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Primary Factors Dominating the Development & Changes  
of a Metropolis

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ABSTRACT

City grew, stagnated and then declined in the past two centuries. This is a general pattern in history in our world. Clearly, there must have been some powerful factors at work. This paper tries to make an explanation of such phenomena.

Primary forces behind economies of agglomeration and urbanization and behind diseconomies of agglomeration are explained and revealed.

Furthermore, in order to avoid such passage, some principles and ways are explored by system dynamic theory and modeling.

The development pattern of a metropolis is closely related to its inner dynamic structure. Policymakers should be well informed and adjust the structure accordingly.

Developing new zones adjacent to a metropolis is an effective way to pump the new life into the city. Meanwhile, the coordination and equilibrium between the new and the old areas should be appropriately arranged and incorporated.

The paper makes a study of the macro relationship among the flows of population, manpower, raw materials, funds and information between two zones and the impact of transportation problem on the whole city.

Taking an example of Shanghai, a megalopolis, a series of policies for rebuilding up the functions of the city are suggested.

I. Urban Dynamics

There exist major problems in central cities or metropolises attracting many scholars and researchers.



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Books are published in 1960's, among which the famous one was Urban Dynamics, written by Jay W. Forrester. It disclosed the dynamics of metropolis, the inner mechanism of its development, its culmination and its stagnation. There is no exception that the main metropolises in U.S.A. all followed that mode, peaking during the period of 1930 and 1950, then damping, stagnating, and taking 150 years to the peak. Statistical material also reveals the industry production of these cities have similar modes. Interestingly, the collapse in Shanghai, the biggest city of China, began in the early 1980's. It almost takes the same mode of its development, although conditions are different. However this coincidence indicates that there must be some inner facts and causes that dominated this movement. But what and where are they?

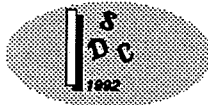
Generally speaking, the development of city originates in its architecture. (Urban Dynamics- Forrester, 1969) According to the principle of attractiveness, the gradual improvement of the road, transportation, housing and infrastructure and the growth of economy attract more and more people to immigrate from the area of high population density to low one. As people and economy grows, jobs must be created, thus employment is enlarged. This helps to build a city of certain economy, politics and culture. However, the effect of this agglomeration is bilateral, positive and negative. When the agglomeration outranges its capacity, the negative side takes dominant part. It leads the city toward decline.

Shanghai just serves an example. It is now declining. Here, we try to analyze its economic situation, industry structure and population by System Dynamics (SD) theory to find a new mechanism for its development.

## II. Background of the Study

Shanghai is a modern city characterized in its industry. Its GNP is 75 billion RMB and population density is 2013 persons per KMsquare in 1990. Shanghai took leading part in its national industry before 1980's. However, the economic reform around the whole China deteriorate it on account of its material and energy shortage. The main problems Shanghai now facing are:

1. It's tertiary industry has sustained a small portion and a slow growth rate, making its metropolitan function incomplete and imperfect.



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2. The superiority of leading industries in Shanghai is declining. The competitiveness of Shanghai's products is weakening in both the domestic and international markets.

3. The provision of raw material and energy for industry in Shanghai is not regular.

Several investigations are made in order to find a solution. We agreed with that one way to get rid of the city's problems is to rebuild the whole Shanghai by developing its eastern area and adjusting the unreasonable structure in the western part. The following questions are being explored:

1. How to transform an industry concentrated city into a multifunction metropolis, i.e. as a financial center, trade center and information center?

2. How to change the strategy to cope with the situation which requires broad regional cooperation and more efficient international transaction?

3. How to coordinate the development of western and eastern part of Shanghai?

### III. The Structure of the Model

In order to reveal the relation between the western and eastern part of Shanghai, we divide the model into two parts respectively, each consisting of subsystem of transportation, population and production etc. The general structure are shown in Figure 1.

GNP is the main index reflecting the economy. It is the sum of three industries. (1st industry: agriculture, 2nd: light industry, textile, machinery, electronic industry, etc. 3rd (tertiary industry): commerce, finance, service industry, etc.) The general trend of GNP from 1988 to 2018 is provided in Figure 2.

The production closely relates to the transportation, raw material and energy supply. The production increase gives rise to extra demand of transportation imposing greater stress on transportation. So does it do to the raw material and energy supply. If the economic structure of Shanghai remains unchanged, then the demand structure of raw material and energy supply will be unchanged and the contradiction of demand and supply will become much more severely imbalanced, constituting



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a negative effect on the production. That is why there is a damping in about 2003 in Figure 2.

Population is another crucial factor in the urban development. From the simulation, the population in Shanghai will rise from 105.4 million in 1988 to 115.0 million in 2000, among which 19.79 million in the eastern area while 75.23 million in the western band. If we don't foresee the potential problem in the population increase, we will face the serious population explosion later.

The above situation analysis encourages us to take some policy tests in the model to search for the dynamic in urban development.

#### IV. Policy Tests

##### 1. Comparison Tests of Different Investment Ratio:

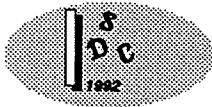
We assume that the unit capital output value of the tertiary industry is higher than that of the second. We differentiate the ratio between these two industries to find a maximum value of GNP. The comparative tests are shown below:

Table 1. Results of policy test of investment ratio between second and tertiary industry

Policy	GNP in 2000	GNP in 2018	GNP in 2048
a: II:III=0.4:0.6	1747	4245	6806
b: II:III=0.45:0.55	1753	4475	8063
c: II:III=0.48:0.52	1757	4621	8971
d: II:III=0.5:0.5	1759	4709	9148
e: II:III=0.55:0.45	1758	4698	11610
f: II:III=0.6:0.4	1747	4420	14010

According to the above value, we are able to draw a curve reflecting the relationship between the investment ratio and GNP in Figure 3.

It is clear that the about equal ratio between second and tertiary industries is a better combination to bring a higher GNP. Because the excessive input in second industry will increase the demand of transportation which inversely inhibits production when its capacity is exhausted. But the situation in the tertiary industry case than the former.



## 2. The Investement Allocation between the Western and Eastern Areas

We have tested the investment allocation between the western and eastern parts. We draw the conclusion that we should put stress on the development of finance, commercial and service industry in the eastern area in order to turn Shanghai into a multifunction, open and modern metropolis. (please refer to the following simulated results in Table 2.)

Table 2. Results of investment allocation between western and eastern part

	2nd Industry in GNP (1)		3rd Industry in GNP (2)		GNP	
	Value	%	Value	%	Value	%
West:East=0.1:0.9	120.3	54.9	93.09	42.5	235.2	1
West:East=0.2:0.8	362.2	60.3	232.0	38.6	600.3	1
West:East=0.3:0.7	600.3	58.9	324.4	33.6	1018.7	1
West:East=0.37:0.6	3704.8	64.3	418.2	35.2	1189.1	1
West:East=0.4:0.6	833.3	69.8	354.4	29.7	1193.9	1

\* GNP is the sum of (1), (2) and GNP of agriculture

## 3. Search for the Dominant Industries

We observed the changes in GNP by replacing the dominant and non-dominant industries in the model. Finally, we obtain that the dominant industries in Shanghai at present should be light industry, chemical, machinery and electronic industries.

## 4. Comprehensive Test

We made a comprehensive study of the above tests and simulated the model according to the following conditions:

- 1) Assume the investment ratio between second and third industry is 0.5:0.45.
- 2) Assume the allocation of the fund between western and eastern part is 0.85:0.15.
- 3) Assume the transportation capacity increases 20%

The sharp damping around 2003 in Figure 2. has been moved out. Refer to Figure 4. The optimal GNP in the



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comprehensive test is 156.8 billion RMB. The tendency of GNP is shown in Figure 4.

#### IV. The Improvement of the Model

In reality, it is impossible for a country to have its demand and supply absolutely balanced in every department of its industries. On the contrary, there is real stock in almost every department. And there is without exception for China. For this reason, we modified the model by introducing inventories into the model shown in Figure 5:

The results with inventories and without inventories are compared in Table 3.

Table 3. Comparison of GNP between with and without inventories

GNP(billion)	1988	1991	1994	1997	2000
With Inventory	66.55	78.64	95.75	126.8	153.5
Without Inventory	66.55	83.3	105.9	141.0	163.3

By comparison, we conclude that the modified model is more realistic.

#### VI. Conclusions

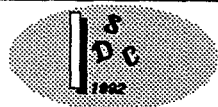
From the above analyse, we hold that the urban development is closely related to its economy, culture and policy. Every metropolis should settle its backbone industries according to its inner characteristics.

Moreover, developing the areas adjacent to the metropolis is an effective way to pump the new vigor into the city.

To modernize Shanghai into a multifunctional, open and central city in China, we should develop tertiary industry by appropriate allocation of fund between its western and eastern parts. Adjusting the industrial structure is another way to help reach our goal.

#### VI. References

1. Wang, Qifan. 1988. System Dynamics. Tsinghua University Press.



2. Wang, Qifan. 1987. et al. The Theory and Application of System Dynamics. New Times Press.
3. Forrester, Jay W. 1969. Urban Dynamic. MIT Press.
4. Statistics Almanac of Shanghai. 1987-1990.

VII. Appendix

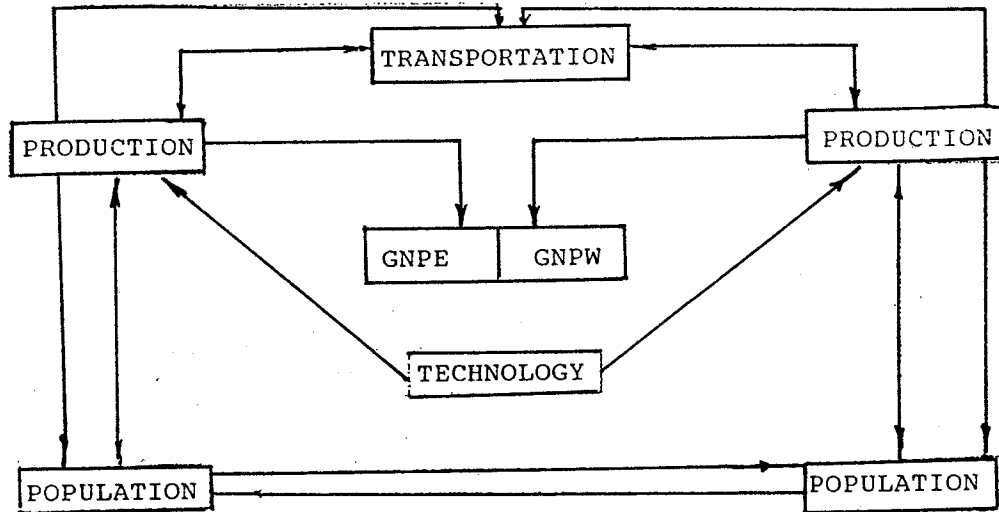


Figure.1. Block diagram of the model

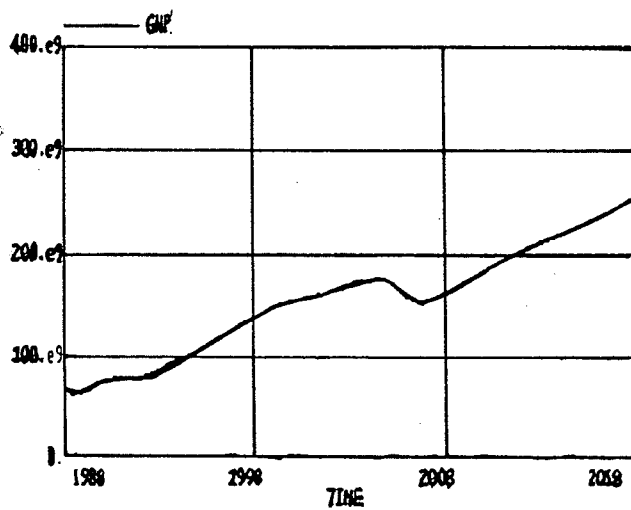
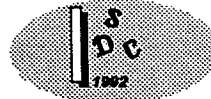


Figure. 2. GNP development tendency



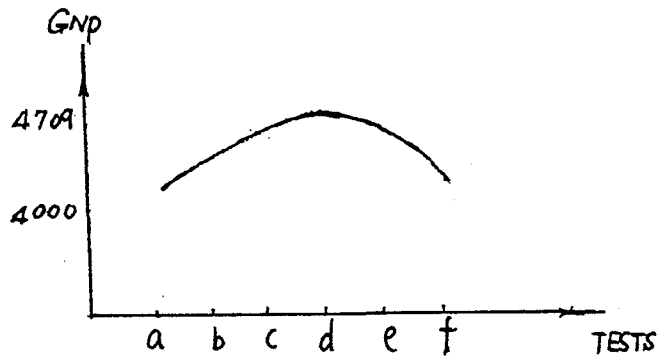


Figure. 3. The relationship between investment ratio and GNP

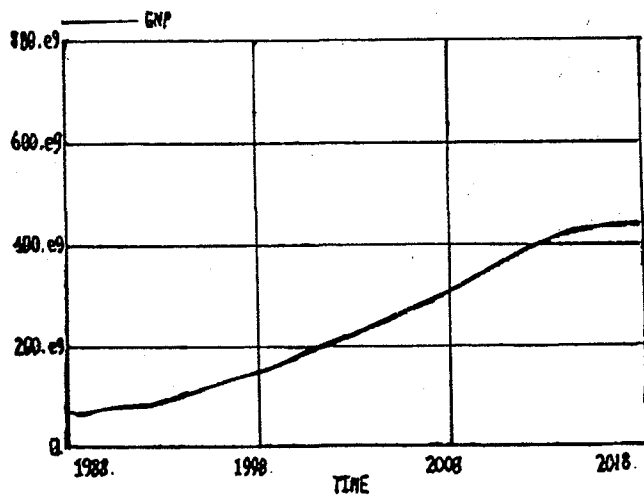


Figure 4. The GNP tendency of comprehensive simulation



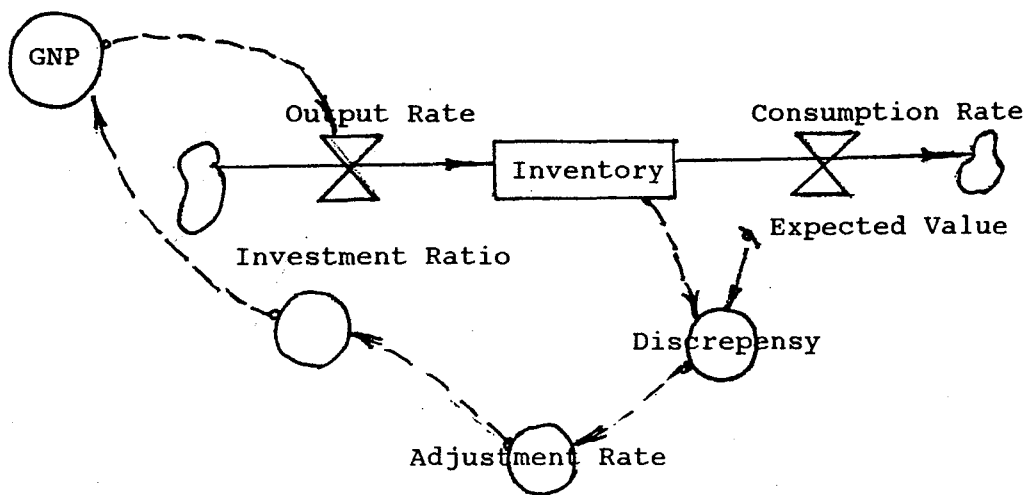


Figure. 5. The flow diagram of improved model

