio State University, notes that George was extremely supportive and encouraging of his proposed move to academia and also had a keen sense of what topics in chemistry would be important in the future, which certainly influenced Babu's own choices of topics to work on.

It was at this time that George went out of his way to help the broad scientific community by accepting the position of Editor in Chief for a volume of *Inorganic*

Syntheses, a job requiring much work that was normally only undertaken by academics. Not only that, he contributed eleven articles himself, all but two as checker of the reported synthesis, requiring him, through his technician, to repeat all the experimental work submitted by the primary authors.

The company soon recognized his great merit, and he was promoted to supervisor of the Inorganic Chemistry group in 1965, with numerous people reporting to him. With the advent of the 1970s, the economic climate became much less favorable and emphasis in the group shifted further from inorganic synthesis to the more obviously applicable field of homogeneous catalysis. The work remained quite fundamental but moved much closer to the company's commercial processes, helped along by the new associate director, William Drinkard, inventor of DuPont's innovative hydrocyanation technology for nylon production.

George's pro bono spirit was again evident with his 1980 book, *Homogeneous Catalysis*, arguably the best on the topic at that time. George covered the reactions of industrial relevance, the science underlying the processes, and future trends in the field. In the preface he pointed out that much of what was then available on the topic referred to problems of academic rather than practical interest. This did great good by raising the profile of the field; particularly because George was an industrial chemist, it gave the impression, correct as it turned out, that homogeneous catalysis would prove to be of continuously expanding practical application. In a similar way, he was simultaneously the Americas editor for the *Journal of Molecular Catalysis*. George's interest in good writing is also shown by his keenness to improve the writing of the members of his group.

As an example of his scientific prescience, George is on record as having suggested as early as 1978 that the cheaper late d block metal catalysts should be able to copolymerize olefins with polar monomers and with CO, ideas which later proved to be of considerable commercial importance. In 1979 George was promoted to head of Chemical Science. His responsibility was to strengthen exploratory organic, organometallic, and photochemistry, later broadened to include building programs in electronic materials to complement a major diversification by the company. The initial objectives were to build programs in electronic ceramics and electro-optical materials. He still kept close contact with his organometallic group, however.

He was delighted to be elected to the NAS in 1984 and always felt this was the greatest honor he could have received in the scientific area. He not only attended many subsequent NAS meetings but also did much hard work on their behalf.

The Parshall organometallic subgroup in late 1980. Standing: Jeffery S. Thompson, Frederick N. Tebbe, Thomas H. Tulip, Patricia L. Watson, Karin J. Karel, David L. Thorn and Wilson Tam. Seated: Steven D. Ittel, George W. Parshall, Donnie J. Sam. Although also a member of the group, Bill Nugent was on a mission when the photo was taken.
(Photo: Parshall family.)

From 1959 to 1984, George produced eighteen patents, only four of which were coauthored with a colleague. The first two described novel phosphorus compounds, followed by work on boronic acids, particularly fluorinated ones. The next, on hydrogen generation by metal-catalyzed hydrolysis, has a very modern resonance with the current interest in hydrogen as a fuel.

DuPont granted him a three-month sabbatical in 1986, and Malcolm Green, now on the faculty at the University of Oxford, again warmly welcomed him. At the time George felt his responsibilities had extended to areas in which he did not feel sufficiently qualified and so he looked for assistance at Oxford in learning about solid state inorganic chemistry, a specialty there.

In 1992 came the second edition of his book on homogeneous catalysis, this time with a young DuPont colleague, Steve Ittel, as coauthor. For many years this, book and its predecessor were used as a text in graduate classes across the world. Indeed, George always enjoyed scientific writing, as indicated by his impressive lifetime total of thirty reviews, thirty more than most chemists ever complete.

As a deep thinker, rather than a fast talker, he drew the ire of an opposing lawyer at a trial involving a complex patent situation in which he had been called on to act as an expert witness. The attorney is quoted as saying to the judge during the trial, “Note my objection to the unconscionable amount of time Dr. Parshall is taking to answer my questions.” After it was all over, George commented that he would never again serve as an expert witness in a trial.

Scientific Work

The present biographer has had to rely on somewhat thinner sources than for his prior biographies, which were of academics who published much more in the open literature, in part because George often declined to be coauthor even when his advice had been influential.

Taking individual papers first, the most influential was probably the one he wrote with Fred Tebbe in 1978 on what has come to be called Tebbe's Reagent. This is a highly reactive titanium methylene complex that is capable of converting ethylene to propylene and ketones, $R_2C{=}O$, to alkenes, $R_2C{=}CH_2$. A later 1979 paper extended the application of this compound to the very important olefin metathesis reaction in which the double bond of an olefin is cleaved and the resulting alkylidene units permuted: for example, propylene can yield ethylene and 2-butene.

Perhaps more important in terms of his influence, however, were the many reviews he wrote in which he collected and interpreted material both from DuPont and elsewhere on problems of wider importance. For example, in 1985, he and Patricia Watson published a review of organolanthanide catalysis, a previously relatively neglected area that has since undergone great expansion under the influence of the review. A solo review on C—H activation with the remarkably early date of 1975 was an important point of reference for my own work on the subject, an area that has expanded to an astonishing extent in the interim to include C—H functionalization, now a mainstay of organic synthesis. He also sagely predicted the rise of transition metal homogeneous catalysis in industrial applications in a series of 1988 reviews in *CHEMTECH* with Bill Nugent that won the 1989 Leo Friend Award as the "most significant in furthering chemical technology of all papers published in 1988 by *CHEMTECH*."[2,3,4]

George and Naomi in the 1990s.
(Photo: Parshall family.)

Post "Retirement"

The ten years after his leaving DuPont in 1992 were particularly good ones for George and Naomi, who both took full advantage of his retirement years to enjoy a variety of activities both joint and separate.

George with Anna Mae Buhl, his second wife, on their wedding day.
(Photo: Parshall family.)

This period was sadly brought to an end when Naomi passed away in April 2003. George married Anna Mae Buhl, a fellow parishioner at their church, in October 2006, thus commencing a new chapter in their personal lives.

George was always very active in the NAS, and this helped give him the opportunity to take up a second career because, coinciding with his retirement from DuPont, he was recruited to join the Stockpile Committee of the National Research Council (NRC) by Don Siebenaler, a DuPont chemist, to assist in the study of disposing of toxic chemical weapons. The Chemical Weapons Convention (CWC) was opened for signatures in 1993 and was eventually signed by 193 parties. In 1997, the Organization for Prohibition of Chemical Weapons (OPCW), with headquarters in The Hague, was established to implement the requirements of the CWC. Its responsibility was to enforce the prohibition of the future use of chemical weapons and the destruction of existing stocks by 2012. The United States and Russia were most affected because they had the largest stockpiles, mostly dating from World War II. The NRC of the Academy of Sciences was asked by the U.S. government to assist the Army in determining how to destroy these weapons safely. George assisted greatly in suggesting ways to safely dispose of these weapons, which generally included both incineration (>2000°F) and neutralization. George was heavily involved in helping to develop an aqueous oxidation protocol. This work involved much travel because the stockpiles were often located in obscure Army Depots throughout the country. One extreme example was Johnston Atoll, an isolated island not far from Hawaii, where 6 percent of the U.S. chemical weapons were stored from 1971–2001, including the infamous Agent Orange. The island is now a wildlife refuge and has no permanent human inhabitants.

After that work was done, George was asked to continue to advise on the destruction of materials not part of stockpiles, such as the World War I-era artillery shells filled with mustard gas that were discovered in some clam beds on the New Jersey and Delaware shores. As a result of his service he was asked to continue with work in international threat reduction. When the Soviet Union collapsed in 1991, it left fifteen Soviet republics

George and Harry Gray at a weapons destruction meeting in 1994.
(Photo: Parshall family.)

that had no foreign ministry, no currency, and uncertain political authority. But they did have large arsenals of biological, chemical, and nuclear weapons under control of Soviet-era regional commanders subject to no higher authority. The republics of Russia, Belarus, Ukraine, and Kazakhstan alone had 27,000 nuclear weapons and 40,000 tons of chemical weapons. They also had the world's largest collection of microorganisms, some of which, such as anthrax, were weaponized, making for an extremely dangerous situation. At this point, Senators Sam Nunn and Richard Lugar introduced legislation that provided funding for these countries to destroy or secure the weapons. This new committee had interesting challenges in understanding the political and economic complexities involved. George suggested an initiative to provide U.S. technical support for three Islamic countries, Libya, Iraq, and Lebanon, that were moving towards joining the CWC.

George wrote, "We were all shaken by the 9/11 scare in 2001. Before this time, the disposal of chemical weapons was generally regarded as desirable, but not urgent. The task took on new urgency as the poison gases stored at various Army arsenals are now seen as major targets for terrorists. Anthrax scares added to the impact on my work during this time. In July 2001, I spent some time in The Hague to help organize an international conference aimed at improving the control of chemical weapons." With his experience in the general area, he was also called upon to help the Savannah River Site in South Carolina dispose of its radioactive wastewater. George commented, "I am beginning to feel like the street sweeper following horses in the parade known as the Cold War."

During his career, he had numerous interactions with foreign science. For example, a 1973 NAS-sponsored visit to the Soviet Union was intended to establish close U.S.-Soviet links in homogeneous catalysis. George was well placed to participate because he had studied Russian and could understand it to some degree. In 1995, he went to Poland for a NATO-sponsored conference. Later visits to Russia intensified his interest in all aspects of the country. In 2011, he encouraged Anna Mae to join him on a riverboat cruise from Moscow to St. Petersburg, which they both thoroughly enjoyed.

Final Days

George W. Parshall, aged 89, died on Sunday, July 28, 2019, at Delaware Hospice in Milford, Delaware. His many friends and colleagues remembered him fondly. John L. Burmeister, Alumni Distinguished Professor at the University of Delaware, commented that he was "a gentleman and a scholar." Doug Taber, another professor at Delaware, remarked that George was one of the smartest people he had ever met as well as a kind and thoughtful person. Harry Gray remembered: "George established a world class program in synthetic and mechanistic inorganic and organometallic chemistry at DuPont. He and I had lively discussions of rhodium and platinum chemistry over many years. He was my go-to guy at Gordon Conferences and ACS meetings. I learned a lot from him." Dick Schrock mentioned his fond memories of George and also his thanks to him for putting up with him in his younger days: "He allowed me to do what I did and for that I am eternally grateful." ACS Past-President Ed Wasserman noted: "George was one of the foremost scientist-managers of the era, the last half of the twentieth century. I knew a few others at DuPont and Bell Labs who led the technological advances that transformed our world. George was on the top rung. His grace, warmth and openness to all will be remembered, together with his scientific accomplishments. It was a rich combination." I have taken great pleasure in compiling this memoir of George Parshall, not only a chemist of distinction, but also that comparative rarity, a thoroughly good man.

Acknowledgments

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