

GROUND EFFECT VEHICLES

By William R. Bertelsen, M. D.

National Safety Congress

October 26, 1964

Itasca, Illinois USA

I am pleased to be invited to speak at the National Safety Congress on the subject of ground effect vehicles.

I wish to reiterate that I believe this new transportation modality to be the most important vehicle so far devised. I believe the ground effect phenomenon will provide us with the ultimate vehicle. The application of proximity effect will ultimately prove to be far more significant than the wheel. The air lubrication principle will be ubiquitous in transportation large and small, heavy and light, fast and slow, free roving and road restricted, land and water, arctic and tropical, public and private. I believe this new facility will bring levels of transportation safety totally unattainable by conventional means.

As a physician the subject of safety is very near and dear to me. There are two very important humanitarian aspects to the improvement in transportation. One is to reduce the accident rate of conventional travel and the other is the true benefit to everyone of free movement of goods and people. Where goods and people move rapidly, economically and safely to all parts of a country, the general well being is much improved. There is available food, medical supplies, the necessities and the niceties of life, the sick and injured are transported easily to centers of care, and the law has force to control crime.

U.S.A. has relatively good transportation of all conventional types compared to the developing nations, yet a sudden 12 inch snow can

paralyze all vehicular motion and we constantly deplore our death tolls from highway accidents.

I consider the improvement of transportation a humanitarian endeavor the equal of the practice of medicine.

I would like to define "good transportation" as the fastest, safest, cheapest, easiest, most reliable, most flexible, most comfortable means of getting persons and freight from any place to any other place that is attainable by the most advanced technology of the time. At points in history "good transportation" consisted of walking, horseback riding, oxen, dugout canoe, and Conestoga wagon. All of these were at one time the best attainable by the most advanced technology of the time.

This is the age of space wherein the most advanced technology includes rockets, jet engines, rubber tires, concrete roads, rails and even monorails and supersonic air transports. But the problem of designing "good transportation" now becomes enormously more complex because by definition it must be not only fastest but cheapest, safest, etc. The problem of economics enters in to complicate the free reign of the designers' technical acumen. Transportation has to be a business success to be cheapest. Rockets might be fastest, but not cheapest on light loads and short runs; they may not be safest or most comfortable either. Rails and monorails may fail on the "most flexible" aspect of the definition, and

roads and super highways fail to be "fastest," "safest," and because of weather fail on the "most reliable."

So many means are available to modern man that intuition, business judgment and technical competence are all necessary qualities in transport design.

The older, conventional transportation means are well understood by all, and I would like to show movies of our ground effect vehicles in action to demonstrate the peculiar properties of this exciting new medium. With the frictionlessness and freedom of motion of the ground effect vehicle in your mind, I would like to describe a new high speed mass transportation system for public and personal vehicles based on the air cushion phenomenon. It is the Aeroduct system first published in August 1961 *Popular Science Monthly*. I believe the Aeroduct system perfectly fits the broadest interpretation of the definition of "good transportation."

(Film is shown)

The film shows the latest and most advanced of our nine (9) full scale Aeromobiles and Arcopters in high speed travel in all weather, all season, on all conditions. These air cushion craft are well along in development and will be widely used over the world. The philosophy of the "good transportation" system should be one of "facility." The designer must believe that speed is good and not inherently dangerous or immoral, that speed reduces hazard in a good system by reducing the exposure time to

accident, and decongests the facility allowing more vehicles per hour per mile, that speed increases utilization of the facility by allowing more mileage per day per person or vehicle, and this reduces the over all unit cost of the facility.

The philosophy favorable to good system design is that travel is good. "This trip is necessary"; short trips and long distance travel are both essential and must be made easy and inexpensive. Personal vehicles are good and best for flexibility of route and departure time. It is not evil to operate a car with only one person in it.

Why is a physician meddling in the transportation picture? I find it frustrating in the extreme to repeatedly treat highway accident victims, mangled patients in the emergency room who never should have been involved in an accident. Our failure to recognize the repeatedly demonstrated hazard - the inability of the human driver to be 100% fail safe in the thousands of judgments he makes daily on the road - our failure to minimize this hazard by automation keeps the hospital and emergency room personnel and the doctors working. The correction of this horrible trauma generator is preventive medicine at its best.

The objective in a general transportation system should be the enviable record of the automatic elevator where more people are carried more miles more safely than by any other means. The elevator is a single shuttle vehicle on a track completely

automated and without possibility of collision.

We cannot hope to have a private road for every vehicle to and from every point to avoid collision, but the fast, frictionless, light footed air cushion vehicle allows us to have more lanes in the right-of-way at less cost.

The ground effect machine fits well into the definition of "good transportation." It is at once the simplest possible powered vehicle having only one main moving part, its motor fan; and at the same time the most capable vehicle in its ability to traverse amphibiously all types of unobstructed terrain frictionlessly at high speed. The air cushion vehicle. can be designed "fastest" with a given power because it is frictionless. The vehicle itself can be "cheapest" ultimately when manufactured in millions because of its extreme simplicity. It is "most reliable" by virtue of its few parts and simplicity and its lack of vibration and racking from road shock on its air cushion. The air cushion also makes it "most comfortable" on land or water by eliminating bumps and wave impact. Aeromobiles are easy to operate by untrained people on open fields or water. The designation "easiest" must include the system design for automation which will clearly make Aeromobiles "easiest." To be "most flexible" a vehicle will have to be able to carry various loads over various routes without delay. The great load carrying capacity of Aeromobiles and their amphibious quality which adapts them to good or poor roads, no road, swamps, open water, snow, ice, ice

floe, sand, etc. gives them the "most flexible" title.

We have the free roving vehicle well along in development, but the most urgent need for high density traffic safety is the Aeroduct system on which to operate them.

We have found that the frictionless Aeromobile tends to gravitate to the bottom of any valley and travel there. If a "U" shaped groove-like graded road is provided, the Aeromobile centers itself in the groove and travels at high speed without steering with good stability. A very shallow groove is needed for this, little more than the crown in intaglio. Very light preparation is needed for Aeromobile traffic as no contact is made with the ground and the air pressure is a mere 10 and 20 lbs. per square foot on the surface vs. thousands of lbs. per square foot for tires. We find that grass will withstand a great amount of "hovering" and may be a practical cover for groove roads. If necessary, soil-cement stabilization or plastic or rubber sheet may be used.

Greater utilization of right-of-way could be cheaply made with grass grooves. An 80 foot wide right-of-way may have only two 10 foot concrete lanes or at most four 10 foot lanes, but could have eight 10 foot grass grooves probably at lower cost. Drainage is less important with these amphibious vehicles except when guidance would be affected by water leveling the groove. The drains would now be single in the center of the road instead of double at the edges of crowned roads.

The groove provides railroad reliability in the guidance of Aeromobiles. Guidance is a most difficult element in wheeled vehicles on roads, and its lack of reliability and high cost have prevented its practical accomplishment.

Given this inherent guidance method, total automation is only a step away. One needs electronic equipment only at junctions to determine the path of the vehicle whether right, left or straight ahead. A limited access groove system would have fewer decision points. A built in proximity sensing system will space the vehicles at safe intervals in the grooves and automatically shift the Aeromobiles to alternate grooves or brake them if no alternative exists. A surface system involving thousands of vehicles cannot hope to equal the safety of the solitary automatic elevator on its shuttle track. But given guidance and only auxiliary need for electronic or mechanical sensors and directors, at least a ten-fold increase in utilization and safety may be expected. A "black box" in the vehicle may be preset by dialing, by tape or punched card to guide it to any destination and return without a driver by reading electronic signals emitted at the junction points.

Thus complete automation is possible for Aeromobiles making the human only a passenger safely dozing or reading enroute. He may be old and inadequate to drive or young with inexperienced judgment, he may be any age and overtired, tipsy, distracted, irate, or sick but his worst possible error now is his choice of

destination. He will arrive safely. It is not proposed that we destroy all existing crowned hard roads and all wheeled vehicles to build groove roads and Aeromobiles. When the feasibility of the groove Aeroducts is thoroughly established, a transition can be made by building wheeled Aeromobiles as we have already done, which travel either kind of road, and put grooves in the center of the interstate roads at first and as new roads are built make grooves more prominent. The old roads inevitably wear out and go to the wrong places. Pure evolution of traffic vehicles and roads will make the transition in time.

The groove need not be of graded earth but of metal, concrete or other material and elevated to cut across traffic, buildings or other grooves. It may be closed into a tube on the surface as a weather free, higher speed conduit. The tube may be elevated, under water, or under ground. The tube allows very high speeds with good vehicle spacing and long distances such as from coast to coast. All aircraft speeds are feasible in a tube with better than aircraft safety. Remember, the Aeromobile is actually an aircraft.

"Good transportation" is the fastest, safest, cheapest, easiest, most reliable, most flexible, most comfortable means of getting persons and freight from any place to any other place that is attainable by the most advanced technology of the time. The Aeromobile and the Aeroduct system, in my opinion, fit this definition better than any other existing or proposed system.

You people who have labored for years to increase safety know that there is an absolute limit to improvement in human reliability. We have reached or exceeded that limit in conventional highway travel. The unique qualities of the ground effect vehicle now present us with a breakthrough in traffic facility and safety. We have amphibious air cushion rescue vehicles now, we can have totally automated transportation tomorrow.