THE ELMER A. SPERRY AWARD FOR 1967

THE ELMER A. SPERRY MEDAL

In the words of Edmondo Quattrocchi, the sculptor of the medal . . .

"This Sperry medal symbolizes the struggle of man's mind against the forces of nature. The horse represents the primitive state of uncontrolled power. This, as suggested by the clouds and celestial fragments, is essentially the same in all the elements. The Gyroscope, superimposed on these, represents the bringing of this power under the control of man's purposes."

Presentation of

THE ELMER A. SPERRY AWARD FOR 1967

to

EDWARD R. DYE
(In Memoriam)

HUGH DeHAVEN

ROBERT A. WOLF

With Citation to the research engineers of Cornell Aeronautical Laboratory and the staff of the Crash Injury Research projects of the Cornell University Medical College

By

THE BOARD OF AWARD

Under the Sponsorship of

The American Society of Mechanical Engineers

Institute of Electrical and Electronics Engineers

Society of Automotive Engineers

The Society of Naval Architects and Marine Engineers

American Institute of Aeronautics and Astronautics

AT THE SAE AUTOMOTIVE ENGINEERING CONGRESS & EXPOSITION LUNCHEON

JANUARY 9, 1968 • COBO HALL • DETROIT, MICHIGAN

PURPOSE OF THE AWARD

The Elmer A. Sperry Award shall be given in recognition of —

"A distinguished engineering contribution which, through application, proved in actual service, has advanced the art of transportation whether by land, sea or air."

1967 BOARD OF AWARD

GLENN B. WARREN — WILLIAM LITTLEWOOD (Dec.)
The American Society of Mechanical Engineers

RICHARD L. KIMBALL — H. NOEL ZELLEY
Institute of Electrical and Electronics Engineers

WILLIAM T. ALEXANDER — HARRY W. PIERCE
The Society of Naval Architects and Marine Engineers

LEONARD RAYMOND — ROY P. TROWBRIDGE, *Chairman*
Society of Automotive Engineers

ELMER A. SPERRY, JR. — CHARLES J. MCCARTHY
American Institute of Aeronautics and Astronautics

CLARENCE E. DAVIES, *Secretary*

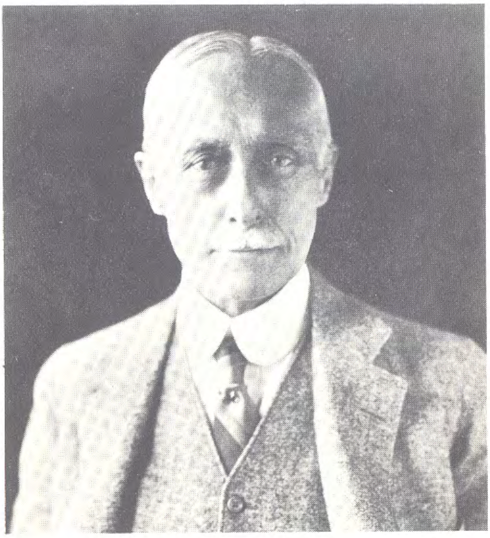
LIFETIME ADVISERS

ROBERT B. LEA, *Honorary Chairman* — WILLIAM ZIPPLER

DAVID W. R. MORGAN — PRESTON R. BASSETT

EDWIN L. STEWART — JEROME C. HUNSAKER

THEODORE P. WRIGHT



ELMER AMBROSE SPERRY
1860-1930

FOUNDING OF THE AWARD

The Sperry Award commemorates the life and achievements of Dr. Elmer A. Sperry (1860-1930) by seeking to encourage progress in the engineering of transportation. Much of the great scope of the inventiveness of Dr. Sperry contributed either directly or indirectly to advancement of the art of transportation. His contributions have been factors in improvement of movement of men and goods by land, by sea and by air.

The award was established in 1955 by Dr. Sperry's daughter, Mrs. Robert Brooke Lea, and his son, Elmer A. Jr., and is presented annually.

EDWARD R. DYE

AWARD CITATION

for the Sperry Award for 1967

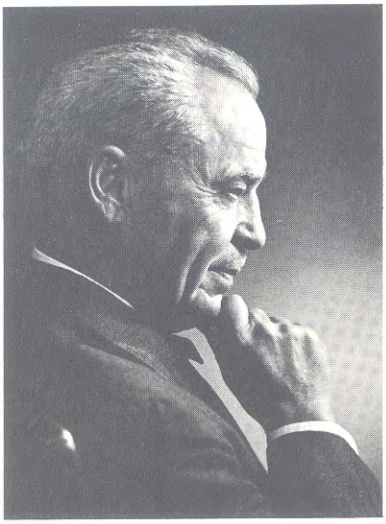
EDWARD R. DYE (in memoriam) for dedicated research on automobile occupant safety, specifically engineering achievements leading to improved seat belts, door latches, padded instrument panels; and for safety features in the Cornell-Liberty Mutual survival car.

ROBERT A. WOLF

AWARD CITATION

for the Sperry Award for 1967

ROBERT A. WOLF for effective leadership of an applied research and engineering team in its multiple approaches to improve automotive safety, particularly Automotive Crash Injury Research, which has guided effective vehicle design countermeasures.



HUGH DeHAVEN

AWARD CITATION

for the Sperry Award for 1967

HUGH DeHAVEN for pioneering safety work, specifically for his inauguration of Crash Injury Research at Cornell University Medical College; and for advancing the concept of "packaging" automobile occupants with restraining devices.

CERTIFICATE OF CITATION

for the Sperry Award for 1967

To the research engineers of Cornell Aeronautical Laboratory, Inc. for their dedication to the improvement of automotive safety, including development of improved guardrails, seat belts and other safety systems, and contributions to Automotive Crash Injury Research.

To the staff of the Crash Injury Research projects of the Cornell University Medical College responsible for pioneering efforts in accident research which, for the first time, scientifically identified and ranked the leading causes of injury in automobile accidents.

AUTOMOTIVE SAFETY RESEARCH

The modern automobile did not come into being as the invention of a single man or even of a closely knit group of individuals. Indeed, it is the child of an evolutionary process that traces its origin back to an era at the dawn of time when man first fashioned a crude wheel.

While uncommon individuals may have dominated the early years of automotive engineering and development, both in this country and abroad, modern engineering relies heavily on the team approach. Such an approach has been particularly well suited to the examination of the varied and complex problems and possible approaches associated with the development and improvement of automotive safety devices and systems. But even though the stress is on a collective assault on automotive safety problems, the contributions of a few far-sighted individuals occasionally stand out.

Three such men are Hugh DeHaven, a true pioneer in the field of crash injury research; Edward R. Dye, a man before his time in automotive safety, who died October 13, 1961, at the age of 59; Robert A. Wolf, whose entire professional career has been devoted to forging advancements in transportation systems technology. As these men were not in the employ of the auto industry or its major suppliers, it would be impossible to credit them directly with specific design of safety components of production automobiles. Nonetheless, their dedication and substantial contributions to automotive safety have left an indelible mark on the modern automobile and highway safety.

Specifically, the engineering efforts of Dye and Wolf and their associates have encompassed automotive seat belts, safety door latches, instrument-panel padding, and highway guardrails and median barriers. DeHaven's contributions emerged forcefully in his original and far-reaching new concepts in the field of injury causation in accidents, first in aviation and later in the automotive area.

The work of DeHaven and his colleagues was accomplished largely while associated with the Cornell University Medical College, New York City, where the scientific approach to injury causation first achieved recognized stature. The engineering research of Dye and Wolf was performed at Cornell Aeronautical Laboratory (CAL) in Buffalo, New York, a nonprofit, autonomous research arm of Cornell University. The Laboratory's research program, while centered in aeronautical and associated sciences, early began to branch into other areas.

Engineering Approaches Guided by ACIR

Automotive safety research, with its roots in earlier studies of aircraft safety at both the Laboratory and the Cornell Medical College, was one such area. This field, automotive research, provided opportunity for the varied research talents of Dye and Wolf. Their engineering approaches were influenced and pointed out in large measure by the findings of the well-known Automotive Crash Injury Research program (ACIR) — a project initiated by DeHaven at the Cornell University Medical College in 1952 and later integrated into Cornell Laboratory in Buffalo.

Ed Dye was with Cornell Laboratory from 1946, the year of its founding, until 1959. He last served as head of its Safety Design Research Department. Bob Wolf has been with the Laboratory since 1951 and currently heads its Transportation Research Department. Since 1960 he also has directed the ACIR program and broadened its activities to include engineering research into vehicle crashworthiness.

As a natural outgrowth of the earlier Crash Injury Research project in aviation, Automotive Crash Injury Research is a statistically and analytically oriented accident research program aimed primarily at identification of the causes of injury in auto accidents; nonetheless, guidelines to effective countermeasures are implicit in its approach. It is the world's longest sustained and most comprehensive program in the field of injury-causation research in vehicle accidents. The project was founded upon and is dedicated to the concept that many persons being injured and killed in automobile accidents could either survive, be free of injury, or sustain less severe types of injury through changes in vehicle design to alleviate impact forces. Such changes are based on comprehensive knowledge of the distribution, duration and magnitude of forces actually occurring in accidents and of the relationship of these forces to the frequency and severity of associated injury to humans.

Variations in Injury Patterns Spur Research

Early clues to the astonishing impact tolerance of the human body were provided, ironically, by records of persons falling or jumping from high buildings and bridges or crashing in airplanes with relatively little injury. Hugh DeHaven himself went through just such an experience and it was to influence his career and mark the beginning of a new approach to transportation safety.

In 1917, DeHaven, then a cadet pilot in the Royal Flying Corps, (later the RAF), was involved in a mid-air collision while flying a JN-4 trainer in Texas the day before he was to be commissioned an officer. He was seriously injured, while the pilot of the other airplane emerged practically unscathed. During his convalescence, DeHaven sought some reason other than fate for this curious twist to injury patterns and resolved to investigate the problem further.

When he returned to duty in 1918, DeHaven correlated injuries to crash severity in a series of aircraft accidents. He was impressed greatly by the evident strength of the human body, the need for stronger seats, safety belts and cockpit structures, and the immense possibilities that could be gained from rather simple improvements. At the time, he was unable to convince others.

From 1918 to 1936 he was involved mostly in the design of automatic machinery and fluid transmissions for automobiles but he never forgot the amazing crash survivals and "needless" injuries and fatalities he had seen. In 1936 DeHaven made urgent proposals in Washington for establishment of a high-speed acceleration-deceleration facility for closer observation of the effects of seat belts and the causes of injury in crashes. His pleas went unheeded and DeHaven undertook studies of his own in an attempt to make some estimate of the forces the human body could withstand in cases involving falls and attempted suicides.

The startling evidence from these cases was a major factor in enlisting the support and interest in 1941 of Jerome Lederer, then director of the Safety Bureau of the Civil Aeronautics Board (CAB), in the establishment of an aviation crash injury research project.

With a source of accident-injury data assured by the CAB, complimentary support for medical aspects of the project was obtained from the Committee on Aviation Medicine of the National Research Council. Dr. Eugene F. DuBois (now deceased) was chairman of this committee and, as head of the Department of Physiology at the Cornell University Medical College, was able to provide working space and the Medical College leadership for the program. A spirited patron of the new approach, Dr. DuBois also contributed directly to its medical research aspects. The Medical College at the time was headed by Dr. Joseph C. Hinsey, who as dean, supported the new effort enthusiastically, and served as Responsible Investigator for the project from 1942 to 1946. Funds for the revolutionary research project came from the Office of Scientific Research and Development.

Physicians Cooperate in Crash Injury Research

Thus, Cornell's Crash Injury Research program, forerunner of Automotive Crash Injury Research, was founded in 1942 in New York City, with DeHaven as its first director. During the war years it functioned under the auspices of the National Research Council under the aegis of Dr. DuBois' department. Dr. DuBois, a noted medical scientist of his day, played an invaluable role in liaison with the National Research Council and the early military sponsors of Crash Injury Research. At the time, many physicians were reluctant to take the time to fill out the necessary medical forms for Crash Injury Research and Dr. DuBois did much to bring them into a willing partnership for the public benefit.

In 1950, Dr. Wilson G. Smillie, as head of the Medical College's Department of Public Health and Preventive Medicine, assumed overall direction of the rapidly expanding project, with DeHaven still serving as its working director.

DeHaven, now living in retirement in Lyme, Connecticut, was born in Brooklyn, New York, on March 3, 1895. He attended Cornell University and Columbia University before enlisting in the Royal Flying Corps in 1917. By a twist of fortune, he was turned down for enlistment in the U.S. Army Air Corps, but was accepted as a volunteer in the Royal Flying Corps, enlisting in Toronto, Ontario. The events that followed were to trigger DeHaven's lifelong interest in and dedication to crash-injury research.

After the 1942 formation of Crash Injury Research, DeHaven began to compile information on the causes of injuries in light-aircraft accidents. From CAB investigators, state police and state aviation authorities he got data on hundreds of accidents and developed methods for coding and analyzing the information. From a mere description of the injury involved in a crash, DeHaven after a while usually was able to tell what model of airplane had crashed. For example, he found that one particular aircraft almost invariably caused amputation of the pilot's feet at the ankles in moderately severe accidents.

DeHaven found that close relationships existed between degree of injury and impact with various forward structures. By calculating accelerations experienced by persons, he concluded that natural laws of physics were at work and, if impact forces were distributed properly and decelerations were controlled, the human body could withstand previously undreamed-of levels of force.

DeHaven, like Dye and Wolf after him, was convinced of the value of seat belts, first for aircraft then automobiles. With data from aircraft accidents, he disproved the notion that belts would cut people in two in crashes, a common belief of pilots in early years. An acceleration and deceleration facility was established on the roof of the Cornell University Medical College and, with the use of relatively crude articulated dummies and high speed cameras, some of the first photographs were taken of the effects of safety belts and shoulder harnesses. DeHaven, in fact, foresaw the need and advantages of a combination seat belt and diagonal shoulder harness for aircraft as early as 1950. Shortly thereafter, such a restraining device was developed, and patented by Roger Griswold, along lines suggested by Crash Injury Research. The late Dr. William A. Geohegan and Dr. Hinsey developed the inertia lock for shoulder-harness control that has been widely used in military planes, and is now being considered for use in automobiles.

The Birth of ACIR

With the success of Crash Injury Research in aviation as a backdrop, a massive planning conference for an automotive program in this field was held at the Cornell Medical College in December 1952, with representatives of the auto industry, state police, insurance companies, the military, various safety groups and others participating.

Out of this, Cornell's Automotive Crash Injury Research program emerged in that year, with DeHaven serving as its director until his retirement in 1954 when he was succeeded by John O. Moore. Actually, a program similar to the Cornell ACIR project, but limited in scope, had been undertaken in 1951 by the Indiana State Police as an almost one-man project by then-corporal Elmer C. Paul, now with the U.S. Public Health Service. Paul's observations from a limited volume of data were a major stimulant to ACIR's multi-state program.

The Commission on Accidental Trauma of the Armed Forces Epidemiological Board, through the Office of the Surgeon General of the Army, was the original sponsor of the ACIR project at Cornell University Medical College. In 1955, the automotive industry acknowledged the importance of ACIR when the Ford Motor Company and the Chrysler Corporation provided the project with funds for expansion.

For some years, ACIR has been funded principally by the U.S. Public Health Service and, through the Automobile Manufacturers Association, by all of the major auto manufacturers. Following Moore's retirement from ACIR, the program in 1960 became the responsibility of Cornell Aeronautical Laboratory and was reorganized and relocated in Buffalo in 1962.

ACIR Sheds Light on Injury Causation

During the 15 years ACIR has been in operation, it has made substantial contributions toward a sounder knowledge of injury causes in vehicle accidents and has identified several means of reducing injuries. Another major function of ACIR is to assess, in detailed studies, the effectiveness of corrective countermeasures, such as auto design changes and seat belts, which have been adopted by the auto industry. In large measure, the efforts of Cornell Laboratory's engineering approaches to automotive safety have been guided by the very problem areas identified in the ACIR investigations.

ACIR engineers and analysts have gathered immensely detailed information and photographs on more than 70,000 vehicles involved in injury-producing accidents in 30 states, as well as medical data on the location and nature of injuries to occupants of those vehicles. This information is supplied voluntarily to ACIR by cooperating police, hospitals, individual physicians and others.

ACIR has conducted nearly 60 studies related to the causes of injury in auto accidents and has made recommendations for countermeasure development. For example, before the project was started, popular notion held that it was somehow safer to be thrown out of a car during a crash than to be "trapped" inside.

Then, at its very beginning, ACIR in 1954 revealed what is probably one of its most significant findings: Ejection from a car in an accident was a serious problem and those who were ejected, on the average, fared much worse than those who were retained inside the car. Ejection subsequently was verified and pinpointed as the leading contributor of death and serious types of injury. The indicated countermeasure was somehow to keep the occupants inside the car during a crash.

The U.S. auto industry, which had also become aware of the danger of ejection during its own experimental crash testing, now had authenticated, quantitative evidence of this danger. The industry responded with several generations of improved, interlocking safety door latches to keep doors closed in accidents. Subsequent ACIR studies showed that ejection had been substantially reduced. The improved door-latch designs, as well as increased usage of seat belts, are credited with effecting this reduction.

ACIR in 1955 issued a preliminary ranking of the 10 leading causes of injury and this list later was refined and verified, providing the auto industry with a well-documented list of priorities for countermeasure development. The industry since has directed much attention to effecting improvements in all 10 areas.

For the first time in transportation history, engineers in the 1950s were getting precisely documented information on how the automobile could be improved as a "package" for the safe transport of human beings. Many of the ACIR findings also served to substantiate safety benefits of corrective measures adopted by the industry for production-line cars. During all of ACIR's existence, the auto industry, of course, has conducted large parallel programs in automotive safety research. Thus, the industry's physical research and ACIR's accident research have complimented each other in an effective partnership.

Dye's Explorations in Protection Against Impact

Cornell Aeronautical Laboratory's engineering research efforts in the area of protection of the human from impact blows and suddenly applied forces date back to 1947-1948 when Edward Dye entered the automotive safety scene at CAL. Dye, like DeHaven, was convinced that monumental payoffs could result from protecting the human body itself from severe levels of impact.

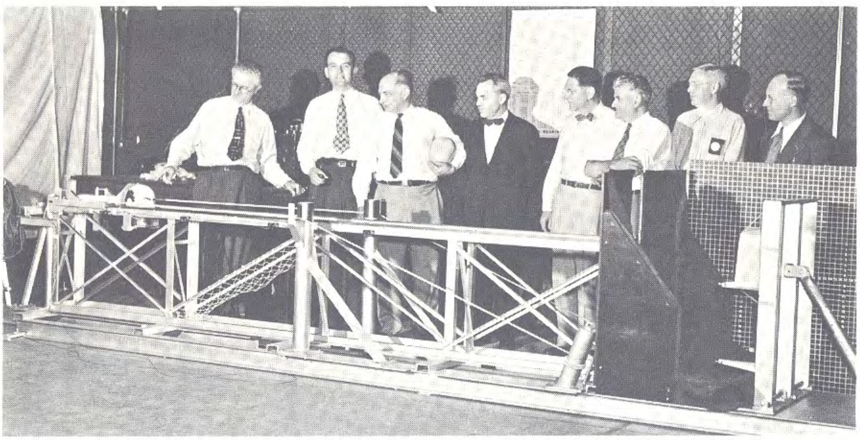
Ed Dye was a man uniquely suited for the tasks he was about to undertake. He had won acclaim at Purdue University (BSCE, 1924) when he received the "Big Ten" award for prowess in scholarship and athletics (football and wrestling varsity teams). He knew roadways from his five years' experience designing bridges and as a project engineer for the Indiana State Highway Commission, from 1924 to 1929. He honed his knowledge of civil engineering at Montana State College (now University), becoming head of the Department of Civil Engineering.

Dye learned the highway's role in safety while working on roadway design and construction during eight summers at Yellowstone National Park, while at Montana State. Further knowledge of structures came to him at Douglas Aircraft (now McDonnell-Douglas) at the start of World War II, augmented by subsequent development work at Curtiss-Wright in Buffalo. In short, everything Ed Dye had done, well fitted him for his assault on the complexities of automotive safety engineering at Cornell Aeronautical Laboratory.

Ed Dye also was an innovator. In fact, he had 16 patents to his credit in a wide range of fields. Among them are a traction cleat for athletic shoes, an energy-absorbing safety helmet, a shock-absorbing boxing-ring platform, a hydraulic power-steering system, a chest crash protector for steering wheels (with CAL's Norris E. Shoemaker), a method of applying paint to roadways and a child's automotive safety harness.

Safer "Packaging" Sought

In much of his safety research, Dye was concerned greatly with head injuries. And, small wonder. A 1948 study by DeHaven at



Members of the Cornell Committee for Air Safety Research, whose scope was broadened to include the automotive field in 1951 when it became the Cornell Committee for Transportation Safety Research, inspect this head-impact machine at CAL in 1948. Left to right: Committee chairman, Dr. Theodore P. Wright, then vice president for research at Cornell University and CAL president; Dr. Emerson Day, professor, Cornell University Medical College; Dr. Clifford C. Furnas, director of CAL; Hugh DeHaven, director of Cornell Crash Injury Research; Dr. Norman Moore, head of medical services, Cornell University; Dr. Richard Parmenter, coordinator of research, Cornell University; Dean S. C. Hollister of the College of Engineering, Cornell University, and Edward R. Dye, director of CAL's Development Division.

Cornell University's Medical College showed that about 75% of private-airplane-crash fatalities resulted from head injuries. (Several ACIR studies since have indicated that approximately 70% of those injured in vehicle accidents suffer some degree of head injury.)

In the beginning, hen eggs were used at Cornell Laboratory as a very crude simulation of the human head. They were tested in a swing-like carriage. By 1948, more realistic, but still crude, head forms had been developed. They were catapulted against various objects to determine the forces and character of blows to the head that can occur in a crashing vehicle. These early experiments, conducted largely with internal funds at CAL, were elementary in concept but they did provide useful guidance for safer "packaging" of car occupants.

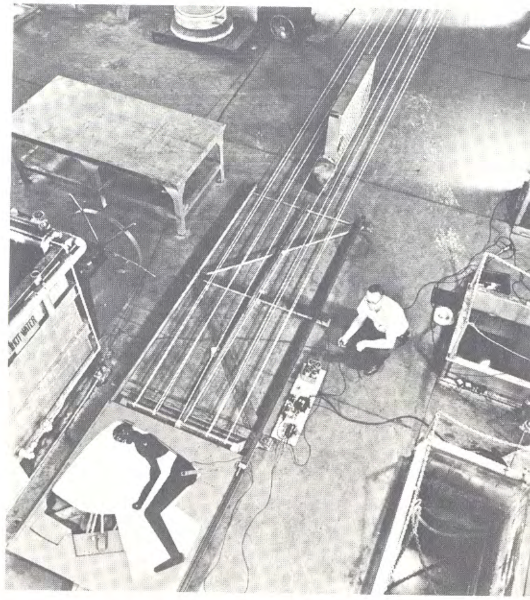
CAL safety scientists reasoned that "safer packaging" of car occupants could be achieved by one of two methods, with maximum protection afforded by a combination of the two. One of these was restraint of the body by a lap-type seat belt. The other was the reduction of the injury potential of objects inside the car that the body might strike.

CAL, of course, did not invent the automobile seat belt. Indeed, the initial entry in a chronological history of automotive seat belts, published by the American Seat Belt Council, lists a U.S. patent in 1895 in the name of Edward J. Claghorn. The mission of Edward Dye, and later Robert Wolf, in this specific area lay in the development on scientific bases of the modern seat belt and in disseminating information to encourage and promote the proper installation and use of belts. This data was based on experimental, analytical and field evidence of seat-belt effectiveness.

Cornell Laboratory's initial efforts in automotive seat-belt development involved a study in 1948-1949 of the kinematic behavior of the human body during crash deceleration. The basic dynamic movements of the human body were stated during these experiments, even before actual modern crash-barrier experiments had been developed. This pioneering method and its results set the pattern for research later conducted by others.

Early Engineering Research on Seat Belts

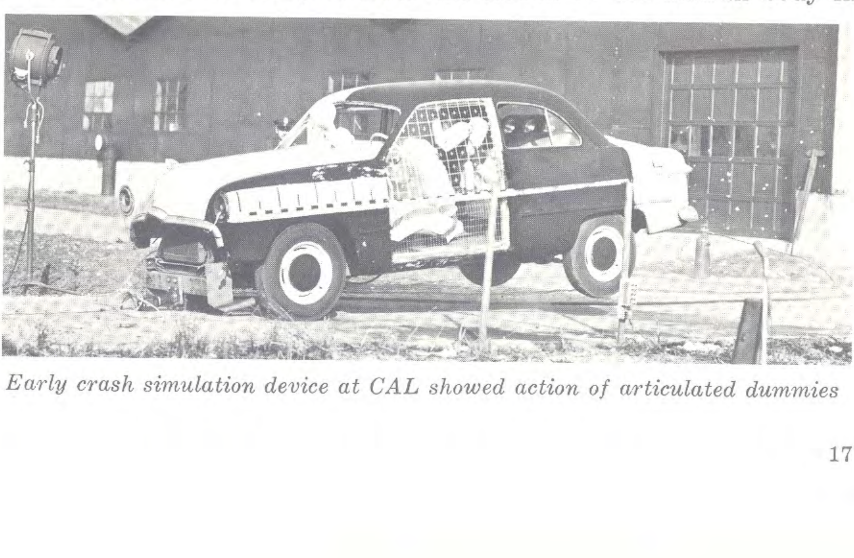
CAL'S first experiments in body kinematics were carried out with a full-scale, proportionally weighted sheet-metal dummy, dubbed "Thin Man"; later Dye would conduct crash simulations with dummies nicknamed "Thick Man" and "Half Pint," simulating



"Thin Man" dummy used in CAL's first seat-belt studies in 1948

grownups and children, respectively. Using these devices, which were relatively primitive by today's standards, Ed Dye and his associates determined the position of the body, the path of its flight, and how much the mass of the body contributed to head impact. "Thin Man" in particular was used primarily for the study of the effect of lap seat belts on the motions of the human and the relative effects of head blows, with and without lap belts.

During the early 1950s, simulated crash experiments were conducted at CAL, using the articulated "Thick Man" and "Half Pint" dummies to study further the action of the human body in



Early crash simulation device at CAL showed action of articulated dummies crashes, again with and without belts. In this work, sponsored by the Liberty Mutual Insurance Company, the researchers used a 1950 two-door sedan and a specially designed crash snubbing device which brought the car to a sudden stop, as in a crash, with the use of cables.

Engineering analysis of this work provided a strong CAL recommendation for the use of seat belts, as well as documented criteria for their design and installation. Recommendations also included interior car padding and "delethalization" of such objects as knobs and door handles. Early strength requirements for automotive seat belts and their anchors were established at the Laboratory. With this data and earlier background in crash safety research, an automotive seat-belt kit was designed in 1954 for the Hickok Manufacturing Company, Rochester, New York. The kit was manufactured and marketed by Hickok.

Ed Dye was deeply concerned with public apathy toward the seat belt and safety in general. To try to help overcome this, Dye and an associate, Alvin C. Smith, co-authored a CAL booklet in 1954 on seat belts, one of the first ever written. It was designed to provide potential seat-belt buyers, design engineers, and manufacturers with information on what constituted a safe and convenient seat belt, as well as installation procedures.

Ed Dye was putting in 80 to 100 hours a week in those years, refusing to take vacations. Often he spent the night on a cot he had set up in the shop area. Even so, progress was slow and outside funds to support his research were difficult to find.

"We are only beginning to scratch the surface in collecting useful engineering information on what happens to the human body in a car during a crash," Dye wrote in 1955.

Improved Door Latches Emerge

It was in 1955 that the auto industry began installing the first safety door latches, following ACIR's identification of ejection as a frequent and serious contributor to injury in accidents. A year earlier, a Cornell Laboratory engineering study had disclosed that the typical door latch on contemporary model cars had an inadequate engagement with its keeper under large structural deformations of the type experienced in crashes.

In a supplementary project, CAL engineers found that the passenger compartment had greater structural ability to resist crushing in rollovers when the doors remained closed. In 1955 a further project was undertaken in which five configurations of door-latch mechanisms were designed to resist door openings.

In light of the door latch's important role, ACIR subsequently evaluated the effectiveness of the new safety door latches introduced on the 1955-1956 production models. The need for further improvement became apparent and there followed another major door-latch design change, for the 1962 and 1963 automobiles. ACIR found in 1964 that door-opening frequency had been reduced by about half by the two generations of latch designs. Doors were still opening, however, and since visible damage to latches was not reported in the ACIR study, completed in 1964, several other possible causes of door openings were advanced by ACIR. It was believed, with sound evidence, that occupants were inadvertently opening doors in panic situations by grasping the door-release handle or bumping against it with a knee or elbow.

This was called to the attention of the auto industry and a new generation of safety door handles started to appear on 1966 models to guard against accidental door openings. Clearly, ACIR findings on the danger of ejection through an open door frame — whether caused by latch failure or inadvertent opening of doors by occupants — were providing stimulus to the auto industry to design and apply countermeasures. In essence, the statistical-engineering approach of ACIR provided a description of the nature and consequence of real accidents involving real people. It thus supplied convincing data to bridge the gap between staged impacts conducted by the auto industry and actual impacts as they occur on the highways. To supplement the industry's concurrent research, ACIR presented the first statistically significant, quantitative data pinpointing the importance of keeping occupants inside the car during an accident and CAL research engineers early devised practical door-latch designs to demonstrate possible countermeasures.

It is noteworthy that not only the U.S. industry but also that of Europe has made direct responses to ACIR's findings. One of the first examples was a special, single-case, investigated by Cornell Laboratory personnel of a high-speed rollover accident involving a Saab, the Swedish-built car. This led to installation of 3-point restraint systems and safety door latches in Saab's racing and rally cars and eventually led the way to application in its broader line.

Within the past few years the Volkswagen company has also directly responded to ACIR findings concerning the need for safety door latches in small European cars.

Early Attention to Padded Instrument Panels

Among the components of the automobile that received early attention by both ACIR and CAL engineers was the padding of instrument panels. Padded instrument panels found their way into U.S. production cars in the mid-1950s, usually as options on a few cars. But Ed Dye initiated specific research on padding materials, with implications to auto design, as far back as 1949. Some of his earliest projects were in the sports area — padding and suspension concepts for athletic helmets and padded boxing platforms — but they involved development of padding materials that later were modified for application to automotive dash panels.

New padding techniques also were brought into being by Cornell Laboratory and a new type of energy-absorbing material was developed in conjunction with a major rubber company. During these programs, the quality of low-density, energy-absorbing foams was greatly increased. Much of this pioneering work in the early 1950s paralleled studies, which necessarily were related, on the kinematic behavior of the human during a crash. Cornell Laboratory's research in padding materials also was stimulated by earlier studies conducted by DeHaven and his associates at Cornell University's Medical College on head injuries in airplane crashes. The studies provided engineers with criteria for designing passenger compartments and cockpits.

In later efforts, CAL conducted studies on experimental tests for a major auto maker on the design of interior components of automobiles and provided an analysis of then-existing crash hazards. The concept of the "hazard factor" for various interior objects with injury potential was developed during this 1954 program. At about this same time, various padding materials were tested for their head-impact performance for another major automotive manufacturer.

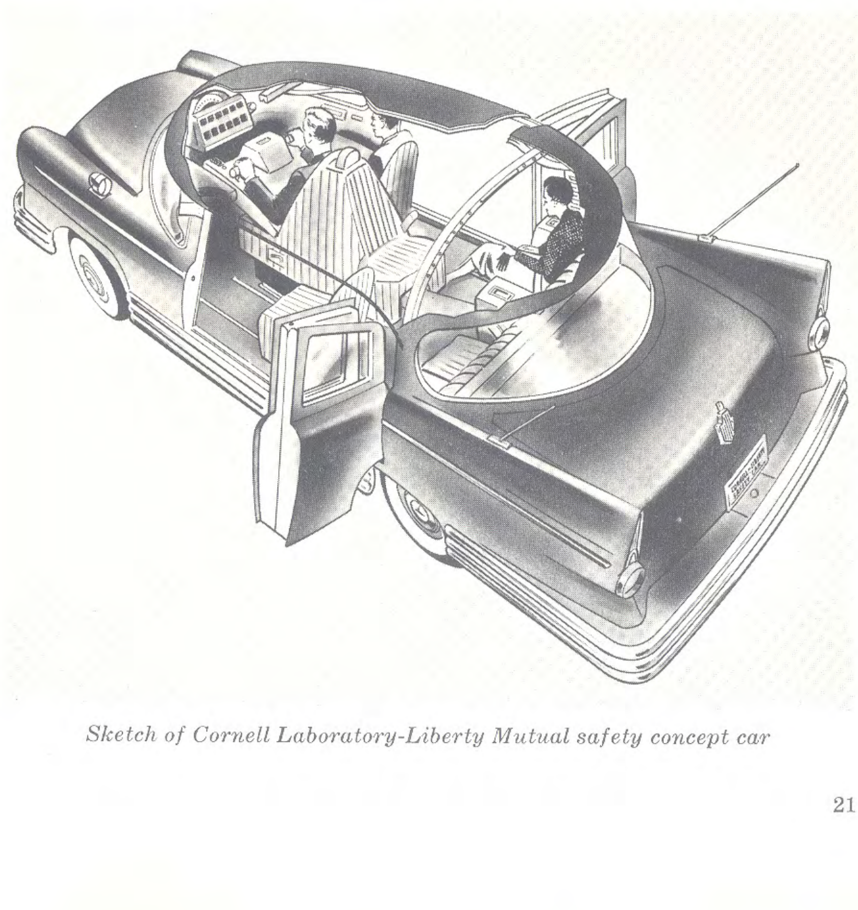
CAL reported in 1955 that an optimum padding arrangement could be developed only if the padding and its supporting understructure were considered in combination. This principle now is being used by the industry.

It was also in 1955 when the role of the instrument panel as a leading cause of injury in auto accidents first was documented by ACIR. Subsequently, a more refined study, which ranked the 10 leading causes of injury, showed that the instrument panel was the No. 1 cause of injury among all classes combined and ranked third in the number of fatalities and serious types of injury caused.

A 1963 ACIR report indicated that under certain circumstances and within certain limitations, instrument-panel padding does prevent some injuries, particularly in impacts of low severity. ACIR also found that such padding helps to reduce the severity of other injuries, especially to the head. Instrument-panel padding, incorporating the understructure in the system, since has been markedly improved by the auto industry.

The Cornell-Liberty Mutual Safety Car

By 1955, Cornell Aeronautical Laboratory's safety design research team had approximately eight years of continuous investigation aimed at solving the complex engineering and mechanical problems of providing a safer passenger compartment for vehicles. It was in that year that CAL and the Liberty Mutual Insurance Company combined in a project to apply the accrued knowledge to the design and construction of a safety concept car. The design team, headed by Dye, worked in close liaison with the late Frank Crandell, chief engineer of Liberty Mutual. The project's purpose



Sketch of Cornell Laboratory-Liberty Mutual safety concept car was to reduce the research from previous detailed investigations and integrate the findings into a more understandable and usable form; to demonstrate that such designs could be engineered, and to make this information freely available to the automotive engineering community. An additional purpose was to create a public awareness of safety features and their feasibility by means of a concrete example.

The unpowered car, unveiled in 1957, contained more than 60 new safety concepts, some of which have since been introduced in various forms on production cars. The Cornell Laboratory-Liberty Mutual Safety Car was designed as a showcase of feasible, engineered safety innovations, rather than as a production prototype. The car was displayed at many places around the nation, including the Smithsonian Institution. It attracted enormous public interest, as well as attention from the auto industry.

From Findings to Practice

In more recent years, under the guidance of Robert A. Wolf, the Laboratory has been instrumental in helping to convert its own engineering findings on seat belts and other devices, as well as the findings of others, into "recommended practices" and vehicle safety standards established by the Society of Automotive Engineers (SAE) and the General Services Administration (GSA). Wolf, in fact, is a member of the SAE Automotive Safety Committee and of the GSA Advisory Panel on Automotive Safety. (He is a former member of the SAE Seat Belt Committee of which an associate, Norris E. Shoemaker, currently is a member.) Wolf in 1967, with Robert Dufort of CAL, co-authored a planning guide for the GSA to be used in future development of automobile safety standards for government purchased cars; many of the recommendations were based on ACIR background.

Wolf's technical background, prior to becoming director of the ACIR program in 1960, had been largely in aeronautical engineering and operations research. But his progression to the automotive safety area was a logical one in view of the similarities in analytical techniques and structural design.

Born on September 4, 1907, in Appleton, Wisconsin, a town dominated by the paper industry, it was only natural for Bob Wolf to study paper chemistry. But after two years of it at Lawrence College, he was inspired by the 1927 trans-Atlantic solo flight of Charles A. Lindbergh to switch to aeronautical engineering at the University of Michigan where he won BS and MS degrees.

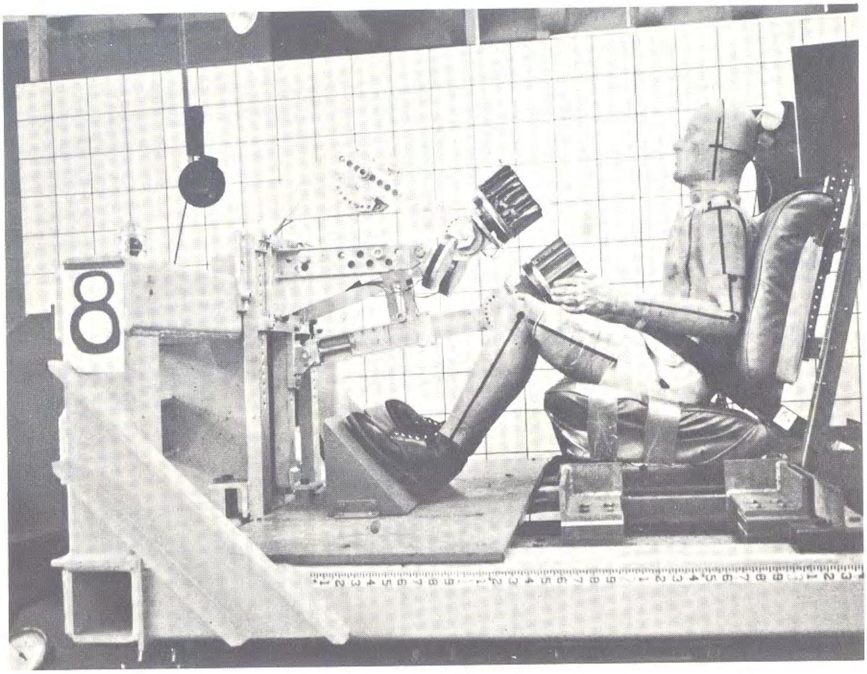
Wolf spent a distinguished 20-year career in aircraft design and development with the former Consolidated Aircraft and Bell Aircraft Corporations in Buffalo. His early experience was in stress analysis and structural design of aircraft, a field which is now coming back into play in research into structural design and crashworthiness of automobiles. Later he became interested in thermodynamics and was responsible for the power-plant and airframe design of the XP59-A, the first U.S. jet aircraft, which made its pioneering flight in October 1942 at Muroc, California. He later developed the early rationale and propulsion-system analysis for the turbo-fan engine for VTOL aircraft. Wolf also played a large part in the creation of the Bell rotary wing aircraft that received the first commercial helicopter license (NC1H) in the U.S.

ACIR Given New Impetus

Wolf joined Cornell Laboratory in 1951 and within a few years rose to head of its Operations Research Department. Called upon to lead the ACIR project when CAL assumed its management in 1960, he has been primarily responsible for the position of preeminence attained by ACIR in its field since that date, with major assistance from Dr. B. J. Campbell, John W. Garrett and others of ACIR's dedicated staff. Wolf revitalized the program when it was in danger of lagging and convinced its sponsors of the need for vastly increased funds to provide more and higher quality data on injury causation. In addition to directing ACIR, Wolf in 1963 became head of CAL's new Transportation Research Department of which ACIR became a part. In this role he has initiated and played a significant part not only in strengthening the ACIR program but in developing closer liaison with automotive engineers.

Under Wolf, CAL's Transportation Research Department's interests have expanded beyond the automotive vehicle itself into the many facets of overall transportation systems. For example, its work has encompassed seat-belt dynamics, highway guardrail development, vehicle crashworthiness, accident analysis, driver perception, pavement mechanics, traffic control systems, and conceptualization of future transportation systems.

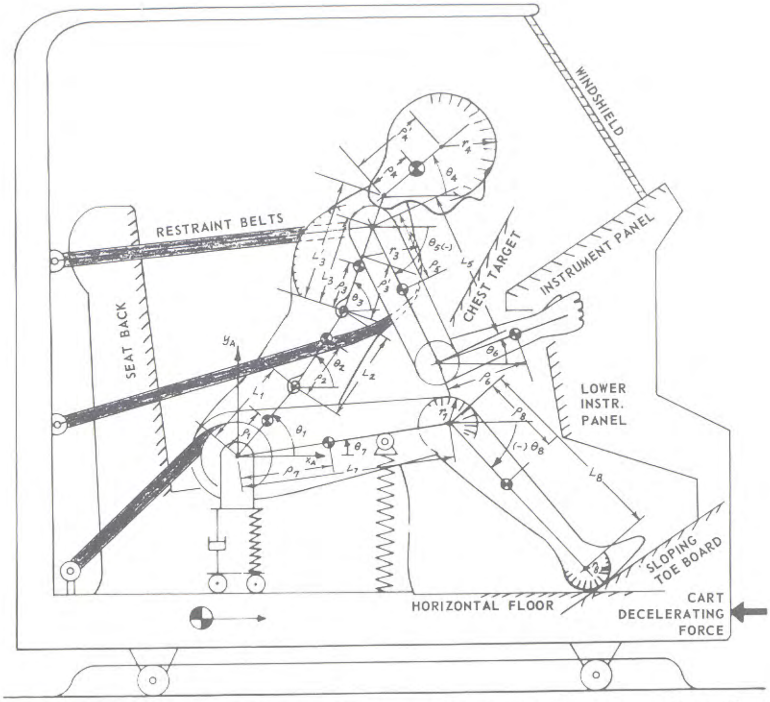
In this decade, Bob Wolf has actively stimulated adoption and improvement of safety features by the U.S. auto industry in several areas, such as the second generation of improved safety door latches, occupant-restraint systems, and energy-absorbing, nonpenetrating steering columns. On the latter subject, in 1964 he highlighted the



Sled test for simulating dynamic action of restrained anthropomorphic dummy (Conducted at Wayne State University)

seriousness of steering-column penetration into the driver's compartment. At that time, he offered a series of engineering sketches in a paper on possible approaches to solving the problem of steering-column penetration and energy absorption. Segments of the auto industry already were devoting considerable attention to these topics in their research and a new steering-column became standard in many 1967-model cars.

Under Wolf's direction, CAL transportation researchers in recent years also formulated and programmed for computer use a mathematical model simulating the dynamic action of a passenger in a car responding to an impact on the front end. This pioneering achievement by Raymond R. McHenry of CAL has sparked a lively, worldwide interest among researchers in digital simulation as a possible substitute for full-scale crash testing and impact sled testing. This engineering activity was first applied to passenger restraint systems and has helped immensely in obtaining greater understanding of the dynamic action of the difference between the performance of seat belts and shoulder harnesses. This research



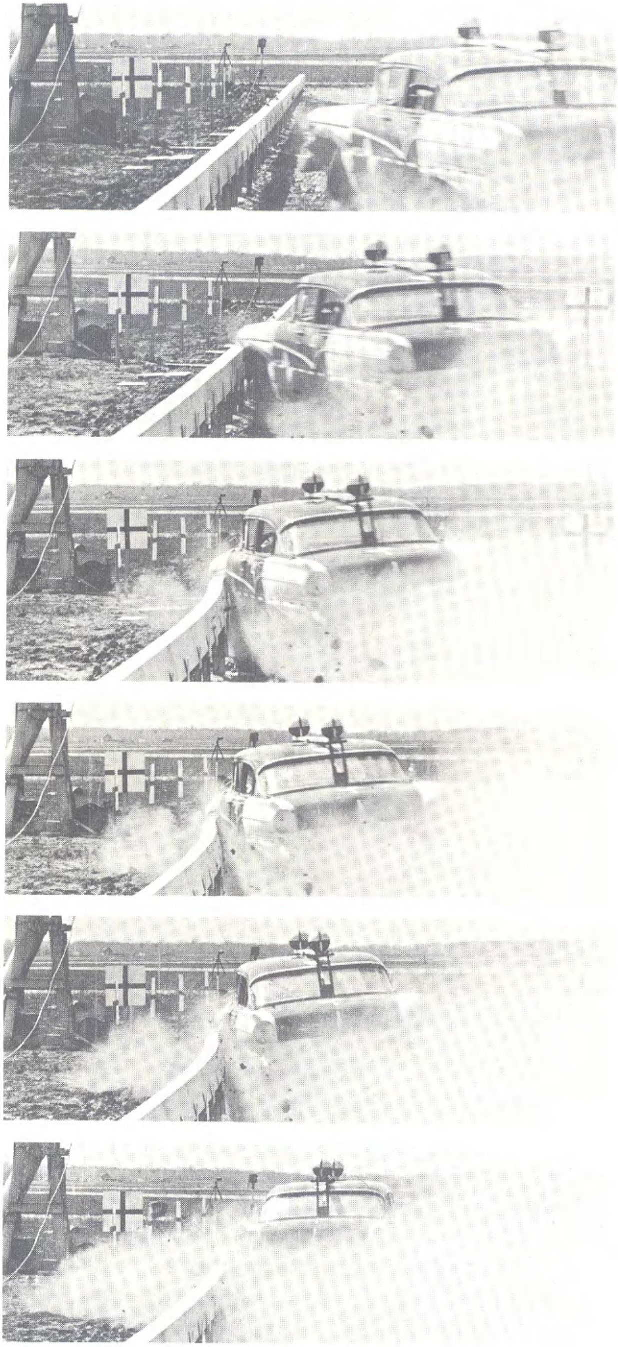
Mathematical Model of Human Body and Restraint System on Test Cart (11 Degrees of Freedom)

has been utilized by the U.S. Public Health Service and the SAE Seat Belt Committee, as well as others concerned with the formulation of restraint-system standards. A series of CAL mathematical models is also being developed for the auto industry to be used in safety-oriented preliminary design efforts and in exploratory investigation of new safety devices and structural components.

Safety Guardrail Design Conceived

While most CAL automotive safety research has been concerned with the vehicle and its systems and with accident and injury causation, the Laboratory also has been involved heavily in the highway environment and its important role in the accident picture. One such program entailed development of an improved roadside guardrail and median barrier design.

In the past, nearly all designs in this area evolved with little benefit from valid structural performance criteria or extensive engineering analysis. Indeed, many of the early guardrails and



Crash test at CAL shows effectiveness of new guardrail design fences were employed primarily for psychological purposes. Guardrail design and development, for vehicle restraint purposes, had been largely an empirical process until 1960 when CAL undertook a research project for the New York State Department of Public Works. With the use of applied-mechanics theory, a computer-simulation technique of guardrail and vehicle dynamics was developed by CAL's McHenry. Using this analysis, a new design was conceived for median barriers and road-shoulder guardrail and bridge railing. Several existing types of guardrail — the familiar cable and W-section beam types — also were modified by New York State to meet the new design criteria made possible by the CAL research.

McHenry's analytical means of predicting dynamic barrier performance was validated in a series of full-scale crash tests and from this work, the new Box-Beam barrier design emerged in 1963 under an engineering team led by Norris Shoemaker.

The New York State Department of Public Works stated in 1967 that the "design concept which we call the Box-Beam, developed by Cornell Aeronautical Laboratory, has, in fact, been proven in actual service."

Many miles of the Box-Beam guardrail have been in service in New York State for the past approximately four years, with some 80 miles of it let to contract by the state in 1966 alone. The concept also is being applied in several other states, including New Hampshire, Massachusetts, Pennsylvania and Virginia.

In 1967, CAL's Shoemaker was granted a patent on the new design. The Laboratory has given New York State a royalty-free license for its use and is now in the process of donating similar licenses to all states.

The performance criteria established and achieved for the new barrier design require that an impacting vehicle be decelerated gradually enough so that occupants can survive most impacts; that the vehicle not go through the barrier; that the vehicle be redirected as nearly parallel as possible to normal vehicular movement to minimize the possibility of collision with other cars in the stream of traffic; that vehicle damage, barrier construction and maintenance costs be minimized.

Essentially, the Box-Beam design consists of a semi-rigid, continuous beam mounted on closely spaced and very flexible posts. By using Box-Beams of different strengths and by varying the strength and spacing of posts, barrier lateral deflection can be controlled. This allows modification of the same basic concept to meet the differing requirements of guardrail, median barrier, and bridge railing on our highways.

Driver, Vehicle and Highway Play Role

Just as Cornell Aeronautical Laboratory's improved guardrail is playing a growing role in safety aspects of the highway environment, so have CAL's research and engineering in seat belts, door latches and instrument-panel padding contributed to safer cars. And while today's cars are far safer than their predecessors, even of a few years ago, so will tomorrow's vehicles be improved over today's.

The art of designing protection for people in crashes remains embryonic. However, the concept of protection from injury in most crashes, pioneered at the Cornell University Medical College and expanded and refined at Cornell Aeronautical Laboratory, has been established in our motor culture. While many of these concepts now are being applied by the auto industry to effect savings in lives and reduction in or elimination of injury in auto crashes, much remains to be accomplished to achieve continuing improvement in vehicle safety.

The automotive engineer is concerned with improving the vehicle, but substantial improvement in the overall traffic safety picture cannot be achieved without major effort, as well, by researchers on the driver and the total highway environment. The rapidly expanding transportation and vehicle research programs of Cornell Aeronautical Laboratory now are dedicated to this comprehensive approach. Their objectives: To conduct the applied research and advanced engineering necessary to provide our nation with better and safer vehicles and transportation systems; to facilitate improved means of transportation, while helping to reduce the toll of injury and death on our highways.

PREVIOUS ELMER A. SPERRY AWARDS

1955 to WILLIAM FRANCIS GIBBS and his Associates for development of the S.S. United States.

1956 to DONALD W. DOUGLAS and his Associates for the DC series of air transport planes.

1957 to HAROLD L. HAMILTON, RICHARD M. DILWORTH and EUGENE W. KETTERING and Citation to their Associates for the diesel-electric locomotive.

1958 to FERDINAND PORSCHE (in memoriam) and HEINZ NORDHOFF and Citation to their Associates for development of the Volkswagen automobile.

1959 to SIR GEOFFREY DE HAVILLAND, MAJOR FRANK B. HALFORD (in memoriam) and CHARLES C. WALKER and Citation to their Associates for the first jet-powered aircraft and engines.

1960 to FREDERICK DARCY BRADDON and Citation to the Engineering Department of the Marine Division, SPERRY GYROSCOPE COMPANY, for the three axis gyroscopic navigational reference.

1961 to ROBERT GILMORE LETOURNEAU and Citation to the Research and Development Division, FIRESTONE TIRE AND RUBBER COMPANY, for high speed, large capacity, earth moving equipment and giant size tires.

1962 to LLOYD J. HIBBARD for application of the ignition rectifier to railroad motive power.

1963 to EARL A. THOMPSON and Citation to his Associates for design and development of the first notably successful automatic automobile transmission.

1964 to IGOR I. SIKORSKY and MICHAEL E. GLUHAREFF and Citation to the SIKORSKY ENGINEERING DEPARTMENT for the invention and development of the high-lift helicopter leading to the Sky Crane.

1965 to MAYNARD L. PENNELL, RICHARD L. ROUZIE, JOHN E. STEINER, WILLIAM H. COOK and RICHARDS L. LOESCH, JR. and Citation to the Commercial Airplane Division, THE BOEING COMPANY, for the concept, design, development, production and practical application of the family of jet transports exemplified by the 707, 720 and 727.

1966 to HIDEO SHIMA, MATSUTARO FUJII, and SHIGENARI OISHI and Citation to the JAPANESE NATIONAL RAILWAYS for the design, development and construction of the NEW TOKAIDO LINE with its many important advances in railroad transportation.