by JOHN W. LEGGAT, JR.

There is no need to discuss the extreme interest developed and efforts expended in recent years by government and industry throughout the country toward improved highway safety. Federal, state, city and other governmental agencies each are recognized as having a responsibility in this field.

Not so readily recognized is the fact that the transportation industry, and the automotive industry in particular, also are aware of a responsibility toward improvement of safety in the mechanical equipment and in the method of control of its product, the automobile.

One way to emphasize this sense of responsibility is to describe some past developments of the industry and some of the current work directed specifically toward improvement of the safety aspect of vehicle operation.

Current problems of automotive safety engineers concerned with product safety vary from the loca-
tion, type and control of headlights in the front to the problems relating to a safe exhaust system all the way through to the tailpipe. These engineers are usually dealing with components of cars which will not hit the road until next year or the following year, so that they must anticipate problems which will be precipitated by proposed model changes—both exterior visible changes and hidden mechanical modifications.

But these deal with recognized current problems. What of the more distant future?

Highways are becoming more congested; people want to travel faster; they want to enjoy more of the scenery; and they want to reach where they are going without accident.

Much study is being given these problems across the nation both within the automative industry and outside it. These studies involve not only automobile improvements, but also highway developments, traffic control and driver education.

One approach suggests itself as a result of recent technological advances in the field of electronics. Electronic equipment is already being applied to the control of aircraft. It may be feasible to adopt such control to automotive travel.

What about radio? How can some of the problems of vehicle control be simplified or eliminated in order to relieve the driver of some responsibilities and permit him to pay more attention to fringe areas which, nevertheless, have been frequent causes of accidents?

One of the major automobile companies has made a study of the frequency with which distracting influences might arise in a driving situation. It revealed that a driver can be exposed to between 15 and 45 events per second in an average driving situation. This same driver can observe in detail only two or three such events and probably makes decisions at a much lower rate.

**NEED FOR CONCENTRATION**

Many of these events, naturally, are not hazardous in themselves, but can reduce the opportunity to concentrate on significant details. A passenger in the car can be a help or a hindrance depending upon whether he is alert and gives the driver room, or whether she has her head on his shoulder and is crowding him comfortably. While I would not suggest substitution of an automatic device in the latter case, it does appear to be reasonable to expect to obtain assistance in reducing the need for concentrating attention in some areas.

This is not to say such equipment is currently available, or that if available, all traffic problems would be solved. Sound engineering developments in this field must be accompanied by progress in such other areas as enforcement and education. The total problem is extremely complex and there can be no single approach, or panacea, for traffic accidents.
Electronic control of passenger cars precipitates many new problems. Any proposed system can be considered an electronic chauffeur or co-driver, so that before development can be completed, we first must know something about the functions of the driver.

Drivers have been the subject of intensive study, but I think that with even a cursory examination, we can recognize the complete driver as a very complex being with a very complex job. However, his duties can be basically reduced to the performance of functions of three general kinds.

(1) Perception
(2) Decision
(3) Motor

His senses make him aware of the motion of his own vehicle, the relative position and movement with respect to other vehicles, the desired path, the information on road signs, weather conditions which have an influence upon the car's responses and the presence of pedestrians.

Figure 1 is a simplified block diagram of the car-driver system. Information input to the driver includes those things previously mentioned plus such things as the driver has been taught about rules of the road, courtesy, etc. Other input information may originate as side acceleration, audible tire squeal, and steering feel. The driver perceives these things through the use of his visual, audio, and tactile senses. He becomes an integrator of the information in terms of both the present situation and the anticipated immediate future. All these things are perception.

PROCESS OF INTEGRATION

Decisions are reached as a result of this process of integration; and decisions in turn result in motor responses of the driver. In a car these responses result in angular displacement of, and torque inputs to, the steering wheel and in position control of the throttle and brakes.

Development of such devices as power steering and power brakes are past application of mechanical devices intended to reduce control efforts; and automatic headlight dimmer controls and automatic transmissions are examples of devices already available to reduce the number of events faced by a driver in a given situation.

All of the driver's control inputs (or motor efforts) are utilized to regulate the car motion, its speed, position, and heading in the two dimensional space in which it travels.

In reviewing the functions which the driver must perform, it is obvious that he might be further assisted in operating a vehicle by supplying him limited aids for perceiving the situation, by simplifying his decisions, or by reducing his motor effort. One of these devices is Hy-Com, which is intended as a driver aid (spoken of earlier as a co-driver).

Such a device could be made sufficiently compact to permit temporary installation as a car entered a toll road, use while en route, and removal upon exit.

Another approach is a means for completely replacing the driver with a system that will perform all of the necessary functions for automatic operation of the car on such a highway. Here, a magnetic field generated by a current passing through wires buried in the road is coupled with a suitable means of detection mounted in the vehicle. The combination manipulates a servo type steering mechanism and senses obstacles in the path of the car.

AUTOMATIC CONTROL

Upon review of the concept of the completely automatic control system, it becomes apparent that equipment is probably required in both the vehicle and the road. Actually, however, the designer has a wide latitude of choice, as to the proportion of the total equipment required in each. Mechanical means of guidance could be mounted in the road with no additional equipment in the car. A train represents such an application. It is also within the realm of reason to consider an electronic system within the car with essentially no additional equipment in the road. A combination is probably more likely.

Naturally, city driving complicates the automatic control problem and for this reason, initial efforts have been centered around application to controlled access rural highways.

Obstacle detection presents a serious problem in any automatic guidance system. Such a system must sense other vehicles being overtaken or stalled, and even non-metallic objects such as pedestrians, if any true relief is expected for the driver.

On the other hand, the system must be highly selective to minimize or eliminate interference by such things as cars stalled or being overtaken in other lanes (see Figure 2) or at the side of the road.
Sensing around curves (Figure 3) and at the bottom and the crest of a hill (Figure 4) can be difficult also.

Numerous sensing devices may be adaptable; for example, photocells, radar, ultrasonics, or infra red detectors, but the problem of selectivity and evaluation exists in all but the human senses.

The problem of reliability is not being overlooked. At the present time, vehicle accident statistics reveal that about 96.5 per cent of all accidents result from some driver error. Only about 3.5 per cent are caused by mechanical failure of the vehicle itself.

It has been proposed that the automatic control system could drastically reduce the 96.5 per cent figure. It must accomplish this, however, without a corresponding increase in the current 3.5 per cent figure.

DRivers MORE RELIABLE?

Although the general impression is that drivers are relatively unreliable, it is questionable whether even simple electronic devices are as reliable at this time. And it is easy to assume that an electronic control system failure would precipitate an accident of considerable magnitude.

Comparison with National Safety Council figures suggests that control system failure which would precipitate a serious accident could not be permitted more than once per 16,000,000 miles or 400,000 hours to maintain even our present safety record of fatalities. Production of electronic control systems of such reliability is certainly a challenge at the present time.

ADVANTAGES IN DRIVING

Another of the complicating factors which has not been mentioned before is the fact that the substitute control system must not conflict with, or limit the basic advantages inherent in, the use of privately owned cars. Some of these are:

(1) Convenience — opportunity for direct service with complete choice of time or arrival and departure.
(2) Flexibility — Ability to change plans at will.
(3) Comfort — Pleasant environment without need for transfer of personnel or baggage.

In summary, we have been discussing application of engineering technology to improve control and safety of existing types of land vehicles. Such vehicles, themselves, will probably still be recognizable in the foreseeable future, but some control devices intended to reduce or eliminate driver functions may appear. Many of these developments will perform the dual functions of increasing driving pleasure and enhancing safety.
Sensing around curves (Figure 3) and at the bottom and the crest of a hill (Figure 4) can be difficult also.

Numerous sensing devices may be adaptable; for example, photocells, radar, ultrasonics, or infra red detectors, but the problem of selectivity and evaluation exists in all but the human senses.

The problem of reliability is not being overlooked. At the present time, vehicle accident statistics reveal that about 96.5 per cent of all accidents result from some driver error. Only about 3.5 per cent are caused by mechanical failure of the vehicle itself.

It has been proposed that the automatic control system could drastically reduce the 96.5 per cent figure. It must accomplish this, however, without a corresponding increase in the current 3.5 per cent figure.

DRIVERS MORE RELIABLE?

Although the general impression is that drivers are relatively unreliable, it is questionable whether even simple electronic devices are as reliable at this time. And it is easy to assume that an electronic control system failure would precipitate an accident of considerable magnitude.

Comparison with National Safety Council figures suggests that control system failure which would precipitate a serious accident could not be permitted more than once per 16,000,000 miles or 400,000 hours to maintain even our present safety record of fatalities. Production of electronic control systems of such reliability is certainly a challenge at the present time.

ADVENTAGES IN DRIVING

Another of the complicating factors which has not been mentioned before is the fact that the substitute control system must not conflict with, or limit the basic advantages inherent in, the use of privately owned cars. Some of these are:

1. Convenience—opportunity for direct service with complete choice of time or arrival and departure.
2. Flexibility—ability to change plans at will.
3. Comfort—pleasant environment without need for transfer of personnel or baggage.

In summary, we have been discussing application of engineering technology to improve control and safety of existing types of land vehicles. Such vehicles, themselves, will probably still be recognizable in the foreseeable future, but some control devices intended to reduce or eliminate driver functions may appear. Many of these developments will perform the dual functions of increasing driving pleasure and enhancing safety.