BASIC IDEA OF MAXIMUM SPEED CONTROL SYSTEM IN JAPAN

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ABSTRACT

Maximum Speed Control System in Japan, which was originally proposed by the author (Taniguchi, 1993b), changes the possible speed performance of a car forcibly when it goes through a gate between an expressway and an ordinary road. Supposed speed limit is 60 or 70 km/h on an ordinary road and 80 to 140 km/h on an expressway. The system is more effective as a deterrent against serious accidents. The basic theory is that effective control of speed behaviour by education is so difficult that physical limitation of the speed performance of a car is the best, that is, deprivation of the possibility of driving at a high speed itself. The system is more realistic than other speed limiting systems due to the simplicity of the system and characteristics of Japanese traffic situation. Simulated effect of the system is roughly calculated to produce a reduction by 10% in the number of deaths per year at least. Some problems regarding actualization of the system are discussed as well. Lastly, differences between this system and the Swedish version, ISA in Lund, are discussed.

1. OUTLINE OF MASCOS (MAXIMUM SPEED CONTROL SYSTEM)

This is a kind of traffic system in which the maximum speed performance of a car is controlled forcibly at the point of passage through a gate between an ordinary road and an expressway (Taniguchi, 1993b). The idea originated in the author's work (Taniguchi, et al., 1992) which was conducted as research commissioned by the headquarters of the Aichi prefectural police in 1991. That aimed to analyze data on fatal accidents in Aichi Prefecture and to suggest deterrent measures.

The structure of the speed limiting traffic system is simple. Maximum speed capacity is limited to 60 or 70 km/h on ordinary roads. The main purpose of the system is to minimize the number of serious accidents on ordinary roads which are mainly due to excessive speed. The majority of serious accidents occur on ordinary roads, and not on expressways. Therefore, the maximum speeds on expressway don't need to be so strict. However, one idea is that they should be switched to 80-100 km/h which are the maximum speeds on expressways now in Japan. The speed could be switched to around 140 km/h on the new Second Tohmei Line which is now under construction. Another idea is that the limits could be more lenient so as to accommodate the actual prevailing speeds which are sometimes 20 km/h higher than the legal limits on expressways. Hardware necessary for the system is as follows: Every gate on expressways is equipped with a controller, which transmits a signal of the maximum

speed to cars. A receiver and a speed limiter are installed in cars which detect the signal and then restrict the speed to the limit, making it impossible to go at a higher speed than that.

Taniguchi (1993c) simulated the effect of MASCOS on the reduction of fatal accidents. It was based on the accident data of Aichi prefecture during 1991. The data included estimated data of speeds just before the accidents. They were obtained from verbal evidence from the drivers or other persons concerned, or from the skid traces. The result showed that three thousand people could be saved per year in the whole country if the maximum speed on ordinary roads were set to 60 km/h, and two thousand people could be saved in case of 70 km/h. They are conjectures based only on fatal accidents, and they are based on more or less strict conditions. Additional factors reducing the number of other accidents could also be possible. More detailed analyses with sufficient data are necessary to produce an exact estimate.

2. A THEORETICAL BACKGROUND OF MASCOS

2.1. Time and speed as determinants of accidents

The determining mechanism of driving behavior consists of two groups of factors, in the same way a general mechanism of human behavior does. They are a person, and an environment which surrounds him. The relation to behavior is simply represented by the equation B=f(P,E). The environment consists of two parts, a car and a road (Taniguchi, 1998a; Taniguchi, 1999a). The proper driving is defined as operating his car in such a way as to not scrape or have a collision with pedestrians, vehicles or other objects. The information process consists of attention, sensation, perception, cognition, judgement, movement, and so on. Accidents originate basically in an error which occurs somewhere in the information process. That is a fault in recognition of the possibility that his car might scrape or collide with other objects, or a fault in judgement and operation to evade the danger perceived. The time is a key factor which decides whether the process works well or not. It regards both the speed of information processing of a driver and the speed of the object processed. The speed of a moving object is focused on here, not on individual or situational differences of information processes.

Speed factor as a determinant of traffic accidents is strongly connected with this point. It is clear that an object moving at a high speed has a tendency to lead to some errors in information process. This is because the object is difficult to catch visually and the processing time is apt to be insufficient. The other important point is that speed of a car decides the level of damage when an accident happens. The faster a vehicle goes, the more energy it should have, and the damage from the collision should be more serious. Those relations are revealed in the data from a survey (Taniguchi, et al., 1993) and actual accidents (Taniguchi, 1993).

Therefore it is clear that control of excessive speed is one of effective deterrence measures against traffic accidents. Traditional measures to suppress speeding has been in the form of education and police enforcement. They have surely had some effect in reducing speeding of some people and under some conditions. However the effect are limited. There are some people who usually go at an excessively high speed and there are also a number of occasions on which momentary high-speed driving is performed by drivers who usually don't drive at such high speeds. Then the strict control of speed is necessary for those people and occasions.

2.2. Motive, incentive and availability

Here is some discussion of the psychological mechanism deciding speeding behaviour.

This approach should improve understanding of the necessity and effectiveness of the physical control of speed. The mechanism consists of three parts: motive, incentive, and availability of incentive (Taniguchi, 1999b). The motive means a level of speed which a person chooses to drive at. The level of speed is changed by the purpose of his driving, his education, etc. And it also differs depending on the driver's characteristics. Some characteristics could be biologically based. Typical examples are factors of sex and age which could have some relation to an instinctive mechanism. That means the motive for speeding is as strong as drives of appetite and sleep, so that they could be strong enough to control human behavior. The incentive is a car itself or the speed performance of the car that could satisfy a person's motive. And the availability is a physical condition in which the motive can be connected with the incentive. Therefore the availability decides finally the possibility of actual speeding behavior which the motive wants to emerge. It is rather difficult to control the motive inside a person. The motive is unstable and is always fluctuating. There could occasionally be an abrupt explosion of strong needs for high speed, no matter what, consciously or unconsciously. On the other hand, the incentive could also be easily controlled. With regards to speed behaviour, both incentive and availability should be focused on for the purpose of control of speed behaviour. At this point, prevention of dangerous speed performance of a car could be regarded as relating both to the incentive itself and the availability of it. Or there could be found slight differences between them. The fact that the car has high-speed performance is being recognized by the driver even while the opportunity for the performance is temporarily limited. His speeding behavior is controlled by the limitation of availability of the incentive. The driver could be satisfied by the possibility of going much faster in other conditions. In that sense, the concept of availability should have usefulness, as something to be differentiated from incentive.

2.3. Metaphor by aggressive behavior, an uncontrollable drive.

The following is a discussion of aggressive behavior as a metaphor in order to improve understanding the mechanism of speeding behavior. Aggression is a kind of instinctive drive which is biologically necessary for survival. It can be considered that human beings at present have still preserved the drive, although in many cases they are not allowed to express it directly, so that it must be redirected in other ways such as through sublimation and repression, which were identified to be parts of the self-defense mechanism by Freud. In spite of the mechanism, there still is a rare situation in which one aggresses violently against someone almost dead, although that isn't common phenomenon with most people or under many conditions. The uncontrollable aggressive drive is figured to correspond to the motive for speeding, and a car with sufficient speed performance, which is enough to satisfy the motive, corresponds to weapons, such as a knife or a gun. The aggression when the latter weapons are utilized is of course different from the motive of speeding in their abruptness, i.e., characteristics of intensity and time duration.

If there is a murderous weapon available when a man experience strong feelings of aggression, he will be sure to use it. The aggressive drive is also accelerated by interaction with the incentive available. Thus the availability of a weapon is one of critical conditions that decides whether a severe attack like murder actually occurs or not. With regard to measures to control the person's behavior, there could be some choices. One is to persuade him not to do that by talking, or some educational program about ethics or morals could be possible. However, none of those are likely to be effective at all once a similar kind of mechanism to FAP (Fixed Action Pattern), the construct of instinctive mechanism in biology, comes into play. The other one is prevention of the use of effective weapons. Deprivation of availability of the weapon will make it impossible for it to be used. The last option left might be his own fist, but that could not yield the same critical effect of killing or hurting another person seriously. There also seems to be a kind

of hesitation when one wants to use his part of body as a weapon, perhaps due to an aversion to what one imagines violent physical contact will feel like. As the metaphor above reveals, if there emerges an uncontrollably strong drive or motive, behavioral control is thought to be ineffective and the most successful measures to control it should be based on physical operation.

2.4. The excessive speed performance

The maximum speed allowed by law is 100 km/h in Japan on expressways. Simply put, nobody may drive at faster speeds than that. In spite of this fact, almost every car has a maximum reading of 180 km/h on its speedometer. The maximum speed is controlled by a "speed limiter". The car manufacturers in Japan have limited independently the maximum speed of cars to 180 km/h, and the power to 280 hp for the past ten years. There had been no limits of speed performance in vehicles until then. Social pressure by an association of children whose parents had been killed in traffic accidents worked as a trigger for this self-regulation. However, there still remains the question of whether the limit of 180 km/h is sufficient or not. What purpose is such excessive speed performance needed for? What does the traffic law regarding speed intend? Is the latter no more than a formality? What is the real intention? Even more surprising is a recent movement to eliminate the self-regulation provided by the 180 km/h limiter (February, 1999).

With regard to this point, the police control of speeding gives an important hint. Police patrol cars sometimes go at a faster speed than the limit even under ordinary conditions. They won't stop those private cars which are obviously speeding. On the other hand, some cars going at a speed only 10 km/h over the limit are suddenly stopped if they unfortunately run into a speed trap, and the drivers have to pay a not very small penalty. An even more surprising thing is the speed standards of automatic "speed vigilance" cameras. They work only when a car exceeds the limit by than 20 to 30 km/h. Thus many cars drive at speeds much faster than the limit in some sections of roads. Consequently, the official policy on speed violation seem to be very complicated in Japan.

3. PROBLEMS TO BE SOLVED

3.1. Necessity of determining legal speed limits properly

Legal speed limits on all stretches of roads must be checked for their appropriateness. Are those limits really proper for the purpose of safety? They should be reconsidered if a mandatory speed limiting system is introduced. For those limits now have been decided in view of a situation in which drivers are largely free to speed. Therefore it could be regarded that the limits have been set to rather lower values than actually safe levels. Moreover, the speed revealed by the speedometer in a car isn't completely correct. In general, the error range is admitted to be within 10 %, and the speedometer is usually set to reveal lower values than the fact. Thus the exact speed might be 45 km/h when the speed meter reveals 50 km/h. This difference should be taken into consideration when a new system is actually introduced. It would be ideal to have all speed values recognized by law, limiter, and meter be correct or to refer the impartial standards.

3.2. Economical influences

It is predicted that transport services would receive not a little blow by the introduction of the "limiter" system. Trucks and taxis are the representatives not only of the companies but also those who work for the companies. It might be possible that people who get their earnings based on travel performance (how much freight delivered or passengers carried within a certain time) would suffer directly. In fact some of them are driving at a

high speed late at night on a ordinary road. It also cannot be denied that high-speed transport late at night has contributed to the prosperity of Japan. However, one field experiment conducted by a taxi company suggests that there could emerge positive effects from the system (The taxi, 1993). The strict limitation of the speed to 60 km/h was carried out in the experiment. Speeds of taxis were recorded by a tachometer and checked afterward. The number of accidents was reduced by half and the revenue increased to the top level among the companies in that area.

3.3. Evasion and overtaking by excessive speeds

There are some arguments about momentary necessity of high speed for the purpose of evading a risky situation and overtaking. According to Hyd∴n (1987), only about 2% of drivers use that kind of strategy to get out of the critical situation in urban traffic. There are 17.2% of drivers who experienced evasion of risk by accelerating a car (Taniguchi, 1998c), although it doesn't differentiate urban and rural roads, nor ordinary roads and expressways. That is, as Almqvist & Nygℴrd (1997) pointed out, the portion of manoeuvres of this kind that take place in urban traffic when a driver has reached the speed limit is unknown.

It is much more difficult for a car with speed limiter to overtake especially when the speed has already reached the limit. Although many drivers (62.9%) think they need high-speed performance for safe passing (Taniguchi, 1998c), it may be well-founded in a high-speed environment but not in urban traffic (Almqvist & Nygℴrd, 1997). Passing other cars at high speed in urban areas should be dangerous and it is rather desirable the overtaking be suppressed by the speed limiter. On the other hand, in rural traffic, especially when overtaking on roads without passing lanes, one should need high-speed performance. The speed limiting system could be modified to enable a car to use high speed for a short time.

3.4. Motor cycles also be controlled

There are huge numbers of motor cycles in Japan. 886 people (9.6%) during their ride on motor cycles were killed in 1998. Clearly, all motor cycles including mopeds should be equipped with the SL at the same time as ordinary four wheel vehicles. There could not be much difficulty to make the SL system fit motor cycles, although they would need some particular modifications. In addition, some field experiments using motor cycles will also be necessary to find any peculiar phenomena or problems to be resolved.

3.5. Regulation in remote rural areas.

How should the regulation using the SL system be implemented in remote rural areas such as the east of Hokkaido? There are no exceptions at least today in the traffic laws which permit any special privileges with regard to speed during travel in such areas. The actual speeds in those areas seem to be much higher than average. Those roads are not as narrow, winding or crowded as general roads in Japan. There should not be any problems even if the system were switched off or the speed limit were raised to a given level in those areas. The creation of technology for the purpose could be made possible by the assistance of GPS, which is the same as the ISA used in the Lund experiment.

3.6. Acceptability of MASCOS

The attitudes of people are the most important factor in deciding whether the new traffic system could be realized. Taniguchi (1998c) surveyed ordinary peoples' attitudes toward traffic speed and some kinds of speed-limiting traffic systems. The result showed that 79.0% of drivers are trying to obey the speed limit. In spite of such an attitude, 44.2%

have exceeded the limit unconsciously. With regard to speed limiting traffic systems, 56.7% answered in the affirmative and 32.2% in the negative regarding the desirability of the MASCOS. 48.3% answered in the affirmative and 34.3% in the negative to the idea of implementing a mandatory limiting system on each stretch of roads, and 20.0% in the affirmative, 66.8% in the negative to the idea of implementing a non-obligatory manual system. The high percentage of negative attitudes to a non-obligatory system was attributable to the fact that they thought it wouldn't have any effect. The affirmative ratio increased to 74.1%, and the negative reduced to 8.8% when additional information was added that MASCOS could save 2,000 people's lives every year. They are almost the same as the results of former studies (Taniguchi, 1994; Taniguchi, 1998b). It can be concluded from the attitudes that there is high possibility that such a kind of speed-limiting system could be realized. The persuading technique should focus on the ethical reasoning that a number of people could be saved by the system.

4. DIFFERENCES BETWEEN MASCOS IN JAPAN AND ISA IN LUND, SWEDEN

4.1. Differences in traffic environments and accidents in Japan and Sweden

There are some differences of traffic environment in Sweden and Japan. The main reason for the difference could be found in difference of traffic density. The population of Sweden is 8,854,000, the number of vehicles in use is 4,145,000 (one for 2.14 persons) and of driving license holders is 5,489,000 (62.0%) as of the end of 1998. The number of people killed in traffic accidents in 1998 was 540, 6.1 per 100,000 (Swedish National Road Administration, 1999). On the other hand, the Japanese population was 125,864,000 (October, 1996), the number of vehicles registered was 86,550,000 (one for 1.45 persons), driving license holders were 69,870,000 in number (55.5% of the population) as of the end of 1996. The number of people injured in traffic accidents was 942,203 and those dying within 24 hours after an accident was 9,942, although about 13,000 people would have been killed finally (Management and Coordination Agency of Japan, 1997). Therefore, the calculated death rate per capita could range from 7.90 to around 10.3. The largest difference between the two countries as a factor influencing traffic environment is the population density. The area of Sweden is about 19% larger than that of Japan. The population density of Japan is 16.9 times as large as that of Sweden comparing simple ratios of total size of the countries and populations. However, it should be much smaller if it is calculated excluding areas in which people don't live.

As shown above, the most basic difference between the two countries is density of population and traffic. The general impression one has of the traffic environment in Sweden after actual driving is that there are only a few cars, no terrible traffic jams, wide and straight roads, and distinct borders between rural and urban areas. The Japanese traffic environment is the opposite. With regards to speeds, rural roads in Sweden are almost like expressways, with their speed limits being the same as those in Japan; apparently it is natural for people to travel at such high speeds. The ratio of the number of people killed to the number of injured is 2.56% in Sweden and 1.04% to 1.36% in Japan. On the other hand, the portion of people killed inside a vehicle is higher in Sweden (64.8%) than in Japan (43.1%). This could imply that there are more accidents at high speeds in Sweden, for there seem to be no other causes than speed to cause drivers or passengers inside cars to die. It also could be supposed that the standards for evaluating injury accidents are equal for both Japan and Sweden. However it cannot be confirmed, for the statistics regarding estimated speeds just before accidents are not available.

4.2. Differences between MASCOS and Lund ISA

The field experiment of ISA in Lund uses GPS and a digital map which includes maximum speed data for each stretch of roads. Every maximum speed of the experiment area is regulated depending the legislated speed limits. On the other hand, MASCOS intends basically to set the limits uniformly on ordinary roads. Limitation on expressways could be viewed more flexibly than that on the ordinary ones. Thus the speed gap between the maximum speed performance of a car and the legal limits is left in the hands of drivers. Drivers are responsible for adjusting their speed within the range of the gap. The Lund ISA is no doubt an ideal speed regulation system. However, given the huge network of roads in Japan, MASCOS is more practicable in Japan the system in Lund as the first step in a speed control system. The aim of MASCOS as the first step toward an absolutely perfect speed control is to eliminate the possibility of accidents at extremely high speeds on ordinary roads. Excessive speeds on the narrow, winding, and congested roads of Japan produce far more risky situations than in Sweden. Reduction of the number of accidents at low speeds is not a concern of the system. The cause of those accidents might originate in other factors such as failure to pay attention or judgement errors.

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