Sperry: Inventing the 20th Century

by George Colpitts

The last years of the 19th century began the golden age of the electronics hobbyist. Henry, Foucault and Ohm might have previously fine-tuned principles of electricity and physics, but it was backyard tinkerers such as Edison, Weston and Siemens who hammered such principles into every-day life. Often at odds with academic scientists, wild-haired inventors and armchair science buffs experimented with the internal combustible engine for cars, dangled from unstable dirigibles or killed themselves in elaborate airplanes. Store catalogues and patent monthlies were crowded with contraptions reflecting the come-hell-or-high-water determination of their creators. "Invention is 95 per cent perspiration," Edison had said, probably without exaggeration and most innovation amassed man-hours which would make modern R&D groups cringe. But the years were exciting. These hobbyists eventually created, patented and sold modern convenience, the degree of which we have never been able to fully match.

Any look at early innovators would have to include inventor-*extraordinnaire*, Elmer Ambrose Sperry, whose hands produced gadgetry which changed the planet. He was lionized as an engineer, initiator of dozens of corporations, including the Sperry-Rand corporation, and the dreamer behind modern avionics, gyro-compasses and truly closed-looped systems.

With little education apart from the reading of 19th Century *Scientific American* magazines and patent journals, Sperry began his career as inventor in home-State New York. As a boy he had set his veranda on fire experimenting with benzine vapours, injured a playmate with a homemade glass-blowing outfit and was generally known as "that Sperry boy." But by the time he was a farmhand adolescent, his mechanical aptitude and avid reading joined together in a mind that innovated, it seems, without coaxing.

Elmer Ambrose Sperry

At 19, Sperry perfected the closed-loop, or self-regulating arc lamp. A few years later he was perfecting mining machinery, developing street cars which impressed the world, and delving into electro-chemistry. In the 1890s, he patented a storage battery which drove an electrical car 87 miles (other batteries at the time charged for 30 miles at most). The Sperry gyroscope, the searchlight which lit up skies laden with World War One Zeppelins, the gyro-compass, the automatic ship stabilizer, and the automatic pilot for aircraft eventually became his children.

And children they were. Sperry's ideas were borne on paper with pencil; his ability to visualize and draw concepts, systems and electrical theory was so complete he was able until his death in 1930, to pass pages of diagrams and sketches to engineers sufficient to initiate yet another Sperry product. More than visualized, most of his 400 patented inventions gained personalities in the Sperry mind. He described them as "he" or "that brute" or "that fellow."

Although he grasped blueprint intricacies, Sperry was a slow reader, and

The Sperry streetcar at the Chicago World's Fair, 1893. Elmer Sperry, right, has his hand on the brake.

friends who had to read silent movie subtitles aloud to Sperry, were relieved when talkies were produced. A notorious speller, he wrote in a notebook, "Hydrochloric acid out of salt by electroleciss." He lived in fear of his teacher's warnings that a poor speller, "might be able to attain the dignity of a grocer's clerk ... but nothing more." "Now that I have lived it down," he said later, "I can see that the whole world does not revolve around spelling."

Sperry's world revolved around technology. Yes, he became a proficient speaker, polished public figure, and writer of passionate poetry to his wife, but Sperry was most comfortable in the intricacies of electricity and engineering. As biographer Thomas Hughes said, "Sperry expressed himself in technology."

Sperry's first chance to express himself came on New Year's Eve in Chicago, 1885, having laboured for weeks installing what he termed the greatest concentration of light in the world — bundled arc lamps — atop the 300-foot tower of the Chicago Board of Trade building. Waiting at the lighting switch was heart throb and future wife Zula Goodman.

On the whole, Chicago was dimly lit. Gas lighting flickered down its streets but only barely lighting sidewalks. Edison's high-resistance, carbon-filament incandescent bulb had been created previously but had limitations for lighting public places.

Over the previous two years, Sperry had been attacking the two major weaknesses in arc lighting. First, he had designed a generator that produced a constant current despite variations in the speed of the steam engine driving it. Second, Sperry had developed automatic regulation of that generator to supply constant current despite load variations — especially when arc lights were cut out of a circuit.

Sperry was really beginning present-day cybernetics, and even though closed-looped systems have always been attractive to electronic and mechanic buffs, few up to Sperry had been able to develop so complete self-regulating mechanisms.

Sperry's arc lamp carried "error signal" intelligence. Within the generator, an adjustable spring was set for the desired current and an electromagnet with a movable armature represented the actual current. The force of the electromagnet tended to move the armature in one direction and the tension of the spring, attached to the armature, in the other. Movement in "error" activated a servomechanism that rotated the brushes of the generator until the output matched the desired current.

When Zula turned the switch, saying playfully, "let there be light," the twenty lights suspended on a ring burst 40,000 candles of light as far as Michigan City, 60 miles distant. Chicago streetcar conductors and drivers reported that all viaducts in the city were well lit, and light reached city limits.

"The atmosphere was very luminous," said Chicago Tribune, "and as far away as Douglas Park houses cast shadows from the light...."

For Sperry, the closed-loop design for the arc lamp carried into most of his other inventions. By 1893, he was demonstrating a superior hill-climbing street car at the Chicago World's Fair with a developed power transmission, electric brake and related controller. The electric brake was interesting. Instead of using an electromagnet to pull the brake shoe against the braking surface of the wheel, he designed an annular electromagnet concentric with the

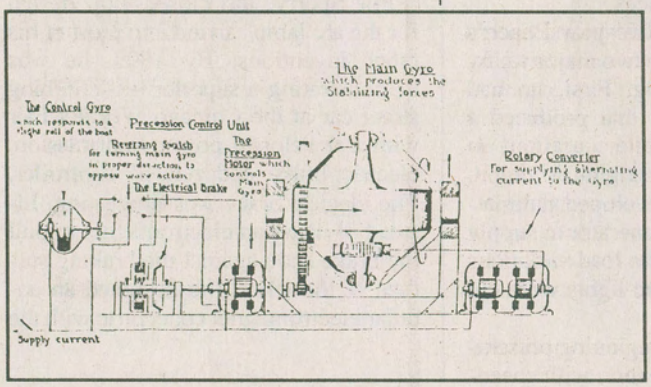
axle of the wheel, but attached to the frame of the vehicle.

Street car innovations naturally lent itself to the still-developing automobile design. Sperry's fingers were on almost every form of technology rapidly forming, the "horseless carriage" being no exception.

Automobiles were being developed in Europe and North America along two philosophies. The internal combustion design, broadly patented by George Baldwin Selden, hiccuped a lot of smoke and noise. The more expensive alternative, which Sperry's "six electrics" were built around, relied on electricity.

Sperry had unwavering faith in electricity. He had a gasoline vehicle at one time, "a thing of beauty with two cylinders, steered by a tiller, upholstered in English Wilton and trimmed with aluminum." But the car was destroyed in a workshop fire, and seeing the wreckage Sperry said to his sons, "that's what you get for deserting electricity."

The Sperry family, about 1910. Standing: (L. to Rt.) Lawrence, Elmer, Jr., Helen. Seated: Elmer Sperry, Edward, Zula.



From The Sperry Gyroscope Co., "The Sperry Ship Stabilizer"

Of course, Sperry approached his car design from different angles. He applied for auto patents for air-cooling the motor, a control system, power-transmission gearing, clutch and brakes. But primarily, he attempted to better the battery power. Sperry's battery contained diaphragms, or separators — fibre composition placed between the plates carrying the peroxide which kept the plates wet with acid. At the same time, the separations kept the plates from losing their peroxide, warping, or coming into contact with each other. The "Sperry Grid" eventually became popular batteries for streetcars, electrics, lights and power stations.

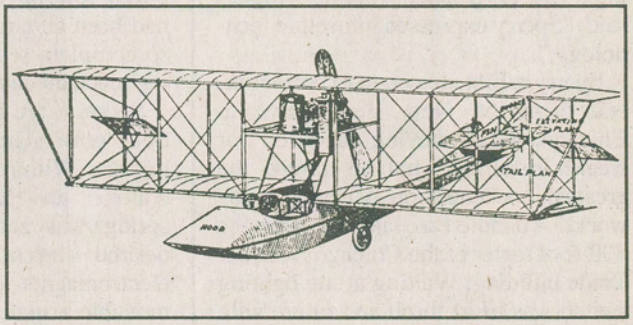
The other problem Sperry addressed was stability. Turn-of-the-century vehicles tended to flip easily. Sperry's own son, Elmer, Jr. narrowly escaped injury when he was thrown from a car and Sperry saw the most pressing concern was to stabilize the vehicle, and he turned, as he did throughout his life, to the gyroscope.

Sperry had approached Barnum and Bailey with his first gyro-invention: the "wonderful trained wheel-barrow," a wheelbarrow concealing a gyro that allowed tightrope walkers to hop in and around it without losing their balance. But Sperry had seen gyroscopes applicable to almost every major technology, his car included.

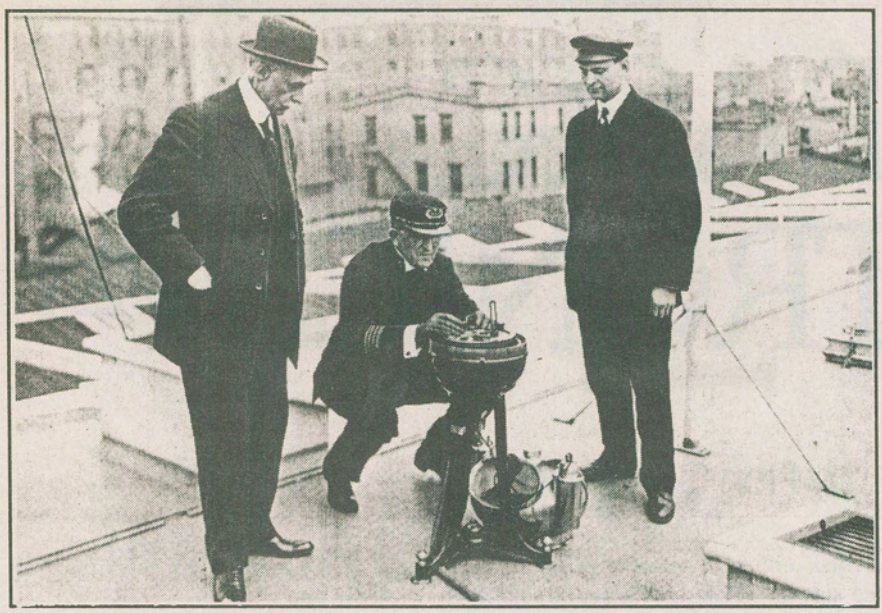
By mounting a precessing gyroscope in the bed of his car, Sperry calculated that a 200 pound wheel could develop more than four tons of resistance to a tilting force. Sperry's contribution to emerging automobile designs was limited. But precessing, or the capability of angular motion in a plane at right angles to the upsetting force, was central to almost all Sperry's application of the gyro. And these applications soon changed the nature of shipping and aviation.

Sperry's life-long fascination with the gyro was not unique to the Victorian mindset. The forces at work within a spinning gyroscope were as full of promise — and elusive to control — as 20th century theories of fusion energy. From the 1880s onwards, dozens of hackers had filed gyro application patents and few of them worked.

In the early 1900s Sperry brought home a gyroscope top for his sons to play with but confessed that he hogged most of its use. Through their growing up years, his sons were deluged with gyroscope toys and Sperry accumulated a library on the subject. By 1910 he envisioned a gyro with two or three degrees of freedom serving to stabilize rough-riding cars, rolling boats and out-



The Curtiss flying boat. The Sperry stabilizer of 1914 was installed on a similar aircraft.



Sperry examining the repeater compass for his gyrocompass installation aboard the Princess Anne, *1911.*

of-control airplanes, or guiding them as a compass by pointing to the axis of the earth. The eventual development of the Sperry gyro-compass, the "Metal Mike' (an automatic helmsman for large steamers) and stabilizers and autopilot mechanisms for aircraft eventually grew from his living room musings.

Sperry's gyro-compass was actually successfully test mounted on the U.S.S. Delaware in 1911, installed in a crude square frame "set up on pipe legs." Sperry's gyro technology soon became central to seafaring. Boats and submarines relied on the compass for direction, and they relied on Sperry stabilizers to lesson stomach-churning rolling on the high seas.

The most fascinating gyro application took place in aviation, however. Perhaps stabilization was a luxury in other areas, but in aviation, especially in the precarious Wright designs, stabilization, or lack thereof, was the greatest challenge after flight was finally attained.

The Wright design placed the onus on the pilot to control all factors affecting his craft. Once airborne, the pilot pushed petals and swung levers — almost frantically — to maintain stability. Not only did a flight require awesome coordination, but stamina.

Sperry's first experiments with aircraft stabilization, fixing a passive gyro to the bottom of Stanley Beach's airplane in 1907, failed. But in 1912, by then working with his son Lawrence, and teaming up with intrepid pilot Glenn Curtiss, Sperry developed an effective automatic stabilizer before World War I which transformed during the war into a major component of an automatically controlled missile. This would be converted into an automatic pilot after the war.

Lawrence must have been fascinated with his father's affiliation with speed-demon Curtiss, especially in light of the boy's love for aviation. In the summer 1910, when his family was away, Lawrence changed the Sperry home into an aircraft factory. He used attic, cellar and bedrooms as work rooms and fired the furnace (drained for the summer) to speed up the dope drying on the wing fabric. When the family returned, Lawrence displayed the airplane in the backyard. But inside, the family found the front hall bannisters had been torn out, that a wall had been demolished to roll the plane into the backyard and the furnace had cracked. Lawrence eventually became a capable pilot, but died when his plane crashed in a channel crossing to France in 1924.

By 1914, Sperry created the gyro design which still endures in missile

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guidance systems, long-range aircraft and submarines. Instead of mounting two stabilizers separately, as he had earlier, he nested four gyros on a single platform. The gyros established a stable reference and servos aligned the airplane with the reference.

Sperry used a combination of electrical, mechanical and pneumatic components to align the airplane automatically with the horizontal stable platform. When the airplane went into an error state — when it deviated from the horizon —the relative movement between the stabilized platform and the airplane initiated a command signal that operated the servomotors, which moved the airplane's control surfaces.

The stabilizer also had control surfaces so that the airplane would not pass beyond the horizontal in its response.

"Sperrys have made aeroplanes safe," the New York Times reported in June, 1914, after a public demonstration of the stabilizer in Paris. And although needing refinement, his stabilizer had, indeed, made the skies more friendly.

Increased research and the production of dozens of inventions made Sperry a corporate head. But one suspects most of Sperry's dress shirts still carried the odd drop of grease or smell of solder. Like most hobbyists, Sperry's mind never ceased to whir with innovation. New Yorker Magazine profiled Sperry shortly before his death in 1930. Ill and ordered by his doctor to stay away from machine shops for health reasons, he nevertheless penned gizmos which he sent to his engineers. He also added, whenever inspiration hit him, to an "ever-present notebook" — No. 78 by the time of the article. Hours before he died after complications from an operation on June 16, he was still inventing. Sperry placed ice before an electric fan to create a cooler breeze beside his hospital bed. ❐