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In many countries the automobile has provided benefits that have boosted the quality of life: better health because of quicker access to medical care, more highly skilled workers because of better access to education, a greater choice of jobs because more are in reach of the average worker, better prices from regional retailers because more customers can go elsewhere, and more recreational opportunities because distant vacation venues are more accessible. In short, the automobile has increased equality through greater choice and liberty through the freedom of movement (NRC, 1999).

Yet the automobile also has had negative effects on quality of life, many of them environmental (NRC, 1997; Forman et al., 2002). By the 1950s the air pollution created by motor vehicle exhausts and by the refining of fuel for those vehicles had poisoned the air in some cities to such an extent that it was shortening life expectancy. In the United States a significant proportion of water pollution can be traced to motor fuels and the oils and salts that wash off roadways. The disposal of old automobiles also is a source of environmental problems. In some places millions of old tires fill entire valleys, and the disposal and reprocessing of used motor oil are a serious environmental problem.

Over the last 30–40 years some industrialized countries have made enormous progress in balancing environmental concerns with automobile usage. Air quality has improved through technology such as advanced engines, modified fuels, and catalytic converters. Highway agencies are required to collect the polluted runoff water from highways for treatment before letting it flow into rivers. New automobiles are designed so that many of their components can be recycled at the end of their useful lives.

Among the most critical aspects of transportation planning in the past have been those related to equity issues. Although technological improvements and capital investments in transportation have improved social welfare in general, they also have often widened the gap between those who can afford automobiles and those who cannot. To the extent that modern land use patterns are highly affected by the automobile, the result is that car ownership has become necessary to take full advantage of the commercial and residential opportunities and of the services that modern societies can provide. In the United States, the disadvantaged are primarily the elderly, the young, and the poor, yet today less than 10 percent of American families lack cars. In China, however, large urban populations will not have cars for many years, and for a long period car owners and non–car owners will both be large parts of the population. In some

countries these populations live in separate communities, sometimes distinguishing urban and suburban areas.

This chapter explores how rapid motorization will affect the quality of life and livelihood of the Chinese people. In view of the complexity of the changing social and economic structure in China, it is clear that isolating the changes arising from motorization alone will be very difficult. Some 10 years of a 15 percent a year rise in motorization in general and a more rapid increase in the number of automobiles have had a very large impact on China. Urban congestion, air pollution, changes in urban transport modal shares, massive construction of transportation facilities, and decentralization of residence and employment are the principal consequences (Midgley, 1994).

The earliest and greatest effects of motorization will appear in the cities. For one thing, most of the new vehicles will appear in urban areas because urban incomes are higher than those elsewhere in China and because they will no doubt continue rising the fastest. Furthermore, the cities have an especially delicate ecology of space use—very high residential densities and a low proportion of space dedicated to streets (around 10 percent)—designed as they were by planners who, before the late 1980s, had no reason to believe there was any need to provide for significant numbers of private motor vehicles. As a result, Chinese cities are subject to great dynamic forces as people struggle to travel in increasingly congested conditions while they seek opportunities at the urban periphery made accessible by increased car ownership.

Because these issues will arise within the context of a rapidly changing urban structure, any examination of the effects of motorization requires a careful look at the process of change itself.

1、Effects of the Motorization Process

Motorization is likely to have severe interim effects before the automobile reaches an accommodation with its surroundings. For example, residences typically shift to the suburbs more rapidly than employment, creating an interim period during which employees have long, congested radial trips to work. The current level of motorization is less important than its rate of increase, because it is the rapid increase of motorization that leaves the urban structure, the infrastructure network, and the access system out of sync with one another. For example, today developed countries with over 900 vehicles per 1,000 persons have reached a limited kind of equilibrium with the automobile (at least for congestion in most localities), yet that transition in the United States took more than 60 years, with some changes still under way. By contrast, developing countries with only a tenth of that level of motorization are tending to experience greater problems than the developed countries because of the rapid shift to motorization.

The growth rate of motor vehicles in Chinese cities has mirrored China’s rate of economic growth, and with the accelerated economic growth of the early 1990s, the growth rate of

motorization became more rapid. In the city of Nanjing, for example, between 1985 and 1990 the total number of motor vehicles increased by around 50,000, whereas between 1995 and 2000 the number increased by around 130,000, reflecting the city's economic growth. In the city of Shanghai the growth rate of automobiles was slow until the 1980s; the average annual increment was 13,000. But during the 1990s the growth rate more than doubled, with annual increments of between 30,000 and 50,000. In Wuhan the number of vehicles increased 7 percent from 1998 to 1999, but from 2000 to 2001 it increased 27 percent. Even though annual changes can stem from many factors, China clearly has entered the phase of rapid motor vehicle growth. And with it, problems of urban transport have increased rather than diminished.

Another problem is that of equity among China's regions. The industrial cities of eastern China have wealthier corporations and more people who can afford cars than the western provinces. Motorization will benefit the wealthier families of the eastern cities, modernizing their lifestyle, notwithstanding the additional congestion and air quality problems caused by the larger vehicle fleet. As a result, the difference in quality of life between the industrialized east and the rest of the country will be magnified, exacerbating the regional imbalance that has been a persistent problem for China (and for many other countries).

2、The Spatial Decentralization due to the Private Car

No issue is more central to motorization than the shift of people and industry from urban centers to outlying areas--that is, spatial decentralization. As one of the most visible consequences of motorization in the medium term, it will change the appearance of the cities and the lives of their inhabitants. Moreover, it will affect nearly every other measure of the social consequences of motorization such as fuel consumption, air pollution, land absorption, viability of alternative modes of transportation, and congestion.

Municipal governments have taken some deliberate actions to reduce the density of the cities in order to reduce congestion and to adapt contemporary lifestyles and associated technologies. To some extent these actions will mitigate some of the congestion in the short term. In the immediate future, the problem will be to accommodate the car in areas of the city not developed with cars in mind.

The view of many Chinese authorities that population densities in large Chinese cities should decline has merit. But the added factor of rapid motorization is likely to accelerate the decentralization of jobs and residences beyond planned levels and should be a cause for concern. For example, such decentralization could jeopardize the feasibility of public transport (which cannot serve low-density areas effectively). Expanded road networks could increase congestion at key intown links, which would be hard to correct without a high cost and severe disruption. Decentralization also would tend to divide the population into high-income (car-owning) and low-income (carless) localities, threatening the Chinese tradition of socially

integrated communities (locating according to work group membership). And because decentralization means people will drive farther, emissions of pollutants and greenhouse gases will rise and more fuel will be consumed.

Another concern arising from decentralization is the fate of China's agricultural land. By world standards, China's amount of agricultural land per capita is very low—0.1 hectares (ha) per inhabitant—and the average rural population density is a high 6.85 persons per hectare or 685 persons per square kilometer (World Bank, 2001). The rapid growth of the cities will absorb large amounts of agricultural land, because most cities are located, for historical reasons, in rich agricultural areas. For example, the rapidly motorizing cities of Shanghai, Nanjing, and Wuhan are located in the rich Yangtze Valley. Authorities in Guangdong Province have expressed concern about the absorption of agricultural land by urbanization in the Pearl River Delta.

The green movement in Europe and those who resist the increasing use of cars in the United States often appear to assume that the automobile is the only cause of spatial decentralization. Yet other forces work toward decentralization in every country, including China. After World War II, for example, explosive decentralization in the United States was driven by the easily available home mortgages on newly constructed suburban houses. Urban policies intended to limit development often focus exclusively on resisting vehicle use or road investments, but other matters should receive attention.

Government action drives decentralization in many ways. For example, new urban highways and public transport systems reaching toward the outer fringe help to open new peripheral areas to settlement. The Chinese government recently set national development standards that require more parking space, wider streets, and increased per capita living floor space. The new government guideline, enacted through the Construction Department, calls for an average density of 80–100 square meters (m^2)—that is, 12,500–10,000 persons per square kilometer (km)—including all land uses averaged over the entire metropolitan area(Construction Department of China, 2001). The larger cities are to aim at the less dense figure. This goal is to be reached gradually while new development at the urban periphery is designated for higher densities and the continued reconstruction of central cities reduces densities in the core. This would have the effect of driving development toward the larger land parcels available in the urban periphery. Furthermore, Chinese home construction, which is no longer the exclusive responsibility of the state-owned enterprises, is increasingly being carried out by developers, who are likely to seek economies of scale by building larger housing projects. They tend to build at the periphery of cities where larger land parcels are available, prices are lower, and land acquisition and consolidation are easier. Developers also seek large parcels because the government encourages them to provide municipal services. That factor further drives settlements to the outer edge of urban areas (Ping and Murie, 1999).

Previously, when land was assigned to state-owned enterprises the value of the land did not vary with distance from the city center. No money was transferred when the land was assigned, and the distance from the enterprise's own prior workplaces and service facilities primarily determined its value to the work group. Since 1987 municipalities have been allowed to lease land and to assign monetary values to the land parcels as a basis for levying charges. The land value is determined, in part, by the distance from the center of the city, thereby encouraging parcel seekers to choose peripheral locations for the lowest prices. This system of designating land value has been important in redirecting urban development toward the periphery. Meanwhile, many of the state-owned enterprises are finding that the land they occupy in the city center has greatly increased in value, but at no benefit to their operations. They are therefore inclined to redevelop this land into central business district uses and move their own operations to the periphery. The outcome, then, is that the redevelopment prompts the sponsoring enterprise to leave the city, as well as the worker population that resided at the former site of the enterprise (Rodrigue, 1994).

Perhaps reflecting an international trend, new industrial plants, universities, and other large establishments in China now tend to locate in very large, campus-like settings, where the buildings themselves occupy very little of the land. Such a trend is another force behind decentralization, because such large parcels are found only at the peripheries of cities. Transnational companies attracted by China's accession to the World Trade Organization (WTO) will no doubt adopt and accelerate this trend. Many of the new industrial plants in the Pearl River Delta are dramatic examples of this movement.

When municipalities purchase rural land and redesignate it as "urban," they are able to sell it to developers for much more than its cost. The municipalities therefore have an inducement to annex land in large quantities in order to raise revenue. Indeed, when land is leased long-term to developers, taxes (infrastructure fees) are charged for the entire length of the lease. Thus the municipality gains no further revenue from the land during the length of the lease, even though the value of the parcel may rise greatly over time. As a result, municipalities are motivated to continue converting rural land to urban in order to have continued land-based revenue.

At the same time, municipal planning offices are actively fostering concentrated dispersion. Fourteen "growth centers" (existing expandable small settlements) are being planned for Beijing, and 11 new towns and 20 external growth centers are planned for Shanghai. These centers, to be situated well beyond the urban periphery, are often designed for very low densities. Commercial buildings and apartments will be placed on large parcels, and the centers will include large central parks and wide, multi-lane local streets.

Trends in the city of Guangzhou are representative of this process. Figure 6.1 shows the difference between land development initiatives before and after the land market reform of 1987. Note how the reform has concentrated new development in both the city center and peripheral

concentrations 21 and 29 km from the center where the government has encouraged growth (Wu and Yeh, 1999).

Another incipient, powerful force behind decentralization is the popularity of portable modes of electronic communication. It permits people to substitute electronic connections and phone calls for trips. Currently in China, there are about 7 conventional telephones for every 100 people (29 per 100 in Shanghai) and long-distance calls are very expensive (World Bank, 2001). As a result, this traditional mode of communication has contributed little to decentralization. Since the 1990s, however, many communications technologies have become available at once, such as the cell phone, general Internet use, and various forms of electronic access (e.g., corporate databases). It is important to note that Chinese culture is showing great flexibility in adapting to the change, unlike countries in the West, where these communications technologies had to tug on long-standing economic organizations with their well-defended vested interests.

While there is no doubt that these forces will produce more livable environments, access to less expensive land and better housing for those able to enjoy them, they also produce a strong momentum toward decentralization. Although motorization is not the only cause of urban decentralization, transportation policy must serve as a very powerful lever to guide urban development into the motor age in a rational manner. Productive decentralization requires careful orchestration of the forces driving it.

Because of all the forces cited, Chinese cities are expanding very rapidly, yet a close look at various world cities with different urban development policies and different densities suggests that the cities of China have choices in this matter. Currently, Shanghai's density is 16,378 persons per square kilometer. But across the world urban densities vary greatly. What explains the differences? Of the many factors, the most important, aside from geography, are income/motorization, regulation of land development, and transportation policy.

Some cities have been influenced by special factors and so are of little interest here. Hong Kong, for example, possibly the world's densest major city at 28,405 persons per square kilometer, was once an isolated colony without room to expand geographically. With its high incomes, expensive high buildings were feasible for apartments, and cars were extremely expensive and stringently regulated.

Seoul, at 23,908 persons per square kilometer, is nearly as dense as Hong Kong. South Korea is one of the higher-income Asian countries, with a history of highly planned economic development during which motorization was firmly discouraged by very high auto purchase and use prices. Seoul still has very stringent land use regulations, including provisions that protect a green belt that contains metropolitan development and retains urban densities

Jakarta, at 17,056 persons per square kilometer, and Bangkok, at 14,955, have roughly the same density as Shanghai, but their densities result from the ongoing operation of urban land markets, whereas Shanghai's results from a half-century of centralized planning. Although both

Bangkok and Jakarta have large numbers of low-income people living at high densities, neither has imposed significant controls over urban expansion or motorization, nor experienced the sudden, rapid changes in political economy that are partly responsible for Chinese decentralization.

Kuala Lumpur, at 5,693 persons per square kilometer, stands in stark contrast to the cities just described. It is characterized by very rapid economic development, a very high level of motorization, and no effort to contain urban development densities. In fact multiple forces encourage very rapid decentralization, especially the government's tendency to give very large land grants to institutions. At the same time, traffic congestion in the city center is intense. If economic development continues apace and if strong preferences for decentralization-forcing policies are sustained, the prospective densities for Chinese cities will approximate those of Kuala Lumpur.

Tokyo (at 7,099 persons per square kilometer) is a high-income city with an array of strong urban development containment policies. Holding development to this density as Japanese income levels rise requires, and receives, strong public support. Auto ownership in Tokyo is very expensive by world standards, and so within the city a very high percentage of trips are made by public transit.

New York and Chicago, at 2,086 and 1,653 persons per square kilometer, respectively, are friendlier to motorization and decentralization. Auto ownership is about twice as high as in Tokyo, residential densities are low, and the costs of gasoline and the other aspects of car ownership and use are much lower in both New York and Chicago. Land zoning is applied to avoid incompatible land uses, but it is generally not used to maintain a density of development. If anything, it is used to keep densities below specified maxima in fundamentally low density environments.

Although these brief sketches leave out a great deal that would further explain urban density, they do show the most basic conditions and options for different urban structures. The Chinese city is at the beginning of a new era. It has the strength of governance that would enable it to make telling choices.

During the 1990s many citizens of Shanghai with medium and low incomes moved to the peripheral areas because of the demolition of houses by municipal engineering projects. When the new residential quarters were built, public transport lines were not yet in operation. As a result, low-priced mopeds became the transport of choice, until recent years when restrictions were placed on ownership because of safety and air pollution considerations.

In view of the current income profiles of urban populations and the expectation that low-income people will continue to migrate from agricultural areas, it is expected that the nonmotorized urban population will continue to be large. The migrant "floating" population tends to be largely concentrated in informal settlements near suburban work opportunities rather than in

city centers, which are too crowded to absorb them. These migrants will join the urban populations who presently rely on bicycles, public transportation, or their own feet for transportation to work.

Workers without cars who are faced with longer distances to work because of decentralization also will face longer transit trips, and the transit itself will be significantly slowed by the heavier auto congestion. New auto owners face congestion too, but they can choose less-congested, circuitous routes or different destinations. Buses, however, typically must use the main arteries, the most congested part of the network. Ironically, the greater the congestion, the greater the advantages of auto ownership. As a result, municipalities will find it more important to examine the possibilities of retaining bicycle transport where possible and providing housing and services in the localities of employment (Midgley, 1994).

3、Transit Oriented Transport Infrastructure Construction (The Case of Shanghai)

The evolving pattern of streets and highways in major Chinese cities has a hierarchy that is similar to that found in other countries. The narrow streets in the residential parts of older cities are interspersed with arterials that carry longer-distance traffic. Many cities have built limited-access urban expressways. The outer, newer parts of metropolitan areas are lower in density and devote more land to street systems. Although there are significant differences among Chinese cities, with Beijing perhaps the most endowed with ample central arteries, the general situation is similar. The arterials, and in many instances he urban expressways, are badly congested during much of the day. Nearly all streets that carry through traffic (rather than simply providing access to nearby property) are now congested and sure to become much more so with currently rapid motorization rates.

The Chinese government's Code for Urban Road Planning and Design is attempting to relieve this situations by enacting a guideline for cities that calls for "road coverage" of 8–15 percent (from the current 10–12 percent) for smaller cities, and 15–20 percent for cities with a population of over 2 million. These figures, intended as averages over an entire metropolitan area, would include the running lanes (at about 10 percent); parallel lanes for two-wheeled vehicles, parking, and pedestrians; and park areas (Technical Supervision Bureau and Construction Department of China, 1995).

During the 1990s Chinese cities, especially Shanghai, made forceful efforts to keep up with motorization rates. Over the decade, Shanghai increased its road length by 40 percent and its public transportation routes by 30 percent, and three subway lines were developed for a total of 65 km. At the same time, the number of motor vehicles increased two and a half times, to more than 700,000. The public transportation services and the traffic management program have improved dramatically. For example, the investment in the city's transportation systems

accounted for 2.6 percent of Shanghai's gross domestic product (GDP) in 1999, a very high rate by world standards. The investment program has emphasized public transport, especially subways, but it also has financed the development of roads, especially in the outer parts of the metropolitan area.

Despite these investments, many of the congestion problems expected from rapid motorization are already present. For example, the Inner Ring Road of Shanghai, completed in 1995, is already congested with traffic. Average vehicle speeds in Shanghai are about 15 kilometers per hour (kph) and rarely exceed 30 kph. Average transit service speeds are 10–16 kph. In 1995 the average travel time for an auto trip was 55 minutes, one of the highest average trip times among the world's cities.

As noted, Shanghai has attempted to keep up with the infrastructure requirements for urban transportation. From 1991 to 1996 the city spent approximately RMB83 billion ($10 billion) on projects that included two major bridges, a tunnel under the Huangpu River, an inner ring road, and the first line of its new subway system. In 2000 a new development plan took effect that calls for numerous improvements by 2020, including 200 km of rail, six elevated busways, and 650 km of divided highway in suburban areas (of which 520 km will be new highway), three new river crossing facilities, and water and air regional transport facilities.

At the same time Shanghai and other cities have adopted various traffic management strategies to control the rising congestion. These include stringent regulations on the time, day, and locality of the use of trucks. Various fees also have been imposed on cars, at purchase and on use. Moreover, the city has made forceful efforts to limit the use of two-wheeled motor vehicles, such as excluding those not registered in the jurisdiction and not accepting new registrations. Efforts to restrict the use of bicycles are aimed at avoiding the conflicts that occur among two- and four-wheeled vehicles in parallel lanes.

Chinese cities are caught between the desire to promote auto motorization and the problem of accommodating all the new cars. Agencies in Shanghai have even proposed ceilings on the number of cars permitted within the city (Shanghai Study Team, 2000). The City Transport Administration Bureau has called for a limit of 1–1.3 million cars until 2020. But even with such a limit, it would be a considerable challenge to provide the necessary infrastructure in the coming years. The experience of other countries demonstrates that, while the number of urban vehicles increases in proportion to income, urban road length does not. Road building in cities is expensive and politically sensitive because of difficulties encountered in acquiring land, relocating businesses and households, displacing utility pipes and wires, and dealing with the confined conditions of construction. Neighborhood interests also may resist construction—examples of such resistance are already evident in Chinese cities.

4、Motorization on Urban Car Based Traffic Management

In general, most rapidly motorizing Chinese cities can expect to experience the following conditions and actions, based on the experience of other cities in the motorizing world:

- The need to construct urban highways will continue, perhaps by concession to private firms and financed by tolls in many cases. In particular, congested links will be reconstructed to increase their capacity.
- Management of the parking stock is required. The investment in private parking spaces near city centers can be expected to occur when the value for parking becomes competitive with that for other uses. This construction will make congestion worse by encouraging arrivals. Employers will likely provide more parking for their employees, adding to the traffic pressure.
- A demand for the construction of public transit facilities will emerge, principally for people still without cars in an increasingly auto-oriented city. (Worldwide experience is that few trip makers will change from auto to transit in the short run.)
- Employers will increasingly provide private bus services for their employees, possibly prompting regulatory requirements because the services will compete with public transit.
- The demand for limitations on bicycle use will increase, especially in the city center, even though for the short trips within the congested city center bicycles are the most effective alternative. This problem is generating an intense debate between those attempting to facilitate traffic and those defending bicycles as effective and environmentally benign transport, especially for lower-income people.
- The demand for restrictions on the use of two-wheeled motor vehicles will increase, possibly ending in their termination in some cities.
- The use of trucks will have to be further restricted, tempered by the need to maintain efficiency of the economy.
- As the number of autos increases, calls will emerge for limitations on their use. So far, other modes of transportation have been controlled by direct traffic management, whereas autos have been controlled principally by pricing methods. Intensified congestion pricing of cars, such as time or area licensing, bridge and tunnel tolls, or parking charges, might be considered, but it is likely that cities will consider direct-use limitations unless there is intervention at the national level.

When the demand for travel increases rapidly, travel demand management takes on special importance. In China such management techniques have already been developed and applied to a high degree. They include regulating trucking (such as requiring night delivery),

limiting the number of days trucks can be used, and limiting areas of the city to trucks with specific uses. These techniques also include special lanes for two-wheeled vehicles, restriction of vehicles in some areas to those with local registration, lower parking fees for local vehicles, and various pricing strategies for the purchase and registration of cars. Especially stringent use of these technologies explains, for example, the slower growth of motorization in Shanghai than in other Chinese cities.

Chinese traffic planners could apply other high-yield options that have been used with effect elsewhere. For example, some cities have restricted the entry of traffic into downtown areas or other dense destination points by the use of special tolls or permits, complemented by parking facilities provided in quantity and price to limit downtown congestion. One of the first to employ this method was Singapore, where a licensing scheme succeeded in reducing auto entries into the downtown area by some 45 percent. Singapore has now gone on to citywide congestion pricing. Other cities that have enacted charges for entering the city center include Rome, Oslo, Bergen, and Amsterdam, and such charges also have been discussed seriously in London and in Tokyo (where seven separate districts are proposed for paid entry).

Still other cities have restricted entry into the city center physically by creating pedestrian ways through which motor vehicles cannot drive or cross. This technique, which compartmentalizes the traffic approaching the city center, is used in hundreds of European cities—among the best known are Munich and Göteborg—and in Seoul. In China, Shanghai and Beijing have pedestrian ways that are clearly popular with shoppers and strollers. Also in many cities in the developing world, even in the absence of regulations the entry of vehicles into central streets is effectively forbidden by the volumes of pedestrian traffic they carry.

The use of advanced electronics for driver advisory functions and incident detection in an intelligent transportation system (ITS) is a potentially important way of increasing road capacity. These techniques include electronic toll collection and real-time electronic or radio reports on traffic conditions and parking availability that help drivers to select travel times and routes to avoid congestion. Systems that provide information on obstructive incidents (accidents and breakdowns) could be helpful; up to one-half of travel delays stem from these events in the United States. Panels that direct drivers to the available parking spaces reduce cruising in search of parking. And computerized programs that guide drivers to their destinations cut back on congestion by reducing the number of cars that get lost in the streets or take overly long routes. It is hoped that knowledge of traffic conditions through online reports will encourage drivers to avoid peak hours, or switch to fast transit on independent rights of way to shorten their travel times.

Car sharing is rising in importance in various parts of the world (Gakenheimer and DeLisi, 2000). Various car-sharing companies provide economical, short-term auto rentals to members of the system from numerous small stations located throughout a city. It might be useful in China as a means of enabling families to secure a car for occasional use without owning (or having to park)

one. In Chinese cities, where there are other modes of transport more suited to various kinds of trips, such an arrangement would enable trip makers to save money and avoid some of the difficulties of car ownership. Car sharing is growing rapidly in Europe, where the leading company, which is in Switzerland, has 600 rental locations and 20,000 members. Successful systems also can be found in France and Germany, and car sharing is growing in popularity in Britain, Italy, and the United States.

Another innovation that has been growing very rapidly in acceptance is high-capacity bus transport. Buses operate on dedicated rights of way, with small stations where passengers pay the fare before entering the bus. The progress of each bus is assisted by sensors that change the signal lights to favor the bus as it approaches. The buses (or trolley-buses) have a large capacity (up to 210 passengers) and large doors that facilitate rapid entry and exit. Originally developed in the southern Brazilian city of Curitiba, this system has been installed in Quito (Ecuador), Bogota (Colombia), and Dublin (Ireland), and is being readied for operation in many other cities. In China, the system is currently undergoing trials for a short-distance test line at Kunming (Tiwari, 2002). In New Delhi, city authorities have decided to undertake a 20 km test line. Although subways have a larger capacity and the advantage of not removing a lane at the surface, subway construction in Chinese cities may well be limited by the very high cost. High-capacity bus transit costs about $5 million (RMB42 million) per kilometer, rather than the $100 million (RMB830 million) per kilometer cost of rapid rail transit. Moreover, it appears to have a maximum capacity of about 45,000 passengers per direction per hour, whereas metro has a capacity of about 65,000 passengers per direction per hour and leaves the surface lanes free.

Finally, those planning expansion of public transport in China may wish to consider various advanced electronic means of improving the efficiency of public transit. These include the use of smart cards for fare payment and the adoption of other routing and scheduling tasks. In Japan electronic platooning of vehicles is being undertaken, enabling buses to travel in train-like groups.

The accident fatality rate (per vehicle) in China is about 30 times higher than that in the United States. The rate may appear high for a generally well-disciplined society, but it is consistent with that of other countries with similar income levels, as reported in Chapter 2. It may be the result of the complex and changing mix of vehicles in the streets, the congestion that limits access of emergency vehicles, and the growing number of new, inexperienced drivers and pedestrians facing heavy vehicular traffic for the first time. Instruction for children in schools that enables them to cope with traffic as pedestrians and driver education in higher grades would be an important help.

Recent reports on traffic accidents in China reveal that from 1990 to 1999 the number of accidents, the number of people injured, and the direct economic loss from accidents doubled

and the number of people killed increased by 70 percent. But during that period the number of motor vehicles in China more than quadrupled, which means that the numbers per vehicle declined by half or more. These trends suggest that accident rates will decline on a per-vehicle basis as motorization becomes a more familiar part of the Chinese scene. Nevertheless, accidents are numerous, and as motorization grows the overall personal risk of accidents increases.

5、The Social Impacts of Rapid Motorization and Requirements for Transit System

Forecasts of adjustments in social behavior resulting from motorization are necessarily very speculative. Many are cultural changes observed in cities of other nations that have been through the motorization process. Each culture, being unique, does not go through exactly the same process of adjustment as others, yet the response has been so similar in cultures so different from one another that a closer look at cultural changes produced by motorization is worthwhile.

It is likely that among families above a certain threshold of income the availability and use of a car will become habitual. As a result, more young people will have access to a family car that they can learn to drive. The long and expensive requirements for learning to drive will ease, and the current dominance of men among driver's permit holders will give way to more equal participation by men and women.

Many of the changes in behavior will appear in the young drivers of the second motorized generation who were able to practice driving their parents' cars. It is not likely that a family headed by parents in their late fifties who get a new car will change its social practices very much. But new, younger drivers are apt to see the geography of their city differently. They are likely to drive a lot more than their auto-owning parents.

Like most Americans and Europeans, these younger people may well own a car before they own a house. In China's rapidly expanding land and housing markets, it is difficult to predict the long-term value of a house bought at a given price today. Although a car is a purchase that depreciates, it is likely to be seen as a safer one, based on a 10-year lifetime. This may mean that a young family will already own a car when preparing to choose a house to own—not the opposite. This observation is important, because it also means such a family may choose a house where the traffic is tolerable and there is room to park the car, frequently at the outer periphery of the city.

At the outer periphery, young families will have a larger set of choices and opportunities: a greater selection of jobs, a wider choice of schools and specialized studies, a wider selection of residential localities, and a wider range of friends and personal associates. They also will be able

to comparison shop before buying, and they will be able to shop for food once a week at larger stores rather than daily at smaller, more expensive stores. The range of personal access will encourage the creation of large-scale shopping centers that will serve large metropolitan subregions. With the recently shortened workweek, people will take more vacations and travel greater distances for outings.

But these profound changes will exclude the major part of the population, who will not be able to acquire automobiles and are likely to be without them for a long time. As in most partly motorized countries, this problem is likely to be starker because of spatial separation. People with cars will seek low-density environments where the housing is less expensive (per square meter), while those without cars will remain in the inner areas. This separation will occur, ironically, through a reversal of the current residential pattern, in which the higher-income people, and probably the highest auto ownership, are in the centers of the cities. This reversal has in fact taken place in many cities of the world. Motorization turns cities inside out.

In summary, local communities in Chinese urban centers may likely become residence-based communities, rather than work-based—a change that entails a very different social organization. The division in society may become serious when the auto-owning group becomes a significant portion of the total population, so that the two groups become aware of each other as competitors with different lifestyles and personal opportunities. Municipal governments may well become increasingly concerned about this division in the society, as they have in other countries. Indeed, the situation puts special priority on maintaining an adequate public transport system and attempting to create cohesion in communities that no longer have a state-owned enterprise employer to assure that cohesion.

In the course of the evolution of motorization, citizen interest groups are likely to appear, and many will start nongovernmental organizations for the purpose of advancing their interests. These groups are likely to include auto owners, bicycle owners, and urban groups opposed to highway expansion. Auto owners would probably advocate substantial continuing budgets to improve the mobility of auto users, an interest resonating with the national government's promotion of the auto industry. They also would encourage local municipalities to continue high levels of investment in roads.

Considerable conflict may develop over the role of the bicycle; after all, most Chinese will not own cars for the foreseeable future. State statistics indicate that in China there are nearly two bicycles per family—an average about constant for all eight octiles of income level nationally. Although many bicycle trips will become impractical in the decentralizing city, bicycles will remain useful for many others. Municipalities will find it very difficult to provide public transit that is reasonably competitive with bicycle trips in the range of 10 km. It is therefore likely that organizations will emerge to advocate separate rights of way and other solutions.

Urban groups opposed to highway expansion are likely to take on the issues that will arise from the public's experience in grappling with the rapid construction of transportation facilities. These issues might include the invasion of natural forests and, especially, agricultural land by the extension of suburbs beyond current urban limits; the damage to air quality because of the increased number of vehicles; and the dislocation and the demolition of valued buildings. One case that has attracted considerable attention is the expansion of Ping An Ave. (Peace Ave.) in Beijing, where the proposal to demolish historic buildings in the course of neighborhood redevelopment has generated opposition from the community.

6、Conclusion

This chapter has attempted to combine the emerging evidence of new motorization-impelled behavior in Chinese cities with the experience of cities elsewhere that are further along the motorization curve. Indications are that the series of changes in store will dramatically change urban life in China just as they have changed urban life in the cities of other countries. In some localities guidance of peripheral land development is receiving serious attention. At the national level, density standards for new development have been enacted. Nevertheless, the process of land development guidance needs to be continually reviewed and refocused in light of the current rapid change in the metropolitan areas of China.

References

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Appendix

《Shanghai Metropolitan Transport White Paper》

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