

# Lyle D. Goodhue

**Lyle David Goodhue** (1903-1981) was an internationally known inventor, research chemist and entomologist with 105 U. S. and 25 foreign patents<sup>1</sup>. He invented the “aerosol bomb” (also known as the “bug bomb”), which was credited with saving the lives of many thousands of soldiers during World War II by dispensing malaria mosquito-killing liquid insecticides as a mist from small containers. The Bug Bomb<sup>2</sup> became especially important to the war effort after the Phillipines fell in 1942, when it was reported that malaria had played a major part in the defeat of American and British forces. After the war, this invention gave birth to a new international billion-dollar aerosol industry. A broad variety of consumer products ranging from cleaners and paints to hair spray and food have since been packaged in aerosol containers.

## Career

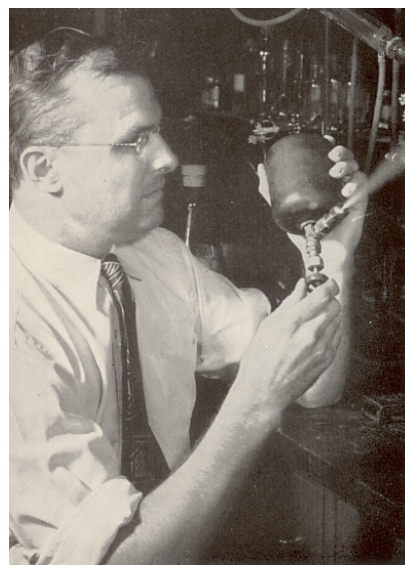
The disposable spray can was largely undeveloped until Lyle Goodhue devised a practical version and filed for a patent in 1941<sup>3</sup> while working for the U. S. Department of Agriculture (USDA).

Dr. Goodhue’s earliest aerosol propellant idea came to mind when he worked in 1929-30 as a research chemist on lacquer formulations at the duPont Chemical laboratories in Parlin (Sayreville), NJ<sup>4</sup>. That aerosol spray concept was greatly expanded, written in his lab notebook, and witnessed by his boss, Dr. Frank L. Campbell, October 5, 1935 when both worked at the USDA’s Agricultural Research Center in Beltsville, Maryland.<sup>5</sup>

As a result of their research, which began January 1941 at USDA, Lyle D. Goodhue of Berwyn, Maryland and William N. Sullivan of Washington D.C. received a patent in 1943 for an aerosol “dispensing apparatus.”<sup>6</sup> This was the first commercially-feasible application which allowed a fine spray to escape through a nozzle mounted on a small container. The design, assigned to the U. S. government, was the ancestor of



<b>Born</b>	September 30, 1903 Jasper County, Iowa
<b>Died</b>	September 18, 1981 Bartlesville, Oklahoma
<b>Known for</b>	Aerosol “Bug Bomb” A vitrol bird repellent



DR. L. D. GOODHUE  
*tests early insecticide aerosol.*

many popular commercial spray products in wide use today. Using liquified gas as a propellant, its one-pound portable cylinder enabled soldiers to defend themselves against tropical malaria-carrying insects by spraying non-toxic insecticides inside tents and troop planes during World War II. From 1942 through 1945, more than 40 million “aerosol bombs” were sent to the troops.

In 1945, Lyle Goodhue, often called the “Father of the Aerosol Industry”, joined Airosol, Inc. in Neodesha, Kansas, as Director of Research. This company, which had been originally established to manufacture aerosol containers of insecticide for the military during World War II, became a leading packager of aerosol spray consumer products after the war.



HOUSEHOLD AID . . . Mrs. Lyle D. Goodhue, wife of the aerosol pioneer, utilizes one of the first containers in a demonstration.

In 1947, Dr. Goodhue joined Phillips Petroleum Company, Bartlesville, Oklahoma as a Senior Research Chemist and Director of Agricultural Chemicals Research. Of the 98 patents which he received at Phillips, he felt that his most important discovery was *Avitrol*®, a treatment which controls and disperses bird infestations through behavioral responses<sup>7</sup>. He retired from Phillips in 1968 as Avitrol Technical Manager.

## **A critical point for aerosol development**

Lyle Goodhue wrote this account in 1969 of his ground-breaking 1941 aerosol experiment while working for the USDA in Maryland:

*“There came a time when the director of research of our bureau began to doubt the value of aerosol research. The Friday before Easter of 1941, the team of Goodhue and Sullivan received a summons to appear at a meeting in his office the following Monday to decide whether our project should be continued. This triggered the first modern aerosol. I said to Bill Sullivan, ‘We better drag out that old idea of mine and, if possible, test it before the meeting with the chiefs on Monday.’ We had been contemplating such a test for some time so part of the materials were on hand. However, I had to purchase the Freon 12 on Saturday and make up the first aerosol on Sunday in my chemical laboratory in Beltsville. I made one successful test with this synergized pyrethrum aerosol in the morning on American roaches left from earlier tests. In the afternoon, friends and families of Goodhue, Sullivan and J. H. Fales gathered at the Entomology laboratory to further test this new method on flies and roaches. The results of all these tests were excellent.*

*“We were ready for the Monday meeting. Goodhue and Sullivan took this rather crude five-pound capacity aerosol container with them to the expected meeting in Washington. We first demonstrated it to the research director. He was not impressed and left the room. Next Sullivan’s chief, Lon Hawkins, saw a demonstration and was very happy to see that the method would work.*

*“After a few more demonstrations for the chiefs of the various divisions, the proposed meeting*

*on aerosols did not materialize, so we took the gadget back to Beltsville and concentrated our efforts on its further development.”<sup>8</sup>*

In a 1967 newspaper interview, Dr. Goodhue had previously revealed a few more dramatic details of his discovery. Wayne Mason, a reporter for the Tulsa World wrote “It was on Easter Sunday in 1941 when the great moment came in Goodhue’s life. He had just sprayed a few dozen American roaches with the new aerosol. In his words, “*In less than 10 minutes all were on their backs. No one else was in the building. I yelled at the top of my voice and danced around wildly. As soon as I could regain my composure, I drove home like a mad man and called Bill Sullivan and John Fales, and with great enthusiasm gave them the results of the first test.*”<sup>9</sup>

## **Honors and Awards**

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- 1928 Highest scholastic record for entire college course, Industrial Science, Iowa State College<sup>10</sup>
- 1938 Gold Medal, Eastern Branch of the American Association of Economic Entomologists, for his paper entitled the “Effect of Particle Size of Some Insecticides on Their Toxicity to the Codling of Moth Lava”<sup>11</sup>
- 1943 Speaker, Herald Tribune Forum, Waldorf-Astoria, New York, New York<sup>12</sup>
- 1945 John Scott Award, Philadelphia, Pennsylvania, for the invention of insecticidal aerosols<sup>13</sup>
- 1948 Alumni Merit Award, Iowa State Alumni Association, Iowa State University, Ames, Iowa<sup>14</sup>
- 1954 Achievement Award, Chemical Specialties Manufacturers Association (CSMA), for work during World War II in developing aerosol insecticides to combat disease-carrying pests<sup>15</sup>
- 1966 Lyle D. Goodhue Research Building, dedicated in honor of his contributions to the aerosol industry, Aerosol Techniques, Inc., Milford, Connecticut<sup>16</sup>
- 1970 Kenneth A. Spencer Award, American Chemical Society, Kansas City section, for outstanding achievement in agricultural and food chemistry<sup>17</sup>
- 1970 Eric Andreas Rotheim Gold Medal, for outstanding contributions to the development of the international aerosol industry, Oslo, Norway<sup>18</sup>

## **Education and Personal Life**

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Lyle Goodhue was born on a farm in Malaka Township, Jasper County, Iowa on September 30, 1903 to Thomas Warwick and Katherine Jane (Engle) Goodhue. Because of his poor eyesight, he was not allowed to enter first grade until he was nine years old. The family story is that his father, a farmer, eventually decided that it would be better for him to go to school than to get tangled up in farm machinery.

Dr. Goodhue graduated from Newton (Iowa) High School in 1924.<sup>19</sup> He went on to earn a B.S. (Chemistry) in 1928, an M.S. (Plant Chemistry) in 1929 and a Ph.D. (Plant Chemistry)<sup>20</sup> in 1934 from Iowa State University, Ames, Iowa.

He was a member of honor societies Sigma Xi (scientific research), Phi Lambda Upsilon (chemistry), Phi Kappa Phi (academic excellence), Pi Mu Epsilon (mathematics), Gamma Sigma Delta (agriculture), and Delta Mu Delta (business). He was also a member of the professional chemical fraternity of Alpha Chi Sigma, the American Chemical Society, and the Entomological Society of America. Dr. Goodhue received a number of citations from the U.S. Army and U. S. Navy during and after World War II. He authored over 100 technical papers and scientific articles.

He married Helen Elizabeth Hamaker, daughter of Charles Haynes and Jenny Leuna (Davis) Hamaker June 19, 1929 in Des Moines, Iowa. A daughter and a son were born in Ames, Iowa while Dr. Goodhue was studying for his Pd.D, another son born in Riverton, New Jersey while working there at the USDA Japanese Beetle Lab, (waiting for a position to become available with the USDA in Beltsville, Maryland), and a second daughter in Riverdale, Maryland during World War II.

Modest and unassuming, Goodhue routinely gave credit to those who worked with him; as a result, most of his patents also include a co-worker's name. He never lost a farm boy's ability to repair or construct what was needed. He built his own photography lab and, later, a greenhouse. He designed and served as the contractor for the house in which he lived for more than thirty years before he died. And then, after his own house was completed, he built two more nearby to rent and sell.

His memory, highly developed over the years to compensate for his poor eyesight, was prodigious. After retiring, he acknowledged that he was legally blind, but that did not stop him from continuing to pursue his hobbies. He was well known for his greenhouse, in which he raised bedding plants, African violets and orchids for local residents. Although he did not profit directly from his inventions, he and Mrs. Goodhue were given a month-long round-the-world trip by a grateful industrialist toward the end of his career. His presentations of colored slides from that trip and other extensive foreign travels were popular events in his hometown.

Lyle David Goodhue died September 18, 1981 in Bartlesville, Oklahoma and is buried beside his wife Helen, who died June 14, 1995, in Memorial Park Cemetery, Bartlesville, Oklahoma.

### **A rare comment about his poor eyesight**

A 1967 newspaper article said "He has had numerous articles written about him but in none of those is his poor eyesight mentioned. He wouldn't have mentioned it either except that he was asked about it. After graduation from high school, he had to take a test (because of his eyes) before being allowed to enter college. He was graduated with the highest honors from Iowa State. Under the legal definition he could be called blind, but Goodhue had enough field of vision to drive a car and gets along with special, powerful lenses. *"I don't drive a car anymore*

*because they got too fast for me,” he says. He said he used to feel like he needed to hide his ‘blindness’, but that “as you get older and successful it doesn’t make much difference.”*<sup>21</sup>

## References

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1. Lyle D. Goodhue obituary, New York Times, September 21, 1981. Also, Tulsa Sunday World, “It Was A Time for Dancing” article about Dr. Goodhue by Wayne Mason, June 18, 1967.
2. Westinghouse Electric and Manufacturing Company in Springfield, Massachusetts, working with Goodhue and Sullivan, developed the first practical aerosol bomb container about 1942. Its employees originated the terms “bug bomb” or “aerosol bomb” because of the unit’s similar physical appearance to a small bomb, according to an article in the May 1965 issue of Aerosol Age entitled “How It All Began”, by Dr. Lyle Goodhue. The “bomb”, he said, was actually adapted from a one-pound Freon 12 cylinder, already in commercial use for charging household refrigerators. Before the end of World War II, Westinghouse had produced over 30 million units, and another 10 million were produced by three other companies.
3. Some early aerosol patents:
  - Patent No. 2,285,950 for “Method of Applying Insecticides”, filed by Lyle D. Goodhue and William N. Sullivan on January 10, 1940 (Serial No. 313,218) and granted June 9, 1942.
  - Patent No. 2,306,434 for “Method of Applying Insecticides”, filed by Lyle D. Goodhue and William N. Sullivan on March 31, 1941 (Serial No. 386,058) and granted December 29, 1942.
  - Patent No. 2,321,023 for “Method of Applying Parasiticides”, filed by Lyle D. Goodhue and William N. Sullivan on July 29, 1941 (Serial No. 404,520) and granted June 8, 1943. Note: This aerosol patent was featured in a special exhibit, which Dr. Goodhue attended, at the U.S. Patent Office in Arlington, Virginia on October 13, 1969. The invention produced the first true aerosol utilizing a liquified gas.
  - Patent No. 2,331,117 (Serial No. 413,474) for an aerosol “dispensing apparatus”, filed by Lyle D. Goodhue and William N. Sullivan on October 3, 1941 (including dispenser drawing), and granted October 5, 1943.
  - Patent No. 2,345,892 for “Synergists to Aerosol Insecticides” originally filed by Lyle D. Goodhue and William N. Sullivan September 30, 1941 (Serial No. 412,960) and granted April 4, 1944 (Serial No. 517,359). Note: This patent was part of a series of 19 patents from No. 2,345,891 through No. 2,345,909 granted in 1944 to Lyle D. Goodhue and William N. Sullivan.
  - Patent No. 2,412,728 for “Device for producing Aerosols”, filed by Lyle D. Goodhue December 8, 1943 (Serial No. 513, 400) with drawing, and granted December 17, 1946.
4. Article “Bug Bombardier”, Coronet Magazine (Esquire, Inc.), by Alfred H. Sinks, March 1946.
5. Letter dated March 17, 1964 from Dr. Frank L. Campbell, then Executive Secretary, Division of Biology and Agriculture, National Research Council, National Academy of Sciences, to Frank J. Reilly, MacNair-Dorland Company, New York, NY, identifying Dr. Lyle Goodhue as being “solely responsible for the scientific and technical development of the aerosol bomb”. The letter goes on to say that “His patent partner, William N. Sullivan, was my former assistant but had nothing to do with the basic ideas and know-how required for development of the bomb... he does not rank with Goodhue as co-inventor.” Also, article “How It All Began”, by Lyle D. Goodhue, Aerosol Age, May 1965. (This article included a reproduction of the lab notebook page initialed by Dr. Frank Campbell October 5, 1935.)

6. Patent No. 2,331,117 (Serial No. 413,474) for an aerosol “dispensing apparatus”, filed by Lyle D. Goodhue and William N. Sullivan on October 3, 1941 (including dispenser drawing), and granted October 5, 1943.

7. Avitrol-related patents and literature:

Patent No. 3,044,930 for “N-oxides of Heterocyclic Nitrogen Compounds as Bird and Rodent Repellants”, filed by Lyle D. Goodhue and Kenneth E. Cantrel on December 8, 1960 (Serial No. 74,447), and granted July 17, 1962.

Patent No. 3,113,072 for “Nitro-substituted Heterocyclic Nitrogen Compounds as Bird Management Chemicals”, filed by Lyle D. Goodhue, Andrew J. Reinert and Ralph P. Williams on November 13, 1961 (Serial No. 152,005), and granted December 3, 1963.

Patent No. 3,150,041 for “Amino-substituted Heterocyclic Nitrogen Compounds as Bird Management Chemicals”, filed by Lyle D. Goodhue, Andrew J. Reinert and Ralph P. Williams October 8, 1962 (Serial No. 229,155), and granted September 2, 1964.

Literature written in 1965 by L. D. Goodhue and F. M. Baumgartner often cited for bird repellent using 4-aminopyridine (4-AP or Avitrol 200): “Applications of New Bird Control Chemicals”, *The Journal of Wildlife Management*, Volume 29, No. 4, pages 830-837, and “The Avitrol Method of Bird Control”, *Pest Control* 33(7), pages 16-17, 46, 48.

Article “It’s For Birds”, *Philnews*, Phillips Petroleum Company, Bartlesville, Oklahoma, January 1965, pages 4-7.

8. Article “Aerosol Industry Milestones: How It Began, and What Happened Afterward”, by Lyle D. Goodhue, *Aerosol Technicomment*, Aerosol Techniques, Inc., 1969, Volume XII, No. 2. Article “How It All Began: What Started the Billion Dollar Aerosol Industry”, by Lyle D. Goodhue, *Aerosol Age*, May 1965.

9. Article “It Was A Time for Dancing”, by Wayne Mason, *Tulsa Sunday World*, June 18, 1967. Article “What Hath Plunkett, Goodhue, Strosacker, et al Wrought?” by Dorothy Parker and James Baldwin Nureyev, *Esquire* magazine, July 1968, p. 52.

10. Third Annual Honors Program, May 25, 1928, Iowa State College, seniors in the class of 1928 having the highest scholarship for their entire college courses.

11. The 1938 medal was reported by the *New York Herald Tribune* November 21, 1943. A later paper delivered to this same organization at Baltimore, Maryland in November 1941 on “The Toxicity of Pyrethrum Aerosols to Mosquitoes” also attracted scientific interest.

12. *Herald Tribune* Current Problems Forum, November 17, 1943 at the Waldorf-Astoria Hotel, New York, NY. Lyle Goodhue’s 1:45 pm talk was on the “War Against Mosquitoes”. A research chemist with the USDA’s Bureau of Entomology and Plant Quarantine, his speech was also broadcast later at 3:15 pm on radio station WJZ. Among others, both President Franklin Delano Roosevelt and his wife, Eleanor Roosevelt, spoke in the same Forum. The full text of Dr. Goodhue’s speech was reprinted in a *New York Herald Tribune* newspaper article dated November 21, 1943.

13. <http://www.garfield.libraryupenn.edu/johnscottaward/js1941-1950.html> (John Scott Award Recipients 1941-1950). Dr. Goodhue received the John Scott Award September 20, 1945 from Walter B. Gibbons, a member of the Philadelphia Board of City Trusts, meeting at the American Philosophical Society, 5<sup>th</sup> and Chestnut, Philadelphia, PA. He split the \$1000 honorarium with William Sullivan. Other John Scott Award recipients have been Mme. Marie Currie (1921), Orville Wright (1925), Thomas A. Edison (1929), and Sir Alexander Fleming (1944).

14. [http://www.isualum.org/documents/.../AllTime|isu award recipients — Iowa State](http://www.isualum.org/documents/.../AllTime|isu%20award%20recipients%20%E2%80%93%20Iowa%20State) (No. 1158, Alumni Merit Award, 1948).
15. CSMA Achievement Award presented at the 41<sup>st</sup> Annual Meeting of the Association in New York City, December 7, 1954. Mentioned in Aerosol Technique's biography of Lyle Goodhue (below) at the ceremony on September, 13, 1966 in Milford, Connecticut, as well as in the February 1971 issue of the American Chemical Society's "Kansas City Chemist" magazine.
16. "Honoring Lyle Goodhue", Philnews, Phillips Petroleum Company, Bartlesville, Oklahoma, December 1966, p.12-13. Herman R. "Shep" Shepherd, founder and president of Aerosol Techniques, Inc. (ATI), 269 Old Gate Lane, Milford, Connecticut, named his new research center building for Lyle D. Goodhue September 13, 1966 and awarded a month-long trip around the world in 1967 to Dr. and Mrs. Goodhue as a prize. U. S. Assistant Secretary of Agriculture George L. Mehren delivered the keynote speech at the Goodhue building's christening ceremony. At the time, ATI enjoyed 21% of the U. S. aerosol contract-filling market, with plants in Connecticut, Massachusetts, Illinois and California, according to a 1965 Harvard case study.
17. <http://cas.umkc.edu/chemistry/kcacs/sper> (Kenneth A. Spencer Award, past winners). The sixteenth annual Spencer award, which consisted of a bronze medal and \$1000, was presented to Lyle Goodhue February 17, 1970 at the Hilton Inn, Kansas City, Missouri. His acceptance speech was "Highlights in a Career of Agricultural Research".
18. The very first Eric Rotheim Gold Medal was awarded August 28, 1970 to Dr. Lyle Goodhue in Oslo, Norway by Mr. H. Robin Hearn, President of the Federation of European Aerosol Associations, which represented members in fourteen western European countries. Also present was C. F. Michelet, president of the Norwegian Aerosol Association. At the time, world production of aerosols exceeded 4 billion units a year, with 3 billion units being produced annually in America. Following the ceremony, Dr. Goodhue and his wife toured the Scandinavian countries, Scotland and England before returning to the United States. Articles, The Bartlesville Examiner Enterprise, Bartlesville, Oklahoma, September 30, 1970 and the November 1970 Philnews, Phillips Petroleum Company, Bartlesville, Oklahoma.
19. The 1924 *Newtonia* highschool yearbook described Lyle Goodhue as a "Quiet lad, but never sad".
20. Lyle Goodhue's Iowa State 1929 M.S. thesis subject was "Chloral Derivatives of Carbohydrates" (OCLC No. 35596837). His 1934 Ph.D. thesis subject was "The Effect of Solvent Upon Polar Properties of Organic Compounds" (OCLC No. 31467802).
21. Article "It Was a Time for Dancing", by Wayne Mason, Tulsa Sunday World, June 18, 1967.