# EUGENE CORNELIUS SULLIVAN—GLASS SCIENTIST

# EUGENE CORNELIUS SULLIVAN—GLASS SCIENTIST, 1872-1962

*Sullivan Park, Corning Glass Works, Corning, N. Y.*

*Portrait of Dr. Eugene C. Sullivan by George V. Augusta, Jr. which hangs in the main lobby at Sullivan Park*

Glassmaking in the first decade of the 1900s was essentially an art of handcraft which followed the traditions of the preceding 35 centuries. An observer of the day described glassmaking as "crude and wasteful" and said that "when things go wrong the trouble should be ascribed to diabolical influence."

The Industrial Revolution had seemed to pass by the producers of glassware. Other industries were becoming mechanized to a high degree, but glassmakers continued to use their age-old forming techniques and to guard their glass formulas zealously.

The problem was simply that glassmakers did not understand their material. Glass was extremely difficult to melt in the first place, and its working quality and uniformity entirely unpredictable.

In 1900 there were 355 relatively small glass companies in the United States employing 53,000 people and selling $56.5 million worth of product. By 1962, the number of companies had consolidated to 142 employing 145,000 workers, but they were producing glassware which sold for $2.2 billion.

The remarkable transformation of glassmaking from a handcraft to a highly mechanized industry producing tens of thousands of useful products is reflected in the career of Dr. Eugene C. Sullivan, glass scientist. As the founder of the research laboratories of Corning Glass Works in 1908—the first laboratory in the glass industry and one of the first in American business—Dr. Sullivan for the next 54 years was closely involved with the dramatic increase in the number of new glasses melted annually, the complex new manufacturing methods, and the accelerating development of new products.

In his memory the new research laboratories of Corning Glass Works are dedicated.

# EARLY YEARS, 1872-1903

Chicago should have been the birthplace of Dr. Sullivan, but Mrs. O'Leary's cow set the city ablaze in October, 1871, forcing the Sullivan family to take temporary quarters in nearby Elgin, Illinois. He was born there on January 23, 1872, the son of Thomas E. and Mary A. Richards Sullivan.

The family returned to Chicago shortly thereafter where Thomas Sullivan was a composing room foreman on *The Chicago Tribune*. Eugene Sullivan graduated from North Division High School in 1890 and that fall entered the University of Michigan.

A good student (he was elected to Phi Beta Kappa a few years after graduation), Sullivan started his industrial career modestly in 1893 while an undergraduate by serving as an assistant in the Department of Mines and Mining at the World's Columbian Exposition.

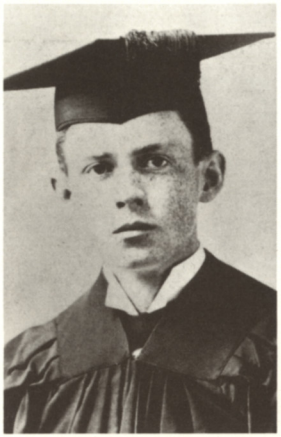
He received a bachelor's degree in chemistry in 1894 and was employed as a chemist by the Aetna Powder Company, a manufacturer of dynamite at Aetna, Indiana.

Returning to Chicago in October, 1894, he was employed as first assistant chemist by the Price Baking Powder Company—winner of the World's Fair Medal and Diploma for Dr. Price's Cream Baking Powder. The Price superintendent, H. Heindenhain, characterized the young scientist as "a man of honorable character, energy and thoroughness." He went on to "recommend him to any party who may desire the services of a chemist of more than ordinary abilities."

The experience at Aetna and Price had convinced Sullivan of the need for further study and research and, typical of many students of the day, he turned to the German universities which were then recognized for their leadership in scientific study.

He entered the University of Göttingen for a semester in the fall of 1896, studying under the brilliant physicist-chemist, Walther Hermann Nernst. (Ten years earlier, Alanson B. Houghton of Corning, N. Y. had also been a graduate student in political economy at Göttingen.)

Sullivan then moved on to the University of Leipzig, attracted by the reputation of future Nobel prize winner Friederich Wilhelm Ostwald. Receiving a doctorate from Leipzig in 1899, Dr. Sullivan returned to the University of Michigan as an instructor in analytical chemistry.



*University of Michigan, 1894*

*University of Leipzig, 1899*

## GEOLOGICAL SURVEY, 1903-1907

Dr. Sullivan thoroughly enjoyed his teaching experience at Michigan. He married the former Ada Bisbee on July 16, 1902, and they were later to be the parents of three children: Eldon, Dorothy and Genevieve.

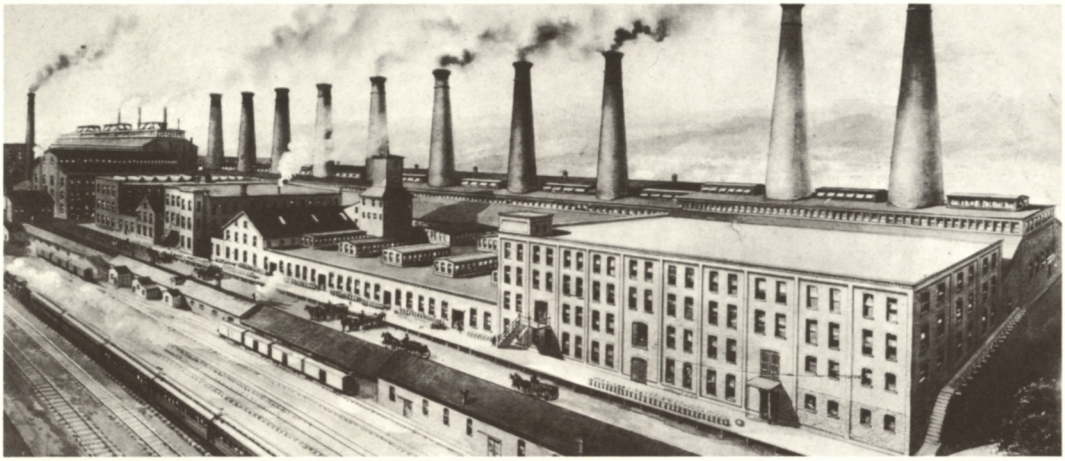
But promotions were slow in university teaching, and Dr. Sullivan resigned in 1903 to join the chemical laboratory of the United States Geological Survey at Washington, D. C. Here he became exposed to silicate chemistry in his work of mineral analysis and the study of ore deposits. And it was here that he became acquainted with two Brooklyn natives and Yale classmates who would greatly influence his future career: George B. Hollister and Dr. Arthur L. Day.

Mr. Hollister left the Survey the following year to accept a position as assistant to the production vice president of a small upstate New York glass company—Arthur A. Houghton of Corning Glass Works. Mr. Hollister was soon reporting back to his former associates at the Survey the excitement of work going on at Corning. One of Dr. Day's former students whom he had taught at Yale, Dr. William Churchill, had been making dramatic progress since 1899 in the improvement of railroad signal lens colors and designs. Dr. Joseph A. Deghuee of the Lederle Laboratories in New York City had been retained by the company in 1900 to develop a solid ruby color for signal lights.

The Houghton brothers—Arthur, the production expert, and Alanson, the marketing and financial specialist—had been brought up in the tradition of scientific glassmaking by their father, Amory Houghton, Jr., president of the company from 1875 to 1909.

As assistant works manager, Mr. Hollister was initiated into the secret art of glass formulation. He suggested that Dr. Day be retained to investigate some of the manufacturing problems and the latter was hired as a part-time scientific consultant in 1905. One of his first contributions the following year was installation of thermocouples to measure the temperature in glassmelting pots—the first time such instrumentation had been used by American industry.

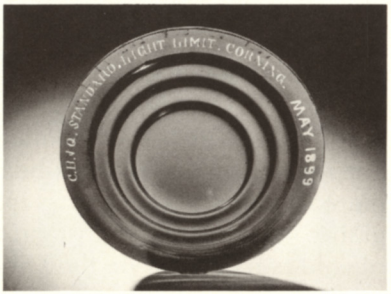
But the need for further application of scientific research to glassmaking was apparent and Dr. Day, by 1907, director of the newly formed Geophysical Laboratory of the Carnegie Institution, recommended to the Houghtons that his former associate, Dr. Eugene C. Sullivan, be employed to direct such activity.



*Corning Glass Works in 1908*

*Lantern globe shop*

*Erie Station and Square*




*Color standards*

# EARLY LABORATORY, 1908-1919

Dr. Sullivan recognized the challenge and reported to his new employers on April 21, 1908.

The two manufacturing plants which Dr. Sullivan toured the next day with Production Superintendent Charles E. Githler were an awesome sight to the 36-year-old chemist. In "A" Factory, the first plant built after the company moved to Corning in 1868, ten furnaces were devoted almost exclusively to the hand-production of bulb blanks for incandescent lamps (more than half the company's business at that time). A rough 100-foot wooden tower projecting through the factory roof contained a machine to draw thermometer tubing by an updraw process patented by Arthur Houghton in 1897, the first mechanization in the glass industry.

In adjacent "B" Factory, constructed in 1904, three 16-pot furnaces were devoted to production of lantern globes, railroad signal lenses, and glass tubing.

Dr. Sullivan set up shop on the fourth floor of "B" Factory with one assistant and 1,200 square feet of laboratory space. The most urgent need described by his employers was that of a glass for lantern globes which would withstand the shock of cold rain or snow on their heated surfaces. Dr. Sullivan was soon joined by William C. Taylor, a June graduate in chemistry from MIT, and together they tackled the problem.

Earlier work had been carried out by Dr. Deghuee who had attempted to extend a composition developed earlier in Germany. Dr. Day had been consulted and Mr. Hollister had also performed some experimentation.

After many trials, in the autumn of 1908 Dr. Sullivan and Mr. Taylor produced a new glass formula with excellent thermal endurance and remarkably low coefficient of expansion. However, the glass had one serious drawback—it was slowly, but completely, soluble in water. Despite this fault, the glass proved to be an acceptable solution to the breakage problem and it was quickly placed in production.

Mr. Taylor left Corning shortly thereafter to serve as an assistant chemist at the United States Agricultural Station at Mayaguez, Puerto Rico. Alanson Houghton succeeded his father to the presidency in 1911 and Arthur Houghton continued as vice president and works manager. Dr. Sullivan turned his attention to the practical problems of glassmaking of which he had little knowledge.

*Chief Chemist, 1908*

*Battery jar baking dish*

*Staff personnel, left to right, Donald E. Sharp, Joseph S. Gregorius, Jesse T. Littleton, William C. Taylor, William A. Yung, James A. Bailey*

*PYREX brand chemical ware*

The Houghton brothers had long been convinced that mechanization of Corning's glassmaking processes was imperative if the company were to maintain the high standard of product quality upon which they insisted. Development of a machine to produce incandescent bulb blanks had been started in 1907 by Orin H. Hanford, later joined by Benjamin D. Chamberlin. Mechanical development was further emphasized with the employment of two college-trained engineers, Albert J. Mayer in 1911 and James A. Bailey in 1912.

To produce the volume of glass needed to handle the increased business, the first continuous melting tanks were installed in "A" Factory about this time. It was a rather bitter joke that more success was enjoyed in melting the refractory materials than in melting the glass. Further production capacity was added in 1912 with the completion of "C" Factory and its three 18-pot furnaces and 187-foot thermometer tubing updraw tower.

Acceptance of Corning specifications for roundels and lenses by the Railway Signal Association had greatly accelerated that business, and in 1911 Dr. Henry Phelps Gage of Cornell joined Dr. Churchill's optical laboratory.

The pace of activity in the chemical laboratory quickened following Mr. Taylor's return in 1910. A major objective was the development of a glass suitable for glass battery jars used in great numbers by the railroads to operate their signalling systems. By 1912, the two chemists had discovered a new borosilicate composition which was not only heat-resistant, but also extremely resistant to corrosion. Products made of this new glass were trademarked NONEX® and included lantern globes as well as battery jars.

To broaden continued study of the increasing numbers of problems coming to light, Dr. Sullivan in 1913 employed Dr. Jesse T. Littleton, a physicist from the University of Wisconsin. Dr. Littleton was intrigued by the unusual properties of the new NONEX glasses and theorized that one of them might make an ideal material for cooking utensils. Mrs. Littleton proved the theory practical by baking a cake in a battery jar which had been sawed off to cake-dish height. The glass contained too much lead, however, and further composition experimentation was needed to develop a glass which would meet government purity tests. The result was the now-famous PYREX® ovenware line, introduced in 1915 and an immediate sales success.

Meanwhile, the accumulation of increasing amounts of data about the chemical, optical, and physical properties of glass was being systematized. In December 1913, Dr. Littleton explained what he believed to be the principles of physical tempering—paving the way for important future work. A new Chemical and Laboratory Building completed in 1914 included 5,440 square feet for the scientists.

Mechanical development continued at a rapid pace, and the engineering group in 1912 put into production a press-and-blow machine to manufacture lantern globes. The following year the "E" Machine was installed to produce lamp bulb blanks semi-automatically at the rate of seven per minute. Almost simultaneously, Robert W. Canfield and Harry M. Hosier started work on the fully automatic "F" Machine. David E. Gray, a graduate of the Massachusetts Institute of Technology, joined the group in 1916.

The increasing demand for bulbs required that tanks be used instead of pots for melting, but refractories then available would not handle lead glass. Mr. Taylor invented a new soda-lime glass which, when used in combination with a new lead glass for bulb stems, solved the melting problem.

Additional capacity was provided when a vacant plant of the Columbia Window Glass Company in nearby Wellsboro, Pennsylvania, was purchased in 1916 and fully equipped with the new "E" Machines. William J. Woods was the first plant manager.

To handle the growing administrative details of the young laboratory, Dr. Sullivan in 1916 hired Otto W. Hilbert of MIT. Chemist Rowland D. Smith joined the staff the same year, followed in 1918 by Dr. George V. McCauley, a physicist. Dr. Lionel D. Duschak and Dr. Frederick F. Shetterly, both chemists, had been members of the production staff group since 1912. Walter W. Oakley, a mechanical engineer and furnace expert, joined in 1917. Corning residents humorously referred to the growing technical staff as "the smoke stack university."

Meanwhile, the outbreak of World War I had cut off German laboratory ware which had traditionally been supplied to American laboratories. One of the new borosilicate glasses was tested and found superior to the imports, and PYREX brand chemical ware was introduced with the enthusiastic endorsement of the National Bureau of Standards.

The war blockade also cut off German clays used for refractories in melting units. Chemist Duschak attacked the problem and soon developed a mixture of American clays which were also better than the foreign materials. Refractory manufacture was assigned Karl B. Faulkner in 1917 and two years later a full-scale ceramic research laboratory was established.

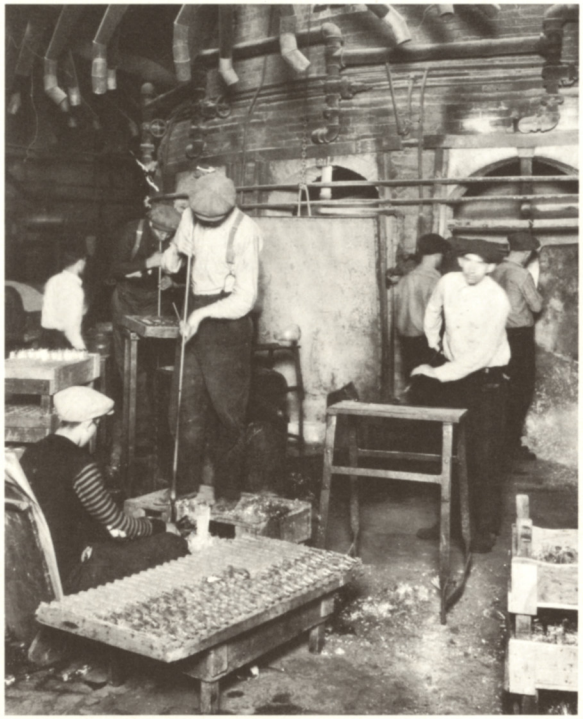
Installation of semi-automatic presses in "A" Factory in 1917 helped meet the heavy demand for PYREX ovenware. In 1918, the rights were acquired to use a revolutionary automatic tube drawing machine invented by Edward Danner, an Ohio engineer. Additional production capacity for incandescent bulb blanks was provided that same year by purchase of the Steuben Glass Works in Corning, marking the beginning of a long and warm friendship between Dr. Sullivan and Frederick C. Carder, Steuben founder.

With the election of Alanson B. Houghton to Congress, Arthur A. Houghton was elected company president in 1919. Dr. Day was persuaded to leave the Geophysical Laboratory and become vice president of production. Accompanying him to Corning was Dr. John C. Hostetter, a chemist who was immediately placed in charge of the newly acquired Steuben factory. Also joining the laboratory as a research assistant that year was Glen W. Cole.

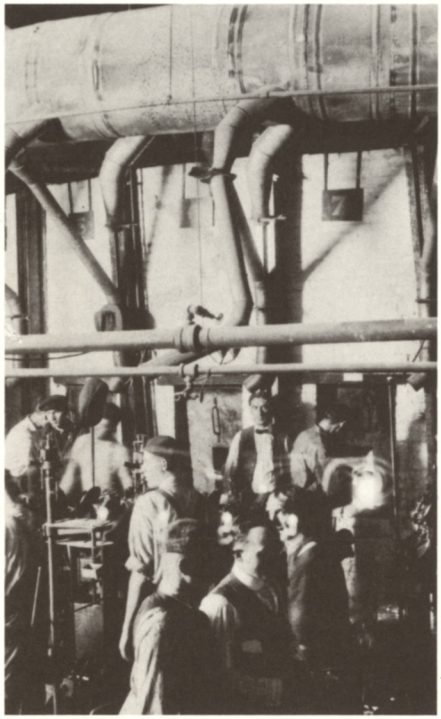
The research laboratory now had a full-time staff of about 25. David Gray's mechanical development group numbered an additional ten and Walter Oakley's melting group perhaps ten more, including Harold T. Brink, Leroy C. Chowning, and George E. Ward.

Company sales had increased more than six times from 1908 through 1919, stimulated substantially by the new PYREX ovenware and chemical ware. Earnings had also increased six times, and employment had more than doubled with the addition of three manufacturing plants.

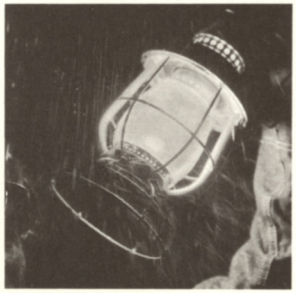
Commenting upon these pioneering years sometime later, Dr. Sullivan was to admit that although much had been learned about the chemistry and physics of glass, "we have just made a beginning on the problems involved."



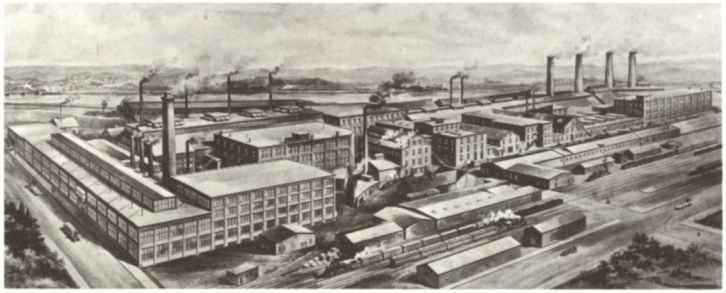
*Hand bulb production*



*"E" Machines at Wellsboro*



*Borosilicate lantern globe*



*Corning Glass Works in 1912*

# VICE PRESIDENT-MANUFACTURING, 1920-1927

Arthur A. Houghton stepped aside as company president in 1920, to be succeeded by Alexander D. Falck, an Elmira, N. Y., attorney who had served as company counsel since 1911.

Mr. Hollister was elected vice president of sales. Dr. Day found industrial management not to his liking and returned to the Geophysical Laboratory, although remaining a vice president and scientific consultant. In his place the directors elected Dr. Eugene C. Sullivan, then 48 years old, as manufacturing vice president.

Mr. Taylor was appointed chief chemist. He was to bolster his small staff with the addition of Harrison P. Hood in 1920 and Lynn B. Webb in 1923.

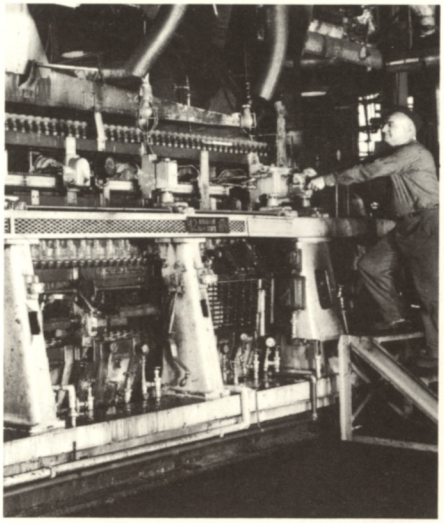
Dr. Littleton was named chief of the physical laboratory and added to his department Dr. William W. Shaver in 1924; H. Clifford Bates in 1925; and Howard R. Lillie in 1927.

Dr. Gage continued as manager of the optical laboratory, joined by Ernest F. Ling in 1920. Dr. Gordon M. Fulcher came to Corning from the National Research Council the same year and was assigned to the new ceramics laboratory.

Mr. Gray enlarged his mechanical development group by the addition of Leander N. Pond in 1920, Edmund H. Wellech in 1924, and W. Roy Wisner in 1925. Mr. Oakley's melting group was to include Charles A. Bowen and Royden A. Blunt.

Much of the work handled by the laboratory during the next few years was production-oriented: product design, testing, temperature calibrations. But fundamental studies continued, and among the achievements were glasses to control the absorption or transmission of ultraviolet, infrared and x-rays. Colored borosilicates were developed for signalware. And important progress was made in the area of physical tempering.

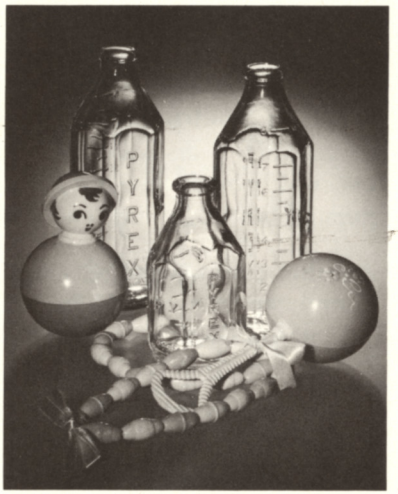
Dr. Sullivan not only concerned himself with the work of his scientists and engineers, but he also was responsible for the rapidly expanding production facilities of the company. Mechanization of production equipment proceeded at a rapid rate as the mysteries of handling new glasses were solved. Two of the experimental "F" Machines were installed in the Steuben Factory in 1921 (others later in "B" Factory) and they proved capable of producing 42 bulbs-per-minute automatically.



*Ribbon machine*

*Physics laboratory*

*Optical laboratory, left to right, Howard F. Adamy, Henry Phelps Gage, William Churchill, William C. Taylor, Emilio Pascucci*




*PYREX brand nursing bottles*

Semi-automatic equipment to produce chemical ware was installed in the new finishing department in 1923. Automatic feeders for the borosilicate tanks in "A" Factory went into operation in 1926. Dr. Shetterly was in charge of PYREX ovenware and chemical ware production.

The post-war recession of 1920 had reduced demand for PYREX ovenware, and an immediate objective was the development of new products which might be made of borosilicate glass. Dr. Sullivan organized a company-wide Suggestion System in 1921 and, as chairman of its New Products Committee, met frequently with committee members Mr. Githler, Mr. Gray, Mr. Hollister, Dr. Shetterly, and W. Hanford Curtiss, who had joined the executive staff the previous year. Among the new products developed and produced during the next several years were lenses for airport beacons, power line insulators, PYREX nursing bottles, and thread guides.

Another company activity which stimulated factory workers and technical people alike was the program of the Production Club which was organized by Mr. Curtiss in 1921. Members of the laboratory were flattered to be invited to explain their various programs.

For several years, the young scientists had been building an unusual esprit de corps through a series of dances, dinners and outings organized by Mr. Hilbert. Dr. Sullivan wished to make sure that his small staff had a pleasant time after work, as well as on the job.

Other American industries were beginning to appreciate the growing importance of scientific investigation and Dr. Sullivan developed a close relationship with many of his counterparts. Willis Rodney Whitney, who had helped establish the General Electric Company research laboratory in 1900, had also been one of Ostwald's students at Göttingen.

Other contemporaries included Francis Cowles Frary of the Aluminum Company of America, Charles Francis "Boss" Kettering of General Motors, Frank Baldwin Jewett of the Bell Laboratories, Edward Ray Weidlin of Mellon Institute, Charles E. K. Mees of Eastman Kodak, and Charles Lee Reese of duPont.

Back at Corning, incandescent bulb blank production was 75 per cent mechanized by 1923, but even greater capacity was needed. The company purchased the Central Falls, Rhode Island, plant of General Electric Company the following

year and added to its three Westlake bulb-machines an additional three. Dr. Hostetter was appointed plant manager.

But meanwhile, one of the most significant developments in the history of glassmaking was taking place behind screened partitions in the east end of "A" Factory. Mr. Woods, recently returned from the Wellsboro plant, had conceived a revolutionary new method to form bulbs. Working closely with Mr. Gray in the execution of detailed engineering, he assembled the now-famous Corning ribbon machine. The first complete machine was installed at Wellsboro in 1926 and began producing bulb blanks at the then-fantastic number of 125 per-minute.

Refractory problems continued to plague production people, however. The corrosive action of hot glass would destroy a melting unit in less than a year's time. A giant step toward solution of these problems was taken by Dr. Fulcher when he invented a method to melt refractory materials electrically and cast into blocks. The new ELECTROCAST® refractories proved to be three times better than previous materials and, to meet the heavy demand for the product, Corning and the Hartford-Empire Company jointly formed Corhart Refractories Company in 1927. Dr. Sullivan was elected a director and vice president of the new subsidiary and prided himself in later years for never missing a board meeting. A similar associate, Societie L'Electro Refractaire, was formed the following year in Paris in partnership with St. Gobain, and Dr. Sullivan also served on its board.

Although the post-war slump had affected sales, the 1927 volume was more than 25 per cent above 1919. More significantly, the accelerating mechanization of glassmaking equipment had doubled company earnings during the period.

# PRESIDENT, 1928-1929

Mr. Falck returned to his Elmira law practice in 1928, and the board of directors voted their confidence in 56-year-old Dr. Sullivan by electing him a director and company president. He continued to be supported by Dr. Day and Mr. Hollister as vice presidents and by Mr. Curtiss who was to become a vice president the following year. Amory Houghton, son of Alanson Houghton, who had joined the production department in 1921 and then served in personnel and sales, was elected executive vice president.

In the laboratories, composition research continued at a brisk pace. Properties measurements included those of viscosity, softness temperatures, and annealing and strain temperatures. Physical studies were highlighted in 1929 with the joint publication by Dr. Littleton and Frank W. Preston, a laboratory consultant, of the paper, "Theory of Strength of Thermally Toughened Glass," which was to be the classic solution to physical tempering.

Dr. Sullivan and Mr. Taylor were honored in 1928 when the Franklin Institute awarded the two scientists jointly the Howard N. Potts Medal for their work on borosilicate glasses. And the following year Dr. Sullivan was presented the Perkin Medal "for distinguished service to applied chemistry" by the Society of Chemical Industry.

Process development during the period included installation of an improved tubing updraw process engineered by Mr. Gray and Mr. Wellech. The new technique made possible fabrication of large-diameter glass tubing which was sold to the process industries for handling corrosive liquids.

Company anniversary dinners to honor long-service employes were inaugurated by Dr. Sullivan when he presided at the first banquet on September 13, 1928. Fifty-year employes recognized at that first dinner were Frederick Deuerlein, Frank J. Hultzman, Sr., George Miles and William S. Rotsell.

The specialty glass business was booming along with the rest of the national economy. During the years 1928 and 1929, company sales increased more than one-third and earnings improved more than 50 per cent.

*Process industry piping*

*President, 1928-1929*

*Updraw tubing process*


*Potts Medal, 1928*


*Perkin Medal, 1929*

## VICE CHAIRMAN, 1930-1936

Although the company had shown remarkable growth during the period of his presidency, Dr. Sullivan was not comfortable in the position. "Those who know him are sure he would be happier behind a laboratory bench with some 'smelly' test tubes than behind a desk or at the head of a board table," Dr. Littleton commented.

At his own request, he was relieved of the administrative burdens of the presidency in 1930 and elected vice chairman of the board. The new president, Amory Houghton, and Dr. Sullivan increased their close friendship and mutual respect in the many years ahead.

Mr. Githler was named manager of manufacturing shortly after the election; Mr. Cole, production manager; and Mr. Hosier, production superintendent of Main Plant. Dr. Hostetter was appointed director of research, with Mr. Taylor, Dr. Littleton, and Dr. Gage continuing to head their laboratories. Mr. Gray was to become consulting engineer the following year, succeeded by Walter C. Weber in the mechanical development department.

The country was entering the depths of a crushing depression, but so great was the faith of Corning's management in the benefits of continued scientific investigation that research and development expenditures for 1930 were almost doubled over those of 1929.

Although company employment declined as sales slowed, additional manpower was provided for the research and engineering staffs. The most unusual addition was the employment in 1930 of an organic chemist, Dr. J. Franklin Hyde, a post-doctoral research fellow working with Dr. James B. Conant who was then professor of organic chemistry at Harvard. Dr. Sullivan had been concerned about the threat to the glass business of the new plastics then coming into use, and he felt that research should be conducted in the twilight zone between organic materials and the inorganic compounds of glassmaking. The vision was to pay off later in the form of silicones and fused silica initially developed by Dr. Hyde during the 1930s.

Certainly the most spectacular achievement of the period was the casting of the 200-inch reflector mirror for the Hale Telescope. The project was carried out under the direction of Dr. George V. McCauley. More than any other single event in the company's history, the casting of the giant mirror focused world

*Pouring the 200-inch mirror blank, 1934*

*PYREX brand range-top ware*

*Fiber glass*

*Dr. Sullivan and Amory Houghton, 1936*

attention on the accomplishments of Dr. Sullivan's scientists.

To provide additional capacity to produce glass tubing, the property of the Fall Brook Railroad on Tioga Avenue was purchased in 1930 and the Fall Brook plant established. Shortly thereafter, the company acquired from a St. Gobain subsidiary the rights to use the Vello tube draw—a process which was twice as fast as the old Danner. Mr. Wellech applied his many years of tubing experience to install the new Vello.

The Hood Foundry on Front Street had been purchased in 1929 and was now converted into a plant to manufacture refractories.

Basic research studies which would have far-reaching future importance were carried out simultaneously by the chemical and physical laboratories: the invention of aluminosilicate glasses and the development of a process to physically temper such glass. PYREX range-top ware was an immediate success.

Other process work of the period included a modification of the ribbon machine into a new machine called the turret chain; it was used to blow products such as coffee maker bowls and large laboratory ware. Equipment to finish chemical ware automatically was perfected and a technique developed to seal glass to metal. Extremely thin ribbons of glass were drawn in laboratory tests.

Another important process development was a method to form and seal glass blocks for the construction industry. The technique led in 1937 to the formation with Pittsburgh Plate Glass Company of the Pittsburgh Corning Corporation. Dr. Sullivan was to serve as a director for many years.

Experimentation with glass fiber production had been carried on since 1924 by Mr. Wellech and the engineering staff. The process had advanced to such a high degree by 1935 that a plant to manufacture fibrous glass was constructed adjacent to Fall Brook. This technology was also moved out to another associate company in 1938 with the formation with Owens-Illinois Glass Company of Owens-Corning Fiberglas Corporation. Again, Dr. Sullivan served on its board of directors.

By the end of 1936, despite the depression, company sales had increased more than 40 per cent over 1930 and earnings more than 50 per cent.

# VICE CHAIRMAN, DIRECTOR OF RESEARCH, 1936-1945

Macbeth-Evans Glass Company of Charleroi, Pennsylvania, merged with Corning Glass Works in December, 1936, adding to Corning's technology 72 years of glassmaking skills and the inventive ability of Macbeth-Evans President George D. Macbeth who had started work for that company in 1913.

In the Corning elections which followed the merger, Amory Houghton remained as president; Mr. Macbeth was elected vice president in charge of manufacturing and research; and Arthur A. Houghton, Jr., who had joined Corning's production department in 1929, was elected vice president in charge of sales and finance.

Dr. Sullivan's longtime associates—Dr. Day, Mr. Githler, and Mr. Hollister—were elected honorary vice presidents. Dr. Hostetter resigned to become a vice president and director of research at Hartford-Empire. And Dr. Sullivan, who would celebrate his 65th birthday within the month, was reelected vice chairman of the board and again appointed director of research and development. He was also elected to the board's executive committee.

With the depression nearing its end and war clouds gathering in Europe, the pace of company activity accelerated appreciably. Pressware plant started production of PYREX ware products in 1938. A long-awaited new laboratory building was occupied in 1940 which, with its 34,300 square feet of floor space, gave the staff of 190 glass scientists, engineers, and glass technologists a total of 61,430 square feet of research and development space.

Important new materials from the research laboratory included announcement in 1939 of the invention of 96 per cent silica glass by Mr. Hood and Dr. Martin E. Nordberg. From the process development groups came a method to seal glass parts electrically developed by Dr. Edwin M. Guyer, a process to physically temper tumblers perfected by Dr. Harry R. Kiehl, an hydraulic press, the Multiform process. An accelerating flood of new products: parts for an all-glass pump, VYCOR® brand laboratory glassware, sealed beam headlamp lenses and reflectors, DOUBLE-TOUGH® tumblers, glass tubing for fluorescent lamps, Christmas tree ornaments, and germicidal lamps.

In an effort to bridge more closely the gap between laboratory development and factory production, a department of glass technology was established late in

1939 under the direction of Mr. Taylor. Key staff members included Mr. Oakley, Dr. Evan J. Lewis, and Rowland D. Smith.

Dr. Littleton was appointed assistant director of research with the opening of the new laboratory building in 1940. He named as his department managers Dr. Guyer, Mr. Hood, Mr. Lillie, Dr. McCauley and Dr. Shaver.

Six months before United States' entry in World War II, Amory Houghton advanced to the position of chairman of the board and Dr. Sullivan's laboratory assistant of 1919, Glen W. Cole, was elected president. William C. Decker, a chemical engineer turned manager, was elected vice president of the company's first line division, Bulb and Tubing (predecessor of the present Lighting Products Division).

Seventy-five per cent of the company's productive capacity was devoted to the war effort for the next four years. Product development in the laboratory accelerated as glass substitutes were sought for critical metals. The staff carried out 174 different research projects under government contract during the period.

Significant new products developed to meet the war needs included tempered opal messware for military use, cathode ray tubes, and electronic inductances. One of the most important wartime developments successfully completed by Dr. John F. G. Hicks and Dr. Charles F. DeVoe was invention of a method to melt optical glass continuously.

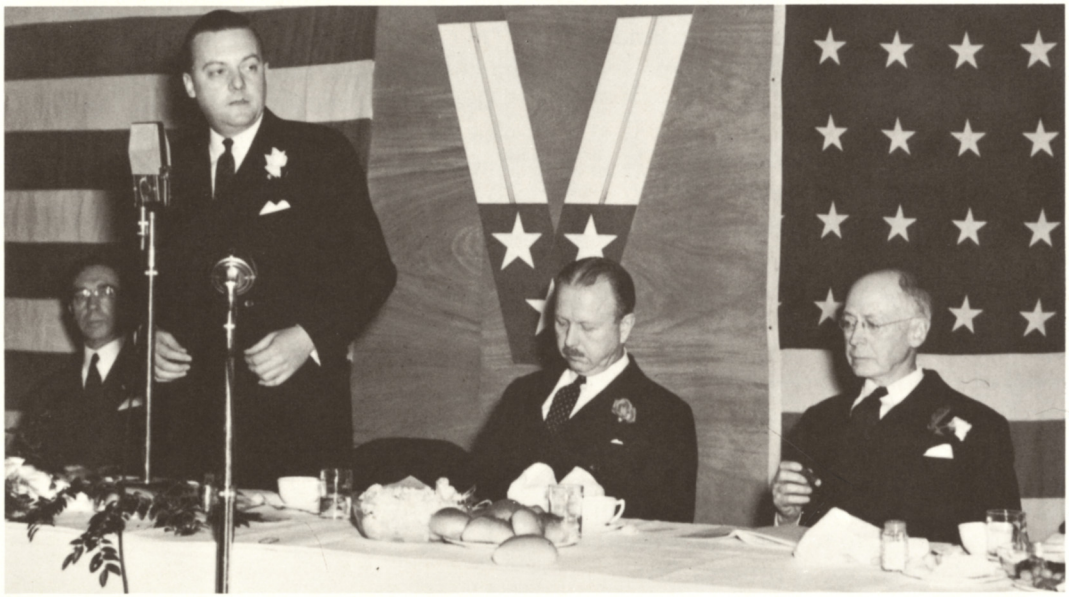
Special recognition came to each of the three key pioneering scientists in 1943. Commercial production of the silicones discovered 10 years earlier led to the formation with The Dow Chemical Company of Dow Corning Corporation. Dr. Sullivan served as its president for the next 11 years and remained a board member until 1962. He was also elected to the board of that company's French affiliate, Societie Industrielle des Silicones.

Dr. Littleton and Mr. Taylor were both elected vice presidents of Corning in 1943 in tribute to their extraordinary contributions in 30 years of service.

Company sales continued to grow, more than doubling their 1937 levels by 1945. The number of scientists, engineers, and technicians employed by the several technical staffs increased to 300 people. Production capacity had been increased by the addition of three plants.

*Electric sealing*

*Pressware production*



*Service dinner head table in 1942, left to right, Alexander D. Falck, Amory Houghton, Glen W. Cole, Dr. Sullivan.*

## HONORARY VICE CHAIRMAN, 1946-1949

With the war ended and conversion to peacetime production a major consideration, top management responsibilities were given to younger men. William C. Decker succeeded Glen W. Cole as president and Dr. Sullivan, at age 74, was elected honorary vice chairman of the board.

But with Dr. Littleton and Mr. Taylor still in charge of research and glass technology, respectively, Dr. Sullivan continued to keep in close touch with daily developments. He read laboratory reports regularly, following up with conversations on details of new developments. And he continued to read scientific journals in all fields.

Ada Bisbee Sullivan died in 1943. Dr. Sullivan was married again in 1949 to Mrs. Gladys Lindsay of Rochester.

New materials continued to flow from the laboratories in increasing numbers: ophthalmic glasses, Dr. S. Donald Stookey's photosensitive glass, and chrome oxide refractories.

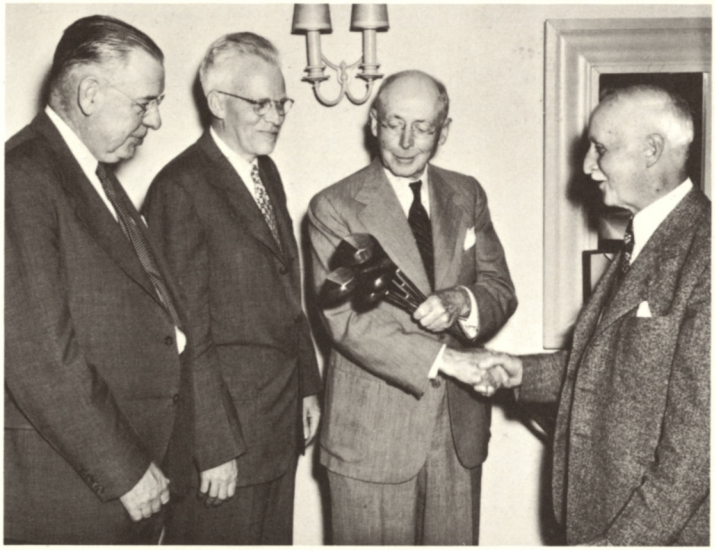
Pilot Plant 1 was constructed in 1946 to finally give the laboratory the experimental facilities needed to test new glasses and forming techniques. A process first developed by chemist John M. Mochel to apply an electrically conductive coating to glass was further advanced by Dr. James K. Davis, later joined by Dr. Edward M. Griest. Improved techniques to produce glass ribbon were developed by chemical engineer Donald N. Brown and physicist Dr. Gail P. Smith.

But the most important developments of the period were directed to the mushrooming young television industry. A key contribution was made by James W. Giffen who invented a method to shape glass television funnels by centrifugal casting. Dr. Guyer's electric sealing processes were adapted to seal bulb parts. Dr. William H. Armistead invented a new lead-free glass for the product. Corning's role in this important new television market was successfully launched.

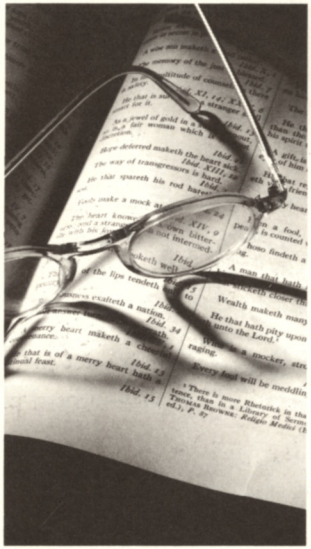
Sales advanced more than 30 per cent and earnings more than doubled from 1946 to 1949. Production capacity increased with construction of the Muskogee, Oklahoma, plant and the leasing of the Horseheads, N.Y. warehouse.

*Electrically conductive coatings*

*Television bulbs, 10-inch round to 27-inch rectangular*



*Corning Country Club testimonial in 1949, left to right, Edward J. Smith, Frederick W. Parsons, Jr., Dr. Sullivan, Frederick C. Carder*



*Ophthalmic glass*

## HONORARY CHAIRMAN, 1950-1962

The final 13 years of Dr. Sullivan's career witnessed an explosion of materials and processes which were to revolutionize the entire glass industry. And as a director of the company and member of the executive committee, he continued to exert major influence in the operation of the fast-growing business.

In 1950, the board paid high tribute to Dr. Sullivan by electing him honorary chairman. Dr. Littleton was relieved of his heavy responsibilities the following year with the appointment of physicist Dr. Edward U. Condon, director of the National Bureau of Standards since 1945, as director of research at Corning. Mr. Taylor served as director of manufacturing and engineering from 1948 to 1954 when both he and Dr. Littleton were elected honorary vice presidents.

Direction of the laboratories was assigned in 1954 to Dr. William H. Armistead, and under his leadership all technical staff groups were consolidated in 1961. The organizational structure was once again closely patterned after that initially formed by Dr. Sullivan in 1920.

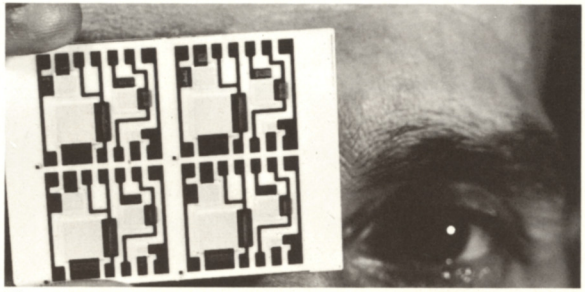
New materials poured from the laboratory in increasing numbers as scientists built on the solid base of fundamental studies carried out years earlier: FOTOFORM® and FOTOCERAM® brand materials, stabilized zirconia refractories, gamma radiation measuring and absorbing glasses, commercial production of fused silica.

Most significant of the many material developments was the discovery by Dr. Stookey of a means to convert by heat treatment special glass compositions to fine-grain crystalline ceramics. One PYROCERAM® brand composition was used to produce radomes for guided missiles; others were later adapted for the production of CORNING WARE® utensils, CERCOR® cellular ceramic structures and, still later, CENTURA® tableware.

Pilot Plant 2 was constructed in 1950 to provide specific facilities to develop new processes and products. New manufacturing techniques were developed in other plants to produce massive optics, fused silica, and a broad range of electronic components.

Hundreds of additional scientists, engineers and technicians were added to the staffs to carry out the expanding activity. A major advance was the construction of two new laboratory buildings which more than doubled the space previously available to the

*Bulbs for color television*



*Electronic microcircuits*

*Laboratory 50th anniversary party in 1958, left to right, Dr. Jesse T. Littleton, Dr. Sullivan, William C. Taylor, William C. Decker*

scientists. In dedicatory ceremonies on May 25, 1957, Arthur A. Houghton, Jr., named the laboratories in honor of Dr. Sullivan.

Growth of the research activity continued to accelerate at such a fast pace that a decision was made only three years later to establish even larger quarters which would centralize all technical staff personnel in one location. Four hundred acres of wooded hillside were acquired in the nearby Town of Erwin and on September 13, 1960, the company announced establishment there of Sullivan Park. Making the announcement was Amory Houghton, Jr., then staff vice president and son of Amory Houghton—the fourth generation of the Houghton family to be counseled by Dr. Sullivan.

First building in the new complex was a Process Research Center which was to be occupied the following year. Dr. Sullivan participated in the lighting of its tanks on August 1, 1961. Meanwhile, detailed plans were being drawn for additional buildings at the Park—a development laboratory of 147,200 square feet, a six-story fundamental laboratory of the same size, and a building to house the technical library, a cafeteria, and an auditorium.

Special tribute to the three research pioneers—Dr. Sullivan, Mr. Taylor, and Dr. Littleton—was paid at a dinner on October 28, 1958, when laboratory personnel gathered to commemorate 50 years of Corning research. Mr. Taylor was to die unexpectedly only a few days later (November 2). Others who had played important roles in the development of the research program also had passed away: Mr. Hollister on January 5, 1952; Mr. Cole on October 18, 1955; Dr. Day on March 2, 1960. (Dr. Littleton died on February 25, 1966.)

But Dr. Sullivan continued to be vigorous and alert, going to his Houghton Park office every day and attending meetings of the many organizations of which he was a board member. In the year 1960, for instance, he traveled more than 10,000 miles on business and pleasure.

In the spring of 1962, a stubborn head cold and subsequent heart attack forced him to be hospitalized on April 29. He died quietly in his sleep on May 12.

*CORNING WARE utensils*

*Fused silica mirror blank*

*Radomes, glassy state and cerammed*

*Dr. William H. Armistead and Dr. Sullivan, 1957*

*Dr. Sullivan lights Process Research Center tank with Dr. Ben Allen, 1961*

## OTHER ACTIVITIES

In addition to being a brilliant scientist and an astute businessman, Dr. Sullivan was an interested and active participant in many civic activities.

His respect for the importance of education led to 36 years of service as a member of the Board of Education of Corning School District No. 9. Joining the board on September 3, 1917, he was elected vice president in 1932, a position he held until his retirement from the board in 1953. He served at various times as chairman of the building and grounds committee, the teachers committee, and text book evaluation.

With the establishment of the Corning Glass Works Foundation in 1952, Dr. Sullivan was elected a charter trustee. He instituted a Corning Fellowship program for outstanding pre- and post-doctoral students and helped develop the Foundation's matching gift program for assistance to employes' colleges and universities. He also helped plan the summer scholarship program for plant town teachers and supported a number of Foundation special grants to the newly formed Corning-Painted Post Area School District to further improve the level of teaching.

A major Foundation program in 1960 was a matching grant of $2\frac{1}{4}$ million to Corning Community College for construction of its new campus. Dr. Sullivan had announced earlier that his four-story home at 222 Pine Street would be turned over to the College upon his death.

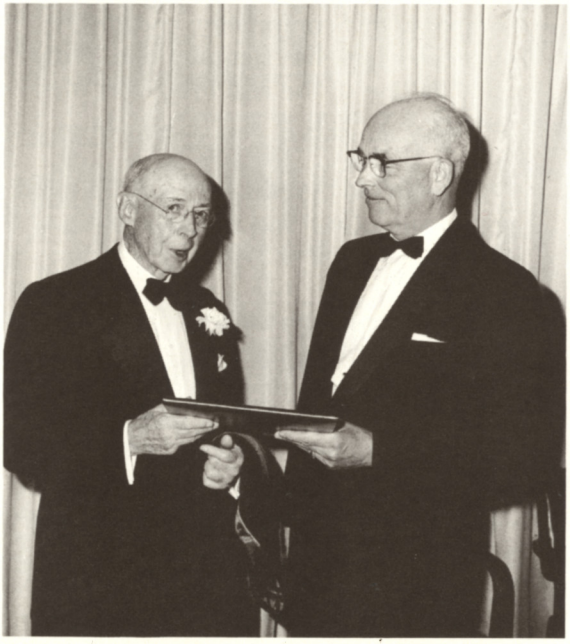
An avid golfer in his younger days, Dr. Sullivan was a charter member of the Corning Country Club and served on its board of directors for almost 30 years.

He served as a director of the Corning Chamber of Commerce for two years (1927-28) and also served as a member of the Corning Library Board. He was a charter member of the trustees of The Corning Museum of Glass.

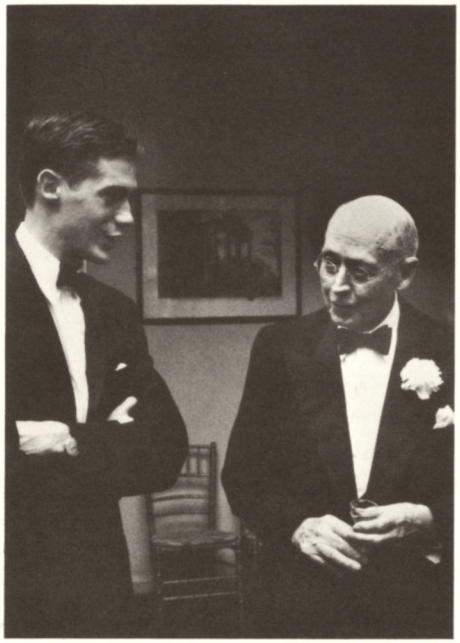
Continually interested in the world around him, Dr. Sullivan served many organizations in many capacities. He was a member of the National Research Council from 1939 to 1942; a member of Governor Dewey's Committee on Technical and Industrial Development of New York State from 1944 to 1948; a member of the editorial advisory board of *Industrial & Engineering Chemistry;* a member of the Chemical Advisory Committee of the Army and Navy


*Bleininger Award, 1961*

*Amory Houghton, Jr., and Dr. Sullivan*



*Dr. Sullivan receives honorary degree from Alfred University President M. Ellis Drake, April 10, 1962*



*At 90th birthday party on January 23, 1962, with grandson Eugene L. Scott*

Munitions Board and Chemical Warfare Service. He also served as chairman of the advisory sub-committee on glass for the National Bureau of Standards.

Joining the American Ceramic Society in 1917, he was elected a Fellow in 1931. He was also an Honorary Fellow of the Society of Glass Technology, and was a member of the American Chemical Society, the Electrochemical Society, the Washington Academy of Science, the American Institute of Chemical Engineers, the American Institute of Mining and Metallurgical Engineers, the Directors of Research, and the Electrical Manufacturers Club.

The University of Michigan awarded him an honorary doctorate of science in 1933 and only one month before his death in 1962, Alfred University honored him with an honorary doctorate of laws.

The National Association of Manufacturers named him a "Pioneer in Research" in 1940, and in 1961 the Pittsburgh Chapter of the American Ceramic Society awarded him the Albert Victor Bleininger Award.

Commenting upon the contributions of Dr. Sullivan at the time of his death in 1962, Amory Houghton, Jr., then president of Corning Glass Works, wrote:

"This world regularly produces men of great talent and leadership. However, for most of us these men are but names to be read about. This, fortunately, was not the case here in Corning because we've been living closely with Dr. Sullivan and his genius for many years.

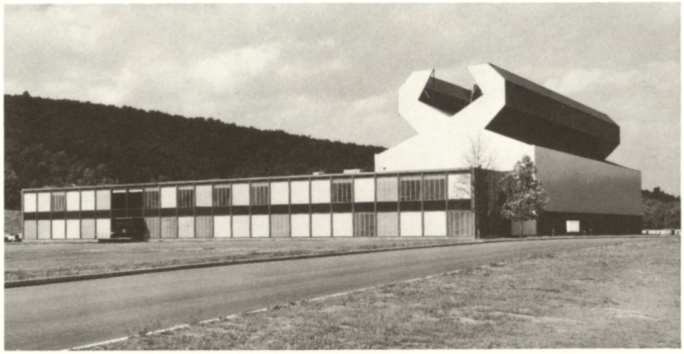
"Not only his great scientific talents, but more especially his deep faith in this company, this community, and this material—glass—has stamped him in my mind as one of the real life-givers of our age.

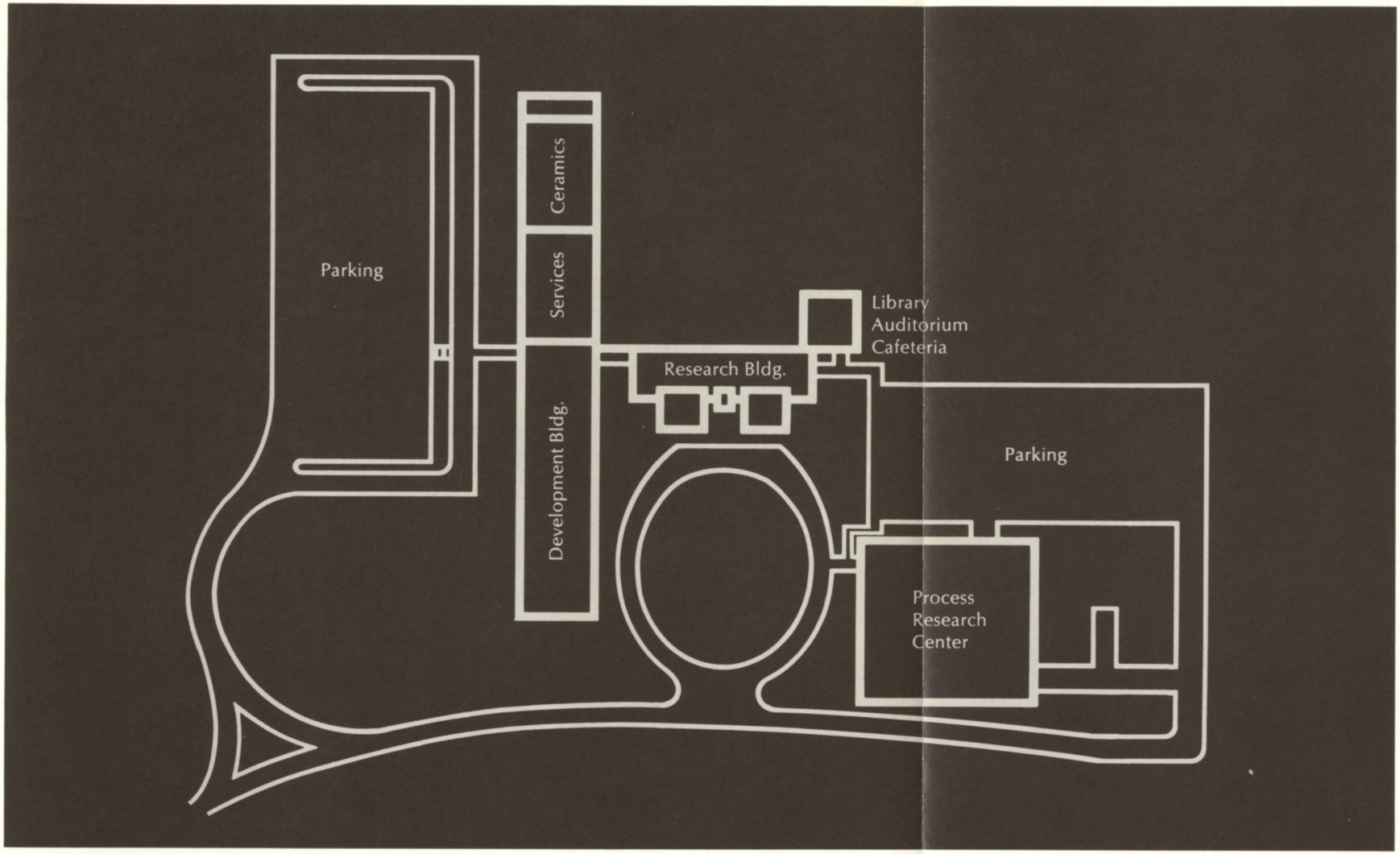
"Although old in years, I am sure his mind was as young as it was when he first came to Corning in 1908.

"He was constantly suggesting ways to broaden our thinking and deepen our understanding of the great future which resided with us if we were able to see our opportunities in proper perspective.

"We've obviously lost an inspiration and an associate, but the true test of his greatness will be our ability to carry on worthily where he has led the way."

SULLIVAN PARK, CORNING GLASS WORKS



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