Carl Shipp Marvel: "Speed at 90"

The challenge of summarizing Professor "Speed" Marvel's long and enormously productive career in his 90th year is a daunting one. To distill the essence of Speed as educator, organic chemist, polymer chemist, university administrator, government servant, industrial consultant, professional society activist, and remarkable human being requires the skills of a professional biographer. To capture his unique, humanitarian style, his low-key matter-of-fact manner so evident in his lecturing and writting, and his artful marriage of excellent education and research also requires magic. We hope the following account, for all its inadequacy, will in some measure convey the admiration, respect, and affection we and so many of his colleagues feel for "Speed at 90".

Educator

Professor Marvel will probably be remembered principally as a teacher with emphasis on research and graduate education. Since 1925, he has trained 176 Ph.D.'s and 145 postdoctoral students. Research with these students and some visiting scientists has resulted in 502 papers and 55 patents. These papers trace and enlarge the development of organic and polymer chemistry in the United States to its present, full fruition. In his "retirement" at Arizona, he has published over 150 papers and is continuing work with three postdoctoral students who turn out approximately six papers a year.

Professor J. K. Stille, of Colorado State University, a student of Speed's and recent winner of the ACS Polymer Award, summarized Speed's contributions in the following quote:

> "Certainly the teachings of Speed Marvel have had greater impact on the growth of polymer chemistry and more influence on its directions than those of any other individual who is still in this area of chemistry. His teachings have emanated from the classroom, the textbook, his scientific publications, his personal relationship with his students and colleagues, and from the many generations of teachers and industrial chemists that have studied with him."

Last April, the University of Arizona recognized his many contributions to its program by naming its chemistry laboratories the "Carl Shipp Marvel Laboratories of Chemistry". Perhaps the ultimate recognition of his contributions to polymer education came in August this year when he received the ACS Polymer Education Award—a truly fitting tribute to decades of educational leadership.

The Early Years

Speed was born on a farm in Illinois and intended to become a farmer as his father had been. His mother, however, insisted that he attend college first, and an uncle advised him to take science courses to be better prepared for new developments in farming. When he began to study organic chemistry in his junior year at Illinois Wesleyan (1913), he enjoyed it so much that he began to do extra experiments to assist his professor. This led to his being offered a scholarship for graduate work in organic chemistry at the University of Illinois. On learning of this, his father suggested that if someone was willing to pay him to go to school, he should do it. Thus Marvel became a chemist instead of a farmer, and the world benefited.

Marvel was granted a Ph.D. degree in 1920 and looked for an industrial position. The war was over and jobs were scarce, so he took an instructorship at Illinois instead and found teaching to be so rewarding that he never again considered industrial employment. In those years at the University, he set the rapid pace he has continued throughout his life.

His early work concerned stereochemistry, hydrogen bonding, valence relationships, and the synthesis of many new compounds. They constitute a substantial contribution to the field of organic chemistry. Professor Herman Mark has characterized these researches as being "in the grand style", elegant experimentation providing new insights into important problems of the time. These studies led to his first major recognition, election to the National Academy of Sciences in 1938.

Polymer Research and Consultation

Professor Marvel became an industrial consultant early in 1928 when he and Roger Adams began alternate monthly visits to the Du Pont Experimental Station near Wilmington, DE. He still maintains half of this relationship today, 56 years later. It is estimated that he has made 265 consulting trips to the Du Pont laboratories, held more than 19000 individual conferences, and stayed 1320 nights (over 3 1/2 years!) in the Hotel Du Pont—surely a record for a consulting relationship, in both duration and breadth.

Speed's interactions with Du Pont also resulted in 46 of his Ph.D.'s joining that company, where many of them made important contributions to polymer chemistry. It is a relationship of great value to Du Pont.

Perhaps the most important part of the relationship to Marvel was his early introduction to polymer chemistry. His friend Wallace Carothers, a former student and colleague at the University of Illinois, had just begun seminal research on polymers at Du Pont in 1928. Drawn by his own curiosity and by his consultation with Carothers and others, Marvel began a research program of his own on polymers. His first paper on this subject, "The Reaction between Sulfur Dioxide and Olefins. Cyclohexene", appeared in 1934. Similar studies concerning mainly the structure of vinyl polymers and copolymers demonstrated

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in 1938 that poly(methyl vinyl ketone) has a head-to-tail rather than a head-to-head:tail-to-tail structure. In 1939 he showed that poly(vinyl chloride) likewise had this structure. His researches also addressed copolymerization reactions (40 papers between 1942 and 1960), Ziegler–Natta polymerization, and block and graft polymerization.

Government Service

During World War II and until 1955, much of Professor Marvel's effort was devoted to research on the development of synthetic rubber. With the Japanese attack on Pearl Harbor and conquest of Malaysia, the synthetic rubber problem assumed crisis proportions. Marvel organized a large research team at Urbana for the government rubber program operated by the Rubber Reserve Corp. In 1945 he visited the German synthetic rubber industry to see what innovations they had made in the production of butadiene–styrene copolymer, the principal type of synthetic rubber, known then as GR-S and now as SBR. His team returned with the news of the redox initiation process, which was then adapted to American practice. It allowed emulsion polymerizations to be carried out at low temperatures, resulting in an improved product.

In the mid-1950s Professor Marvel's attention shifted to heat-resistant polymers, a field that has dominated his research interests to the present day. This work was carried out on a contractual basis with the Air Force. A highlight was his classic 1961 paper "Polybenzimidazoles, New Thermally Stable Polymers". This was only one of many new classes of materials developed under this program; others included polythiazoles, polyoxadiazoles, and polytriazoles. This work has been summarized by R. S. Van Deusen, Chief, Polymer Branch, Nonmetallic Materials Division of Air Force Wright Aeronautical Laboratories.

> "The following years in the '60s found the literature plentiful with reports of newly discovered high-temperature polymers, and Marvel and his students were leaders all through this great decade of new polymer discoveries. More importantly, those first Marvel accomplishments in high-temperature polymers acted like a catalyst in showing the way for many laboratories around the world to move into this new field. Considering the hundreds of new high-temperature polymers discovered in Marvel's laboratories through the '60s, especially the early breakthrough with the poly(benzimidazoles) (PBI), it is not surprising that he is thought of as the 'father of high-temperature polymers'. Highly deserving of this honor, his remarkable contributions following on through the '70s and '80s have continued to inspire investigators in this field throughout the world.
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> During the '60s, '70s, and '80s, the Air Force, through the Materials Laboratory and the Office of Scientific Research, engaged Marvel in polymer research. The results of these investigations are clearly outstanding and invaluable, his works continuing to provide scientific basis for current programs aimed to provide advanced high-performance, nonmetallic materials for use as far into the future as the year 2000. Interestingly, Marvel's PBI has been developed as a synthetic fiber and woven fabrics and webbings used by NASA to take advantage of its superior oxidation resistance in space vehicles, as well as in astronaut clothing. Looking for low flammability, toxicity, and off-gasing, PBI was used in Apollo and Sky Lab for restraint system webbings and various interior fabrics. The Space Shuttle EES (ejection escape suit) utilized PBI. Transported in the lunar landing vehicle, the Rover and other extravehicular equipment have PBI materials aboard which remain on the moon today. Navy aquanauts used PBI material in submerged vessels due to its nonflammability characteristics. Because of its fire resistance, PBI commercialization is aimed for use in firemen's and welders' gear and garments, flue gas filters, and other applications such as asbestos alternates and fire-blocking fabrics for aircraft seatcovers".

For this outstanding work, he received in 1966 the Air Force Materials Lab Distinguished Service Award and the Air Force Systems Command Award for Outstanding Achievement. The synthesis of the useful polybenzimidazoles demonstrates Speed's powerful combination of knowledge of synthetic methods and understanding of structure–property relationships, both worked out over many years of research.

University Administrator

Professor Marvel remained on the senior staff of the University of Illinois for 41 years. He held the title of Research Professor of the University from 1953 until 1961.

Speed participated in University Administration at Illinois, serving as head of the organic section of the Chemistry Department under Roger Adams for many years. He was a forceful leader, helping to build Illinois into a "world-class" department and keep it there for many years. The basis of his administration was his ability to spot scientific talent well in advance of any obvious demonstration of its presence and to develop latent skills in young chemists.

He retired to become an Emeritus Professor at the age of 67. Since he had no intention of truly retiring so early, he accepted a position as Professor of Organic Chemistry at the University of Arizona in Tucson. His contributions in building the department at Arizona have also been great though less direct.

Professional Society Activist

Professor Marvel has been active in the American Chemical Society for many years, his career paralleling the spectacular growth of the Organic and Polymer Divisions. Of his first national meeting, which he attended as a first-year graduate student, he spoke as follows:

> "It was held at Urbana, and I recall that the Organic Division met in a room which seated about 35 to 40 people. There were seats to spare for all the members of the Society interested in the Organic Division's meeting and all graduate students in organic chemistry at the University of Illinois".

Marvel was elected president of the American Chemical Society in 1945 and served on the board of directors for 3 years. He was chairman of the committee to raise funds for the national office building in Washington, where the lecture room is named Marvel Hall. In 1980 he received an award for serving as an ACS Council member for 40 years. He has been active in an editorial role and on the editorial boards of many ACS publications.

Awards and Honors

Throughout his career, Professor Marvel has received many honors from his scientific colleagues, including honorary doctorates from Illinois Wesleyan in 1946, the University of Illinois in 1963, the University of Louvain in 1970, and the Polytechnic Institute of New York in 1983. He was elected to the National Academy of Sciences in 1938, the American Philosophical Society in 1945, and the American Academy of Arts and Sciences in 1960. He received the Nichols Medal of the New York section of the American Chemical Society in 1944, the Presidential Certificate of Merit (for his synthetic rubber research) in 1948, the Willard Gibbs Medal of the Chicago section of

the ACS in 1950, the Gold Medal Award of the American Institute of Chemists in 1955, the Priestley Medal of the ACS in 1956, the International Award of the Society of Plastics Engineers and the Witco Award of the ACS in 1964, the Madison Marshall Award of the North Alabama section of the ACS in 1966, the Chemical Pioneer Award of the American Institute of Chemists in 1967, the John R. Kuebler Award of Alpha Chi Sigma Fraternity in 1970, the Borden Award of the Division of Plastics and Coatings in 1973, the Alumni Achievement Award of the University of Illinois in 1976, the Creative Science Award of the President's Club of the University of Arizona in 1978, the Polymer Award of the Division of Polymer Chemistry of the ACS in 1979, the ACS 40-year Council Member Award in 1980, and the Polymer Division (ACS) Education Award in 1984.

Speed as Speed

In addition to his educational, scientific, and professional career, Speed has pursued many other activities with interest and skill. His lifelong interest in farming has continued—the boyhood farm remains in the family today. He can tell you of mallards on the Illinois River and bass at the "Pollywogs", of catching muskies and walleyes in Minnesota with Carothers, and of giving lessons in both poker and birding. Speed's keen eyesight, hearing, and memory combine to make him a superb birder, with 629 species in North America and a world list of 1043.

Professor Marvel's concern for people is unobtrusive, but it is a most important aspect of his remarkable personality. His door is always open, inviting student or faculty to enter freely to ask and get advice on chemical, professional, or personal problems. He maintains friendly, personal relationships with polymer chemists all over the world.

His 50-year marriage to Alberta Hughes (1933–1983) and his obvious affection for daughter Mollie and son Jack reveal him as a devoted family man. The participation of both Mollie and Jack in the recent dedication ceremonies of the Carl S. Marvel Laboratories at the University of Arizona amply demonstrated their feelings for their famous father.

We join his many friends all over the world in congratulating Professor Marvel for his contributions to organic and polymer chemistry and for his successful promotion of polymer education. We find it remarkable that Speed, whose pace is always leisurely and who is never in a visible hurry, has covered so much ground in so many areas. The name Speed seems justified to us in a new way. This year finds him continuing research at Arizona, publishing papers, consulting, receiving two exceptional honors, and on Sept 11, celebrating his 90th birthday. Soon Speed will earn a new nickname...Endurance Marvel.

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