

Urban mass transportation in India

by

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INTRODUCTION

The urban transportation problem though often taken to be relatively new and associated with an increasing demand for mobility is both global and historic. The City of Man is becoming more and more immobile and this is common to the various world urban centres. The present metropolitan immobility is the result of perpetual imbalance between the transportation demand and the available transport capacity. To an Engineer or an Architect, the City of Man no more represents houses and buildings as one thought decades ago. It is much more than that. Neither an Engineer nor an Architect can produce city structures unless proper infra-structure is provided for mobility of the citizens.

The function of any urban system is to provide for movement of men and materials. A passenger movement ranges from a pedestrian movement to the mass of commuters daily entering and leaving the various activity centres. It includes automobiles, omnibuses, rail roads. It comprises many travel routes for a variety of purposes, viz. work, education, shopping, pleasure, etc. The combination of these demands for transport and the transportation units to serve them compound the equation for the system. It embraces walk-ways, services, streets, major streets, highways, freeways, railways, etc. The total urban transportation system has a variety of functions to serve. The urban environment largely depends on this transportation system so as to be attractive to the society.

Every one of us has a different picture of the city. This is because every urban centre not only in India but in the world is facing a crisis because of growing imbalances between demands and available capacities for almost all the amenities. Man is failing miserably in cities because of too many students for schools, too much sludge for sewers, too many sick for the hospitals, too much crime for the police, too many fumes for the atmosphere to bear, too many chemicals for the water to carry, too many cars for the highways, too many commuters for the transport system, etc.

The city populations are exploding. Some people think that this can be avoided by planned dispersal and effective constraints on migration. It is, however, very doubtful indeed whether city populations can be effectively controlled and planned, particularly in a developing economy where cities become nerve-centres of industrial activities and this would be the picture obtainable in India for some decades to come. The only solution, therefore, available to India and every other country placed in similar economic conditions would lie in using technology to create human conditions within an inhuman frame. The populations in these cities would continue to grow in geometric progression and this growth can be faced by connecting cities into a continu-

ous network. Within a city itself, there must be a powerful transport network to connect the various parts so that urban mobility is adequately ensured. Advancement of every phase of civic life is not possible without efficient arteries for transportation of the people.

It is in this context that I propose to present this paper to this August Conference detailing the present Indian scene in the urban mass transportation sector.

URBANISATION

The population in India as in other countries is steadily becoming urban intensive. Cities with a population of over 100,000 (one hundred thousand) each are growing in number, area and population decade after decade. Trends in rural and urban population as shown in the table below denote the increasing urbanisation of the country:

Table 1 – Indices of Population Growth

Population	1911	1921	1931	1941	1951	1961	1971
Urban Population	100	108	129	170	241	304	421
Rural Population	871	860	946	1058	1151	1388	1692

The cities in India are thus in the process of a rapid growth. The two thickly populated cities viz. Bombay and Calcutta have approached a level of development as regards amenities comparable to many developed European towns. Apart from the state of urbanisation, mass transportation problems in some of the major Indian cities are becoming as acute as in other parts of the world. The four jumbo cities as they are called, namely Bombay, Calcutta, Delhi and Madras, have reached a stage when expansion and modernisation of the public transport system need preference over other important municipal investments. With the rate at which urbanisation is growing in the country, the urban transportation system is becoming more complex than ever before. Mere addition to the road kilometrage, number of omnibuses and capacity of suburban railways will not offer any lasting solution as expanding population together with the rising incomes is paralysing existing transportation facilities in every urban centre. At the same time, the financial constraints put limitations on ambitious projects like an under-ground railway. It is in this context that we in India have to think of solutions to relieve traffic congestion in urban centres.

SURFACE TRAFFIC

Because of changing urban growth pattern, urban motor vehicle travel has risen sharply for the last three decades in India. The number of automobiles is increasing quite fast and as is usually the case, a large portion of these vehicles is concentrated in urban areas. The present number of motor vehicles on the road would be around two million as compared to 0.2 million in 1947. Bombay is the commercial capital of the country and a study of the growth of different types of motor vehicles in this city would give a fair idea of what is happening in major cities in the country. Table 2 below indicates the magnitude of growth of different types of motor vehicles in Greater Bombay.

Table 2

Types of Vehicles	YEAR				
	1951	1956	1961	1966	1971
1 Motor Cycle & Rickshaws	2188	2352	5341	8977	24799
2 Motor Cars	19701	25800	36899	46119	82586
3 Taxi Cabs	1495	3390	5150	7543	15924
4 Stage Carriages	409	672	1067	1310	1569
5 Heavy Vehicles	6870	7363	11653	17335	24013
6 Ambulances, School buses & Service Vehicles	107	114	413	589	970
7 Trailers & Tractors	—	—	770	1026	1290
8 Others	111	519	88	109	328

The above figures reveal that during the two decades from 1951 to 1971, the total vehicles in Greater Bombay increased about 5 times, motor cycles about 12 times, motor cars nearly 4.5 times, taxi cabs about 10 times and heavy vehicles nearly 3.5 times. The growth during the five years 1966-71 is particularly significant.


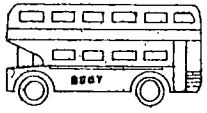
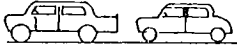


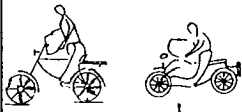
This tremendous increase in the number of motor vehicles in urban centres in India has seriously aggravated traffic conditions for daily movement of the citizens. In a city like Bombay, the present car ownership is about one car per 80 persons. The riding habit has reached a figure of approx. 365. Thus even if the occupation ratio for a car is taken to be 4, actually it is around 1.7. The transportation demand in respect of the other 76 trips has to be met through public transportation system. This demand becomes particularly important as the majority of the trips are required to be made to reach work-places in the morning and residences in the evening. A study recently carried out in Bombay indicates that about 80% of the total trips made are work-trips.

The system of suburban railways is one of the principal modes of transport only in Bombay. In the other cities, this mode has not developed yet to any appreciable degree to the extent that it can serve the line-haul component of the work-trip as is the case in Bombay. The percentage of trips made by bicycles and the bus system, therefore, would increase in these cities.

The picture that emerges is that for Indian conditions, people in urban centres move mainly for work, and therefore their mobility becomes of prime importance for economic development. Secondly, movement by omnibuses is, and would continue to be for some decades to come, the backbone of the overall transportation system. With constraints on finances, it would be difficult to develop even the surface railways, let alone costly systems like grade-separated metropolitan railways in cities where these facilities do not exist. Therefore, the study of urban mass transportation system in India centralises around the system of road transport by passenger buses.

The distribution of person trips by various mechanical modes on an average week day in Bombay is illustrated in the chart:

DISTRIBUTION OF PERSON TRIPS BY VARIOUS MECHANICAL MODES ON AN AVERAGE WEEK DAY
GREATER BOMBAY AREA - 1968

MODE	PERCENTAGE
 SUBURBAN RAILWAYS	39.0
 BEST BUSES	39.0
 CARS	10.6
 SCHOOL BUSES	1.5
 TAXIS	9.3
 BICYCLES MOTOR CYCLES & OTHERS	0.6
TOTAL No OF DAILY TRIPS = 4,721,611	100.0

PROBLEM OF MASS TRANSPORTATION

Having concluded that the majority of commuter trips are work trips, the mass transportation problem has to be mainly a peak hour problem. The major percentage of trips is for journey to work in the morning and these trips are naturally concentrated in a few hours on certain corridors. The trips are repeated on the same corridors in the evening but in the opposite direction. The hourly passenger carrying capacity, therefore, becomes the criterion to decide the configuration of the overall transportation system. For a given conveyance the passenger flow would have a limit which would depend on the maximum number of passages that can be made by transportation units and also on the carrying capacity of each unit. Considering the present urban street pattern in India, it has been observed that the auto system has an hourly passenger carrying capacity of around 3,500. In the case of buses, this figure reaches 12,000 to 15,000. In the case of railways, it is around 35,000 to 40,000. As far

as the bus system is concerned, there would then be two major considerations. One is the carrying capacity of the vehicle which would be governed by considerations of type of chassis, community preferences in service quality, climatic conditions, etc. The other consideration would be the speed of movement. Apart from the considerations of engine design etc. it is mainly governed by factors such as street congestion, traffic management, traffic engineering, etc. which are external as far as the operator is concerned.

The expression Mass Transportation indicates a system in which great volumes of passengers are on the move. In urban centres, it would be necessary to adopt large capacity modes of transportation, particularly along the corridors of heavy traffic demand. The choice of mode of transportation, however, must be made within reasonable practical and economical limits. It would not be economically feasible to introduce a high speed metropolitan railway on stretches where a bus every few minutes would easily perform the task. Nor would it be technically feasible to operate on a narrow street a bus service for which passenger volume requires an hourly carrying capacity of 40,000 to 50,000 passengers. It would therefore, be necessary to integrate several modes of transportation, namely buses, tramways, metropolitan railways, etc. in such a way that the total traffic demand is met efficiently and economically.

In India, considering the financial constraints for introduction of powerful modes like railways, surface or otherwise, the main part of the total strategy becomes the optimisation of the bus system by adopting various low capital cost traffic management measures and the solution to the problem depends on such issues and on an approach which would not result in undue strain on finances and at the same time ensure the required priority to the town and transportation planning.

APPROACH TO THE PROBLEM

Considering the availability of resources, it has now been accepted by the planners in India that the success of any transportation system depends on how closely its planning is co-ordinated with the land use. Transport is only a service industry, not an end in itself and must be co-ordinated with development in communications and with the land use planning to make the city life more pleasant.

Considering the low car ownership in India, it is certain that undue priority cannot be given to the car traffic. On the other hand, top priority has to be given to the needs of public transportation systems and this is probably the most important aspect of the overall urban transportation planning. The policy should be to move more people and less vehicles. It has now been understood in India that the entire transportation planning in cities must emerge from this basic requirement.

Another important aspect is the fact that movement of people in urban areas is being considered as a welfare activity by the community, as such fares for this movement are low and cannot meet the operational cost which keeps growing. In such considerations, every system has necessarily to be productivity conscious as far as the operator is concerned and has to be suitably subsidised as far as Government is concerned. The approach will therefore, have to be towards maximising operational efficiency, thus minimising operational costs. This approach will only enable the level of subsidy to be as low as possible.

As said earlier, the mass transportation problem being mainly a peak hour problem, the hourly carrying capacity of the various modes of transport becomes important. Every mode has certain limitations in this respect. In case of the bus system as said earlier, the modal capac-

ity cannot exceed approx. 15,000 passengers per hour. In growing urban centres like Bombay and Calcutta, unlimited addition of buses will not only fail to solve the problem, but will add to the already prevailing traffic chaos on roads. This fact has been well recognised, and the construction of an underground railway corridor is already at hand in Calcutta. In Bombay, two additional railway corridors have been planned. One of these corridors will be largely underground. The construction of these corridors however, is not in sight for want of funds.

It has, however, been recognised that judicious distribution of traffic among the several forms of transport is an important factor in the sound economic yield of the whole transport system. The various modes available have to complement each other and should not compete among themselves. Major cities like Bombay and Calcutta would have a mass transportation system built around the hard core of rapid rail transit, while in other cities a system will be built around a well organised bus transportation system.

KEY TO SUCCESS

It is thus clear that while in developed countries it is possible to build the overall transportation system around the most powerful mode like a metropolitan railway, in developing countries where the bus system would continue to play the main part for public transportation in urban areas, emphasis is necessary on low capital intensive measures to reduce transportation congestion and to improve mobility of the people. We have thus recognised in India that it is necessary to optimise the bus system by wide use of technological and management controls with a view to combating congestion in major travel corridors that lead to and from work places. The bus system is able to collect and discharge passengers in an adoptable, flexible way and yet can proceed to give rapid service for thousands of commuters in congested corridors leading to the central business district, if optimally operated. Bus transit in India has just begun to realize its potential and the future undoubtedly will see many more applications of this concept. Further improvements would be seen in the vehicles and travel ways. Vehicle improvements can be anticipated with respect to aesthetics, passenger comfort, performance and environmental effects, guidance and control features, etc.

It is certain that the key to making the urban population adequately mobile in developing countries like India, is by insisting on a more comprehensive approach to managing urban transportation. It is imperative to cope with increasing travel demands without major capital works as an immediate solution. Demand on available road space has inevitably become more fierce, and under these circumstances it must be recognised that unless special arrangements are made for buses, bus operations tend to suffer disproportionately with a consequent downward economical spiral. With this background in India, the low cost measures for optimising the urban bus transportation facilities become the need of the hour.

STRATEGY FOR BUS DEVELOPMENT

The carrying capacity can be maximised by operating the maximum number of seat-kilometers in the required time span. The operation of seats would depend on the number of seats which would be kept moving in a certain period. Such operation of seats would be governed by internal factors such as fleet utilisation obtainable, route planning, bus scheduling, staff scheduling, etc. The fleet utilisation in Bombay, 'the urbs prima in Indis', is as high as 93% and this is probably the highest in the world. Various cities have started thinking in terms of scientific

route planning, based on origin destination surveys. Bus scheduling, staff scheduling are also being maximised.

Delhi Bus System till recently severely suffered from a poor routing network developed over the years. The system consisted of a large number of low frequency services circulating through the city and was characterised by substandard operations, uncertain services, long waiting time and highly wasteful carrying capacities.

Additions of routes on piece-meal basis and on regional consideration had made the net-work destination oriented. After a proper study and with a view to rationalize the route plan a revised network of high frequency services converging into a central node from nine traffic focal points on the periphery of the central part of the city was launched in March 1974. A concept of direction oriented travel was thus introduced. This plan proved to be very successful.

The new pattern of operation drew international attention. The New Scientist of London observed: *"By introducing direction-oriented rather than destination-oriented travel, Delhi's buses became able to carry 40 per cent more passengers with only a marginal increase in fleet size. This software rather than hardware solution is a classic instance of the use of appropriate technology, relevant to London and other western cities"*.

The speed with which the vehicles can move, however, is largely governed by factors such as street congestion, road traffic management etc. The traffic management plays a key role in ensuring optimum utilisation of urban bus transportation. It should be the aim to optimise the speed of buses so that not only the operational costs are minimised but also the carrying capacity of the system is maximised. It has, therefore, been recognised in four jumbo cities in India that it is necessary to give priority to passenger buses on streets, particularly as resources would be limited in the immediate future for powerful modes like a metropolitan railway as the basic system. Against the background of increasing fares, bus priority measures can be identified as one of the first steps forward to a more enlightened transport policy in which

public transport operations not only survive economically but regain favour with the travelling public because of improved level of service.

IMPROVEMENT MEASURES

Improvement measures which would require minimum resources and implementation time, can be broadly divided into three inter-related fields:

- a. Economical Balance in the use of Transportation Systems.
- b. Modal Co-ordination and Management improvements;
- c. Relating Urban Form to Transport.

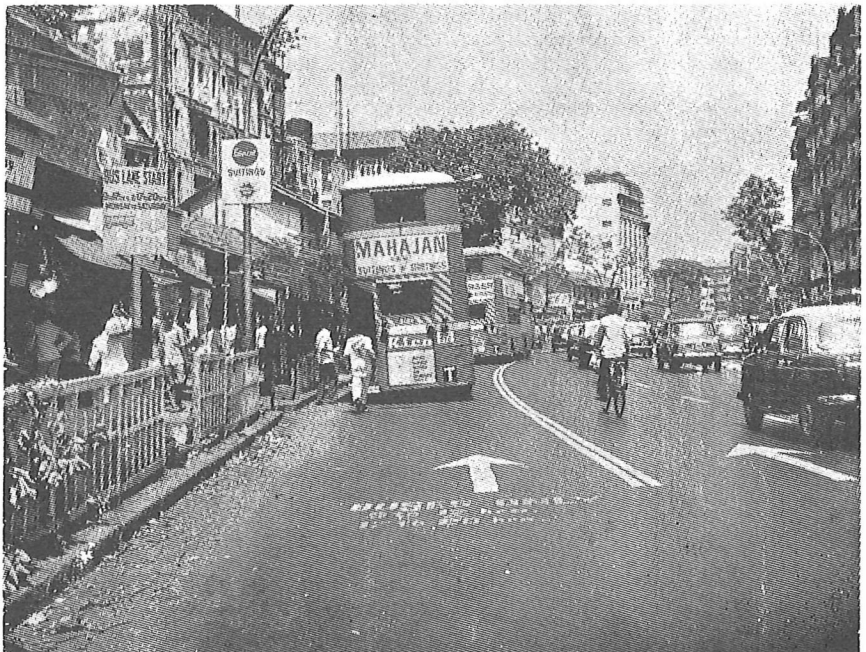
ECONOMICAL BALANCE IN THE USE OF TRANSPORTATION SYSTEMS

It has been accepted in India that extravagant use of road space by private cars means high cost of delay and inconvenience to the vast majority of the other road users like those moving in buses. A start has, therefore, been made to give priority on the streets to the mass transit system like buses in the urban centres. Automobiles are being dissuaded from entering into the C.B.D. during peak hours by the levying of parking charges, etc. A thought is also being given to charging for peak hour use of congested streets similar in principle to the higher charges made in some countries for peak period use of telephones.

It is necessary to prevent cars from going to the congested parts in an urban centre by providing a reliable bus service to the automobile owners as an alternative. In this context a thought is being given to run point-to-point service in Bombay by assuring seats to people at pre-determined hours so that they can reach their workplaces at the appointed time. Such service would also be available in the evenings for returning home.

Bus Priority Measures are generally classified into two categories:

- a. Geometric Preferential Measure;
- b. Real Time Control Measure.



Bus lane
(Photograph 1)

Geometric Preferential measures range from simple curb radii improvement at an inter-section to construction of exclusive right-of-way for buses. Exclusive bus road-ways on their own right-of-way with complete control on access would provide the higher type of service. A stage has, however, not come in India for providing bus road-ways on their own right-of-way, as they would be costly and slow to implement. Instead bus lanes (Photograph 1) have been provided in the normal direction of traffic with a view to giving priority to the bus traffic. In a recent experiment in Bombay, it has been found that the introduction of bus lanes has reduced the travel time on the stretch by about 15%, thus improving the carrying capacity of the system.

A wrong way or contraflow bus lanes (Photograph 2) using a portion of the roadways that serve relatively light traffic in the opposite direction has been tried on a large scale in Bombay. They have improved bus flow and at the same time have not reduced the peak directional highway capacity for the other traffic. One such exercise shows on a very congested road in Bombay that late arrivals at termini of buses operating on 11 routes enjoying contraflow facilities were reduced by 65%.

Schemes are also under way for providing a complete separation of cars and buses. Such bus streets not only improve the transit facilities but also create better environments for pedestrians, as it results in a traffic auto free zone. Provision for pedestrian precincts has to be encouraged in countries like India.

Co-ordination of road construction and traffic improvements of bus services will improve street efficiency. Street improvements and removal of bottle-necks will improve bus effectiveness. These improvements include street extensions to increase traffic capacity or bus route continuity, traffic signal improvement such as system co-ordination, inter-section improvements, turn-controls for special permits for buses, bus lay-byes for loading and unloading, longer curb radii, etc.

There are two forms of Bus Priority Real Time Control Measures. The first form deals with strategic measures of optimising the bus operations. These measures hinge on being able to know, within a reasonable degree of accuracy, the location of vehicles within a fleet identification of each vehicle and the status of each vehicle. The second form of Real Time Bus Priority Control Measure deals with technical measures by improving bus

operations and are primarily concerned with changing the timings of specific signals to favour bus movements. Certain measures in the first form are adopted in Indian cities with radio communication. In the second form, automatic signals have been introduced but without bus priority measures. More sophisticated equipment as is available in developed countries is not yet available. It has been recognised however, that both classes of priority measures will have to be integrated with a view to obtaining optimum results in the total traffic management system.

MODAL CO-ORDINATION MANAGEMENT IMPROVEMENTS AND RELATING URBAN FORM TO TRANSPORT

The Modal Co-ordination and Management improvements can be attained through a Central high power authority. With such an authority, it should be possible to develop an integrated overall transport system for urban populations. It has also been realised that the land use plan must be so worked out that self sufficient neighbourhoods are established. The land use should be so planned that the trips generated are within the carrying capacity of the overall transportation system. The transport planning must thus be an integral phase of general planning. Equally, it must be comprehensive and encompass all types and modes of transportation, present and future. Transport also is the most powerful tool in city planning, provided transportation is regarded as a total system and as a vital part of the city infrastructure. Transportation must be compounded of different modes serving the many varied purposes it does in an overall metropolitan transport organisation. In this context, Development Authorities have been introduced in the urban centres with a view to co-ordinating the activities of the various agencies like the State Government, Municipal Corporations, State Road Transport Corporations, etc. In Bombay, the State Government has set up the Bombay Metropolitan Region Development Authority for integrating the entire development in the metropolitan area and the transportation would form one of the important functions of this Authority. Such authorities either have been constituted or are being contemplated in other metropolitan cities also.

It should now be possible to carry out an integrated programme for future traffic and transportation projects



Contra flow bus lane (Photograph 2)

and optimisation of the existing ones so as to achieve the maximum benefits at minimum cost for the largest numbers.

VEHICLE CARRYING CAPACITY

Another important factor for improving the carrying capacity of the bus system is the carrying capacity of the vehicle itself. This is particularly important now as the speeds are fast dropping down on account of street congestion. Various measures have been adopted in India for improving the carrying capacity of a vehicle. Some of these measures are (a) use of double-deck buses, (b) use of predominantly 'standee' buses, (c) extension of rear overhang from 50% to 60%, (d) extension in the front so that the entrance is ahead of the front axle and (e) use of road trains.

The use of double-deck buses is not common but in thickly populated areas and in congested areas as the speeds are low, it would be preferable to have vehicles of maximum carrying capacity and in this context, double-deck buses are preferred. During non-peak hours, double-deck buses may become uneconomical because of lower load factor. However, for peak traffic hours these buses are most useful. It is thus clear that what is required in countries like India is the composite fleet comprising of both single and double-deck buses. Normally, double-deckers are about 40% of the total fleet. As far as use of predominantly 'standee' buses is concerned, such vehicles are in operation in some cities but the society is not quite prepared to accept this measure freely as it adversely affects the comfort of commuters and particularly so in a country with a tropical climate. It also increases the workload of conductors considerably. Any such measure is to be accompanied by a suitable system of centralised bus fare collection or by introduction of season tickets. The extension of rear overhang from 50% of the wheel base, which was the case till recently, to 60% is quite common. So also the front extension.

In some cities a bus carrying another bus as a trailer forming a road train is also used on straight and wide roads. The use of such road trains is of course very restricted because of difficulties in manoeuvrability.

DIESEL CONSERVATION

Before I conclude, a special mention has to be made in respect of counter measures that have been taken in response to the increasingly critical need to conserve energy and curtail pollution. Besides, there is an urgent need to economise on its consumption as it amounts to 13% to 15% of the total cost in urban transport. Over 6 million tons of HSD oil is consumed every year in India. This constitutes nearly 30% of India's total consumption of petroleum products. The bulk of it is consumed in the road transport sector.

Studies have been carried in as many as nine State Transport Undertakings in respect to conservation of diesel oil. These studies have established that percentage diesel saving ranging from 10% to 18% can be obtained by simple short and medium term measures like:

- a. stricter control over fuel handling-avoiding spillage, leakage, pilferage, etc.,
- b. proper mechanical maintenance of vehicles.
- c. periodic maintenance of fuel injection equipment, proper calibration and derating of fuel injection pumps, checking of nozzle spray patterns, etc.,
- d. frequent checks for brake drag and tire pressures;
- e. good driving habits like control over maximum speeds, avoiding needless idling, etc.

There is another dimension to this problem that along with simple measures as listed above, effective system of implementation is also required to be devised.

CONCLUSION

I have, in the short time available to me, put before you important aspects of the Indian scene in the field of Urban Mass Transportation. Not only the urban centres are growing in number in India but the urban population in all these centres is exploding. This increase in population in the geometric progression is resulting in continuous increase in traffic demand. There is also constant clamour from the citizens to provide better amenities and travel conditions. The Urban Mass Transportation problem is thus becoming more and more complex in nature. With limited resources, it is becoming difficult for transport planners to satisfy the increasing demand and provide better amenities. I have, therefore, suggested a specific approach to this problem and discussed the various low cost measures to optimise the mass transportation modes, particularly the bus system. Proper discipline and effective co-ordination between various modes will, I am sure, achieve the results.

In the process of tackling the urban mass transportation problems, we in India have developed expertise in various disciplines in this field and this expertise could be made available to other countries facing similar problems. As far as my paper is concerned, I would be too pleased to answer your queries and clarify any point.

I consider it to be a great privilege to have had this opportunity to address this World Conference and I convey to the fellow participants my most sincere thanks for the patient hearing.

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