

Discussion on the Strategy  
for the Rail Transportation Recently  
Developed in Shanghai

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## Discussion On the Strategy for the Rail Transportation Recently Developed in Shanghai

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### Abstract

This paper discusses the necessity, strategy and objectives of the rail transportation recently developed in Shanghai. The objective should not be regarded just as a term project, but should be taken as an urgent mission with priority and extraordinary development strategy instead. At the beginning of the 21st century, Shanghai should possess a network of about 100 km of rail transport lines.

To this end, the following measures are suggested: grade separation of all lines on elevated structures; developing the rail car industries; full utilization of all available transportation facilities; optimizing the use of the space resources of highways; bringing into play the initiatives of all parties concerned.

Recently, it has become a popular consensus that the development of high-speed, safe, punctual, comfortable, non-pollution rail transport with large capacity is the best and only solution to Shanghai urban transportation. In this respect, this dissertation deals with the development strategy for current Shanghai rail construction, together with the infrastructure in Shanghai, positioning the developing target; meanwhile, some proposals and solutions to hit this target will be put forward for the reference of leaders and experts.

#### 1. The necessity of giving priority to the rail transport

##### 1.1 The urgent needs of developing urban transport

Currently, the public transport volume in downtown areas of Shanghai is very large, the density of transport is surprisingly high, therefore, it's far too difficult to further enlarge the capacity of public buses, however, it is in these areas that we need public transport most urgently. The problem of demand and supply is prominent. Thus, the only solution is to develop non-ground transport in those areas, i.e. rail-transport. Secondly, with the

enlargement of city, the newly developed suburb areas of the city, such as Zhong Yuan area, Cao He Jing area, Pudong new area etc., their linking with the downtown area is very difficult. Besides, in order to improve the urban transport, the municipality has made big investment including many new constructions. But their annual increase of overall traffic capacity is 3~5% only. Rather, the conclusion of each construction only relieve the constraints of some lines and conjunctions. Only by the time when a network is established, can it solve the problem ultimately. Usually, the increase of traffic volume is much higher than that of traffic capacity. In the past few years, the increase of vehicle is 12% annually, in 1993 alone, 20%. According to the statistics and forecast, in 1992 the daily average volume for bus traffic is 1,603,000 persons, by 2000 there will be 28,100,000 persons, average annual increase is 7.3%. Therefore, the overall situation looks worse and worse. We, people in Shanghai, can feel it personally. In accordance with the rail-transport-construction proposals, by 2000 the metro No. 1 from Xing Zhuang to Shanghai Railway station, No. 2 Zhong Shan Park to Long Dong Road in Pudong with a total operation length 32.5 km, the daily average traffic volume will be about 1,860,000 persons. This metro traffic capacity is 6.6% of total traffic volume. We can see clearly that the demand for transport is much higher than the process of city construction, as a result, "rob Peter to pay Paul". Therefore, we should not regard it as an ordinary construction project which can be effective only in the long-run, instead, we should regard it as an urgent mission of first priority. Only in this way can it meet the demands of city transportation.

## 1.2 The urgent needs of economic development strategy in Shanghai

The development objective of Shanghai is to build the city to be a modernized metropolis with "a dragon head and three centers". So its city form and basic construction must, accordingly, conform to the requirements of international metropolis. But recently, Shanghai has many weaknesses in transport constructions. For example, nowadays, many cosmopolis have formed a comprehensive transport system, based on rail-transport, supplemented by buses. The overall length of rail is over 1,000 km. Its volume accounts for more than 80% of the overall public transport. Whereas in Shanghai, only 16 km metro exists. Road area per capita is 2.9 m<sup>2</sup> only, less than 1/4 in Tokyo, 1/6 in London, 1/12 in NY. This gap shows that the infrastructure of Shanghai is far behind the goal to build the framework, Shanghai by year 2000 will become the *international Center of Economy, Finance, Trade*. Therefore, we must adopt a correct urban transportation strategy.

### 1.3 Rail-transport is the only solution

The key problem is "*too many persons, too many vehicles and less road space*". The simple solution is to pave more roads. However, even if the current road space is doubled, it's not enough to relieve the crowdness. Besides, it's difficult to increase ground road. Rail-transport has the features of big volume, less occupation, punctual, safe, non-pollution. Particularly the first 2 are most prominent. If a lane is equipped with rail-train, it can load over 60,000 persons per hour, its full-load is 20 times as much as when its run by cars. Therefore, experts from both China and abroad deem it the best and only solution to urban transport, thus it has developed by big strides. In Shanghai, there are too many buildings, residents and traffic cars, so this solution is even more important. Besides, the rail-transport-construction in Shanghai has already lacked behind. Therefore, we must adopt the correct development strategy, in this way to improve the transport problem earlier,

### 2. The objectives of rapidly developing the urban rail-transport

Because Shanghai's rail-construction started too late, while the city has been developed very fast, the difficulty thus occurred. Therefore, the proportion of rail will be a bit lower than other metropolises. But the gap can't be too wide, otherwise, it would be helpless.

The objective of construction should be to shorten the "*the gap scissors*" of traffic demand and supply, so as to meet the demands of economic development. Based on that, Shanghai must set up a framework for the rail-transport-construction at the very beginning of 21st century. The obbbjectives are as follows:

(1) Fundamental goal — besides metro No. 1, No. 2, the northern part of No. 3, No. 4, and Pudong area should be included. Thus forming the framework of rail-transport to set a foundation for the development in 21st century, in the meantime, to promote the progress of Pudong, better the investment environment, as a result, serve the economic objective of building Shanghai to be a city of "*a dragon head and three centers.*"

(2) The percentage in overall transport volume — the volume of rail-transport should account for 30% of the total urban public transport, thus to better the transport conditions of residents, to enhance the overall efficiency.

(3) The length of rail — in 6~7 years to come, 133 km rail lines will be completed, i.e. besides the metro No. 1 16 km already concluded, another

110 km will be built, 16 km annually. This rate will be surprisingly high.

The rail transport lines of Shanghai in the beginning of 21st century

Name of Lines	Operation length (km)	Cost (100 millions RMB)	Daily trips (10 thousands)
Metro line No. 1	19.5		114.0
Metro line No. 2	13.0	123.4	72.2
Rail-transport of Yuan An Road	14.9	39.0	74.5
The northern part of Metro No. 3	15.7	53.0	78.6
The north & mid part of Metro No. 4	34.3	85.0	158.6
PD-A line in Pudong	25.4	72.4	40.9
G-G line of Light Railway	10.2	22.4	45.0
<b>Total</b>	<b>133.0</b>	<b>395.2</b>	<b>483.8</b>

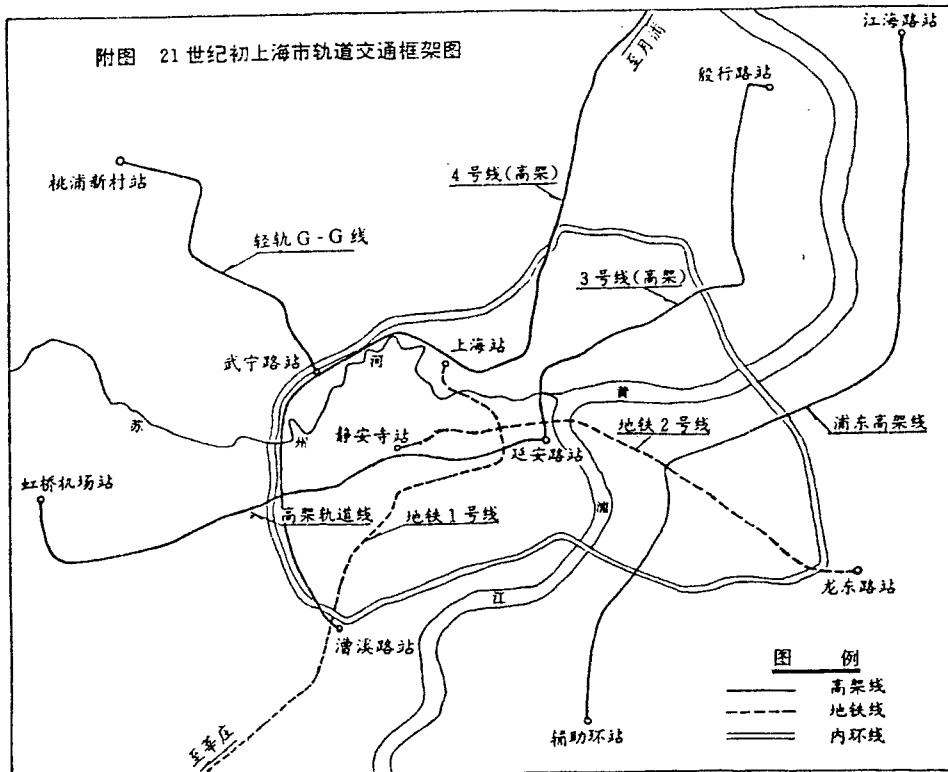


fig. Rail transit line in Shanghai

### 3. The scheme of developing rail-transport

According to the report of metro No. 2 dated Nov. 1994. At the first stage, the cost is 900 millions RMB per km, average 3.25 km a year. If Shanghai adopts the simple way of metro for the construction of 110 km rail, at this cost and rate, the cost will be 99,000 millions RMB, in 3~4 years. However, it's much too difficult to raise such a huge amount within 6~7 years.

Besides, the long construction period can not possibly solve the present urgent problem. Obviously, big investment and long period are main obstacles to the development of rail transport. For that, a solution must be made to reduce the cost and shorten the period drastically. As far as our research goes, we hereby furnish the solutions as follows:

### 3.1 Grading separation of elevated structures.

Rail-transport should adopt the way of overpass, which can effectively overcome the construction difficulty of underground water and bad soil in Shanghai. It's also the most effective measure to reduce cost and shorten construction period. Yet, the biggest obstacles are noise pollution and spoil of scenery. For all that, the trains, controlling equipment and engineering have adopted a series of advanced technology. In the mid 80's, Canada took the lead in using linear motor vehicle. This is a new city vehicle, characterizing in low noise, low wagons, to pass short radius, strong capacity in climbing. This kind of train can move flexibly, even pass through high mansions, no need for noise-shield. The whole structure of overpass is simple, beautiful, dainty, in coordination with the surroundings. Therefore, in less than a decade, 6 cities in 4 countries already used this vehicle. Of them, 4 cities of 3 countries put it at overpass. We should also apply this mature high technology, surpass normal stage, to pave a new way for the transport construction in Shanghai.

The primary evaluation shows, for the same traffic volume, elevated rail over pass costs only 1/3 of tunnel, 1/9 of metro. Overpass not only reduces the cost of civil engineering, but also reduces the investment in ventilation, environmental protection, water-outlet, lighting and equipment for disasters-proof, in the mean time, saving the time for construction.

### 3.2 Establishing rail-car industry.

In building rail-transport system, we have a great and long term demand for cheap and qualified cars. Suppose, Shanghai is going to build 110 km rail transit line, then it requires over 1,000 cars. Nation-wide, 23 cities are planning or building rail-line, thus, the demand for cars are tremendous. From now on, with the development of the economy and concentration of city residents, there will be more and more cosmopolis. Mid-scale cities will also build rail-line successively as the developed cities did. Therefore, there exit a promising market for railway cars. However, rail-car industry is high value-added. If we always depend on imported ones, the cost is very high, later, we are likely to be controlled by others. Cars come together with the investment, thus the models vary, which is an obstacle to the standardization

of vehicles. Foreign manufacturers will also charge exorbitantly for car-maintenance. Secondly, the investment in cars accounts for as much as 24~40% of the whole system. If we can manufacture domestically, this percentage is bound to be lowered. It's another measure to reduce rail-construction cost. Thus, we must associate rail construction with rail cars, introducing key technology, or co-producing with foreign producers, taking the way of nationalization, establishing rail-car industry by ourselves. In this way, the cost for cars can be lowered by about 30~50%, at this rate, the cost for 1,000 cars needed in Shanghai will be spared by 5,500 millions RMB. Suppose we set up a joint venture with annual output of 180 cars (assembly), with an investment from China 51%, it is about 300 millions RMB. If we take the advantage of a certain existing factory, which is in the process of adjusting its products structure, the investment can be further lowered. If Shanghai takes the lead to set up the rail-car industry, it can occupy domestic market promptly, then probing international market with advantage in pricing, its social benefits are prominent.

### 3.3 Breaking through the restriction, making the most of transport resources.

Breaking the current restrictions, making the most of available transportation facilities, optimizing transportation resources. It is also the effective way to implement an urgent, prior and extraordinary development. For example, Son-Hu railway passes the most crowded North-East area, but is tabled for a long time. If we break through this restriction, convert it to overpass of big capacity, thus it can relieve the transport jam in this area. This project has no need for residents-emigration. In this field, attention should be paid to the way of Sydney; in 1988, Thomas Group invested in Sydney to build a rail-circle overpass as long as 3.5 km, crossing crowded down town area and harbors; this Group signed a 25-year lease contract with local government. Local government can receive 1 million Australian dollars profits a year. Railway ministry and Shanghai municipality can adopt the same way, co-developing, fully utilizing the current transport resources. Besides Son-Hu railway, from old Shanghai railway-station to new one, from Xu Jia Hui to Xing Long Hua, we should also co-develop them, make them function for city public transportation. This approach not only costs less investment, but also pays off promptly.

### 3.4 coordinating the road construction with rail establishment, optimizing road space.

In city transport construction, comprehensive consideration should be taken. We should break through the situation that all parties think of

themselves only. More rapid constructions must be undertaken. For example, we can take advantage of the building of overpass to set rail transit. This measure optimize the limited road space, resulting in the road, overpass and highway rail overlapping on one "*rapid passage*". Moreover, this plan costs less investment, less time. The cost is about 10% of the according overpass, takes 3~4 years to complete together with the overpass.

3.5 Shifting the situation where Municipality monopolizes the rail-construction, bringing into play the initiative from all parties.

In order to expedite the construction of rail-transit, we should make most of initiatives from Municipal, District Government, and other Ministries, enterprises, to raise cash from as many channels as possible. We can issue bonds, raising money locally, developing real estate. We should try every means possible, concentrating all efforts to get each party into play directly or indirectly. In a certain long period, we must spare no effort to insist on rail-transit-construction as a key business, thus, synchronizing the construction rate with the growing demand rate.



# 上海近期发展城市轨道交通的策略探讨

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## 摘 要

本文阐述了上海近期发展轨道交通的必要性及其策略和目标定位。上海不能再把轨道交通看作一项只能在远期才能见效的工程，而应把它作为近期迫切的建设任务，采取优先发展、超常发展、跨越发展的策略。在 21 世纪初，上海应建成 130 公里左右的轨道交通，使其线网初步形成框架。为此提出了如下对策：线路高架化；兴办轨道车辆产业；充分利用现有交通资源；优化配置道路空间资源；调动各方面的积极性等。

目前，对于“发展大容量的快速、安全、准时、舒适、无废气污染的轨道交通，是解决上海交通的最佳选择和唯一出路”这一观点，已成为人们的共识。为此，本文阐述了上海在近期内轨道交通建设的发展策略，并结合上海现有基础和市情，对其发展目标作了定位；同时，对如何实施这一目标提出了一些对策和建议，供领导和专家们决策时参考。

### 1 优先发展轨道交通的必要性

#### 1.1 城市交通的迫切需要

目前，上海市中心区的公交客流已经非常大，公交车流的密度已非常高，因而在中心区再要扩大公交汽车的运能已经非常困难。而这一地区恰恰又是最需要公共交通的地区，供求矛盾十分尖锐。因此根本的途径是在这一地区发展道路外公共交通，即轨道交通。其次，城市不断扩大，城市边缘地区，如中原地区、漕河泾地区、浦东新区等同城市中心的联系单靠地面公交在出行时间上也很难令人容忍。此外，近年来为了改善交通状况，市府已投入了大量资金，建设了许多工程。但这些工程的交通总容量年增长率只在 3%~5% 左右。何况每项交通设施的建成只是缓解了点、线上的矛盾。只有当这些点、线足够形成系统网络时，才能根本上缓解面上的矛盾，这就需要更多的投入和更长的时间。但当前交通量的增长率却大大高于上述交通容量的增长率。如：近年来机动车的年增长率平均在 12% 左右，而 1993 年则高达近 20%；又据有关部门的实测和预测，1992 年的公交日均客运量为 1603 万人次，2000 年将高达 2810 万人次，平均每年递增 7.3%。因此，交通状况只能是局部改善，而整体上则是日益恶化。这是大家都亲身感受到的现实。再据有关单位提出的轨道交通建设计划，2000 年建成地铁 1 号线莘庄至上海站以及 2 号线静安寺至浦东龙东路，营业线共长约 32.5 公里，日均客运量约为 186 万人次。地铁的这一运能还不到届时公交客流增加量的四分之一（仅占公交总运量的 6.6%）。由上可可见，上海城市交通日益增加的需求远远大于城市交通设施建设的进程，必然造成“旧帐未清，又欠新帐”的局面。因此，不能再把轨道交通看作一项只能在远期才能见效的工程，而应把它作为一项近期的、迫切的建设任务，突破常规，实施跨越式的建设战略，才能满足城市交通的需求。

#### 1.2 上海社会经济发展战略的迫切需要

上海的社会经济发展战略目标，是建设成为“一个龙头，三个中心”的现代化国际性大都市。那么，其城市形态与城市基础设施的现代化程度也必须符合国际现代化大都市的要求。但就目前而言，上海在这方面，尤其在交通设施方面还存在诸多不足。如当前世界上的一些国际性大都市都已建成以轨道交通

为主、公交汽电车等为辅的综合公共交通体系。其轨道交通的线路总长度都在 1000 公里以上，所承担的客运量占公交总运量的 80% 以上。而上海目前仅有 16 公里地铁，人均道路面积仅为 2.9 平方米，还不及东京的 1/4，伦敦的 1/6，纽约的 1/12，上述差距表明，上海的交通基础设施与上海到 2000 年要初步成为国际经济、金融、贸易中心之一的框架，到 2010 年基本建成国际经济中心之一的社会经济发展战略要求极不相称。因此必须采取跨跃式的发展战略，否则不可能在一个较短的时间内改变这一面貌。

### 1.3 轨道交通是走出交通困境的唯一出路

上海交通的根本矛盾是“人多、车多、路少”。解决这一矛盾的简单办法是多修路。然而，即使将现有道路面积增加一倍，仍然不足以解决交通拥挤的状况，何况增加地面道路交通也是困难重重。轨道交通具有运量大、占地少、准时、安全、无废气污染等优越性。其中特别是前两项的效益尤为显著。一条车道上如行驶轨道列车，每小时能运送 6 万人次以上，其运能是一条通行小汽车车道的 20 倍以上。因此国内外专家都把它看作是解决城市交通问题的最佳选择和唯一出路，而加以大力发展。对于市区建筑、人口和交通均十分密集的海更应如此。何况上海的轨道交通建设起步已晚，因此更应采取优先发展、超常发展、跨跃发展的战略，应用最新的科学技术，使上海的交通问题尽早得到改观。

## 2 实施跨跃式发展轨道交通建设的目标定位

由于上海的轨道交通建设起步已晚，而城市又已经开发，故实施的难度很大。因此，轨道交通所占客运量的比重会稍低于其它国际性大都市，但也不能相差太悬殊，否则无济于事。

建设目标的定位，必须能尽快遏制交通供求矛盾中的“剪刀差”日益扩大的趋势，也必须适应社会经济发展的需要。基于这一点，上海就必须在 21 世纪初就初步形成轨道交通系统的基本框架。现将这一跨跃式发展的目标定位如下：

(1) 基本目标——除地铁 1、2 号线外，还应建成 3 号线的北段以及 4 号线的北、中段和浦东 PD - A 等线路，使轨道交通系统初步形成框架(见附表及附图)，为 21 世纪的大发展打下基础，也为促进浦东开发、改善投资环境，最终为上海成为“一个龙头，三个中心”的经济战略服务。

(2) 承担交通总运量的比重——轨道交通承担的公交运量应占总运量的 30%，改善居民的交通条件，提高城市的整体效率。

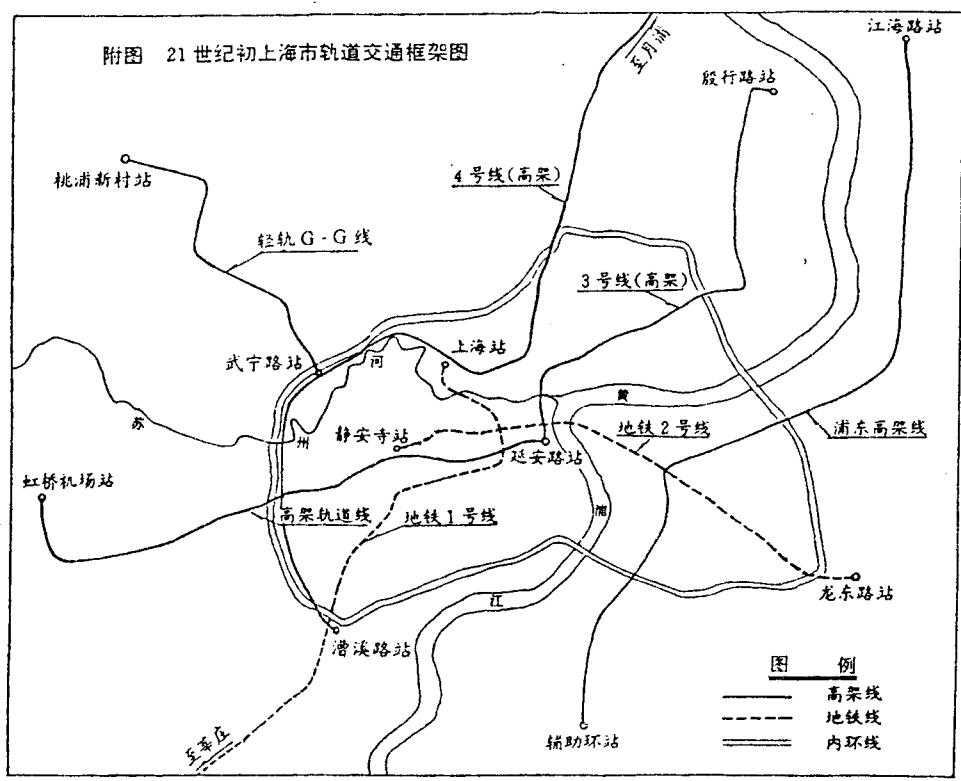
(3) 轨道交通线长度——在今后六七年内建成约 133 公里的轨道交通线，亦即除已建成的地铁 1 号线 16 公里之外，还需建成 110 公里左右的轨道交通，平均每年需建成约 16 公里。这一建设速度在轨道交通发展史上将是超乎常规的。

附表 21 世纪初上海市轨道交通线概况表

线名	营业线长 (km)	投资额 (亿元)	日均客运量 (万人次)
地铁 1 号线	19.5		114.0
地铁 2 号线	13.0	123.4	72.2
延安路高架轨道线	14.9	39.0	74.5
3 号线北段	15.7	53.0	78.6
4 号线北、中段	34.3	85.0	158.6
浦东 PD-A 线	25.4	72.4	40.9
轻轨 G-G 线	10.2	22.4	45.0
合计	133.0	395.2	583.8

## 3 发展轨道交通的对策

据1994年11月地铁2号线研究报告，一期工程平均每公里造价为9亿元，平均每年建成3.25公里。若上海今后建设110公里轨道交通的目标仍采用单一地铁模式，则按上述造价及建设速度，其所需的条件是：资金约990亿元，工期约34年。然而，要在六七年内筹集这笔巨额资金是极其困难的；而其漫长的建设周期也难解当前交通的燃眉之急。显而易见，投资大和工期长是制约轨道交通发展的主要因素。为此必须寻求大幅度地降低建设轨道交通的造价和缩短工期的对策，才能使跨越式发展轨道交通的战略目标得以实现。根据我们的研究，现提出以下几条对策供参考。



### 3.1 线路高架化

线路高架化是指轨道交通的线路尽可能多地采用高架形式。线路高架化可以有效地克服上海地下水位高、土质差等自然条件对地下线路建设和使用带来的不利因素。它也是降低造价和运营费用以及缩短工期的最有效措施。但在市区采用高架线路的最大障碍是噪声和景观问题。然而，由于轨道交通系统当前在车辆、控制设备及工程结构等方面不断采用了一系列的先进技术措施，使其发展已出现了高架化的趋势。80年代中期加拿大率先研制使用的线性电机车辆，是一种最新型的城市轨道交通工具，具有噪声低、车身矮、通过小半径曲线和爬坡能力强等优点。使用这种车辆的高架线路可以急上急下、走街窜巷，甚至从高楼大厦中穿过，且无须设置声屏障；高架结构也显得简洁、轻巧、美观，且与周围环境相协调。因此，在至今不到10年时间内，已有四个国家的六座城市使用了这种车辆，其中三个国家的四座城市应用在高架轨道交通系统上。我们也应该应用这一成熟的高新技术，超越常规的发展阶段，实施高起点、跨越式的发展战略，让上海的轨道交通建设走出一条新路。

经初步估算，在运送能力相同的情况下，轨道交通区间的高架桥造价约为地下隧道的1/3；高架车站的造价约为地下车站的1/9。高架化不仅能降低土建工程造价，而且还可节省通风、环控、排水、照明及防灾等机电设备的投资，同时还能大大缩短工程工期。

### 3.2 兴办轨道车辆产业

建设城市轨道交通系统，车辆的需求是大量的、长期的，更希望是质优价廉的。上海如在近期再建 110 公里轨道交通线，则就需要车辆 1000 多辆。在全国，共有 23 座城市也在拟建、筹建或在建轨道交通，因而车辆的需求更是大量的。今后，随着社会经济的发展以及城市人口的集中，大城市的数目将不断增加，中等城市也将会同发达国家的中等城市一样纷纷建设轨道交通。由此可见，轨道车辆的市场需求将是十分巨大的。然而轨道车辆是一项高附加值的产业。如果这些车辆长期依赖进口，不但所费不赀，日后还将受制于人；再加上因是从不同国家引进资金而造成车辆类型纷杂，埋下诸多隐患，不利于轨道车辆的标准化和系列化；车辆的维修备品外商也会漫天要价。其次，由于车辆的投资可占轨道交通总投资的 20%~40%，如果国内能自己生产，必然可降低车辆在总投资中的比例。这也是降低轨道交通造价的一项重要措施。为此，必须打破轨道交通的工程建设与轨道车辆产业脱钩的现状。工程建设部门与工业部门应联合起来，引进关键技术与国外合资生产，并实现国产化的道路，自己兴办轨道车辆产业。这样，车辆的造价估计能降低 30%~50%。据此计算，上海近期所需 1000 辆车的购置费用约可节省 55 亿元。而建设一座年产 180 辆的合资厂(主要是组装)，中方投资 51%，估计仅需 3 亿元左右。若利用某厂调整产业结构的机遇兴办轨道车辆厂，投资还可以减少。上海如能率先兴办轨道车辆产业，则可迅速占有国内市场，进而利用价格上的优势开拓国际市场，其社会经济效益将是十分显著的。

### 3.3 突破条块分割的管理体制，充分利用现有交通资源

突破目前条块分割的交通管理体制，充分利用现有的交通走廊，实现交通资源的优化配置，也是实施跨越式发展轨道交通建设目标的有效对策之一。例如，淞沪铁路贯穿市内交通最繁忙的东北地带，但被长期搁置。如能突破条块分割的管理体制，打破大铁路限于市际交通的格局，把它改造为大容量的高架轨道交通，则可大大缓解这一地带的交通阻塞状况。这项工程不用征地拆迁。在这方面，澳大利亚悉尼市的作法值得重视：1988 年，托马斯全国运输集团出资在悉尼兴建了一条 3.5 公里的环形高架独轨铁路，跨越拥挤的市区和港口；该集团与地方政府签有一个为期 25 年的经营租约，地方政府每年可得到 100 万澳元的利润。铁道部和上海市也可采取类似的做法，共同开发、充分利用已有的交通资源。除淞沪铁路外，从老北站经新客站、徐家汇到新龙华的铁路内环线，也应共同开发，发挥其为城市公交客运的作用。这一途径不但投资省，而且见效快。

### 3.4 突破道路建设与轨道交通建设分割的局面，优化配置道路空间资源。

在城市交通设施的建设中，应统盘考虑，突破各自为政的、自成系统的分割局面，尽可能更多、更快地建设轨道交通。例如，可趁建设高架道路的有利契机，增设大容量的轨道交通。这一对策优化配置了有限的道路空间资源，使在同一交通走廊上既有地面道路和高架道路，又有高架轨道交通，从而使其交通功能更完善，改善交通的作用更大，达到事半功倍的效果。此外，这一方案投资少，建设周期短。在高架道路上增设轨道交通的交通土建投资仅需相应高架道路投资的 10%左右，且仅需三四年即可同高架道路一次同时完成。

### 3.5 突破市府统包轨道交通建设的局面，调动各方面积极性

为加速轨道交通的建设，应突破由市府统包的局面，充分调动市、区两级政府以及各部门、单位、企业、公司的积极性，多方式、多渠道地筹集资金。如发行建设债券，地方集资，沿线土地及物业开发等。也即必须采取各种可能的政策措施，集中一切的力量使方方面面都直接或间接地投入到轨道交通的建设中去。在相当长的时间内，要锲而不舍地把轨道交通建设作为重大实事来办，从而使交通设施的建设速度同交通需求增长的速度相适应。