Articles

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Washington: U.S. Government Printing Office, 1970, p. 153-207: 22 fig.

Testimony of Constantinos A. Doxiadis before the United States Senate Committee on Commerce on the National Transportation ACT,

Washington D.C., April 14, 1970

SYNOPSIS: In order to create human settlements that satisfy the population's needs, we first need to take into serious account man's movement in space as it has been transformed throughout the centuries. Man's movement has passed several stages, from relying solely on his physical strength to the use of automobiles. However, today there is a loss of equality in movement and transportation, based mainly on class differences, since humanity has failed to readjust its physical and social structure when coping with the problem of modern settlements. In order to re-establish order in human settlements, people need to avoid pollution, to create an urban environment friendly to the inhabitants, and to increase the efficiency of public transportation means.

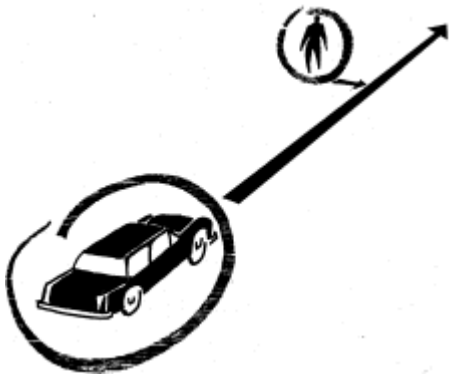

Fig. 1. The car enters the picture and changes the scale of dimensions which was previously controlled only by man.

Mr. Chairman,

I am very glad that your committee has taken the initiative for the National Transportation Act, and I am very honored that I have been invited to testify during your hearing. I think that the Act represents a very important and revolutionary effort to face this major problem of the nation and that its concept is in the right direction. I am very much impressed by your statements on "major transportation regions", on "a balanced and integrated system of transportation designed to meet the social and environmental needs of the entire region, as well as to provide a framework for the orderly movement of people and goods".

I feel that it is my task to present my views to you, which are based on a lifetime's work for human settlements, in a way that will connect your immediate concern about transportation with your broader concern about man and his welfare and happiness, a concern that is made apparent in the Act and in your address of February 20th this year.

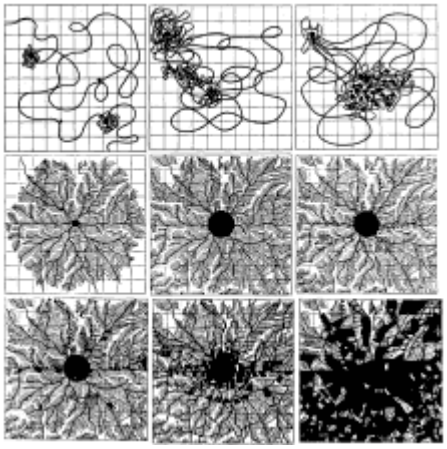

Fig. 2. (first row-left) Energy model of hunters without a permanent settlement. (first row-middle) Energy model of hunters who begin to cultivate the land. (first row-right) Energy model of hunters and farmers - early phase. (second row-left) Energy model of a vilage. (second row-middle) Energy model of the central settlement of a system of villages. (second row-right) Energy model of the central settlement of a system of villages during the era of the automobiles. (third row) energy model of the central settlement of a system of villages during the era of the automobiles and of industry.

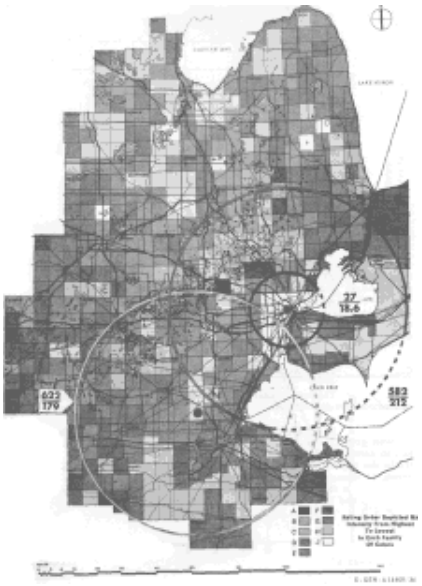

Fig. 3. This map shows the Urban Detroit Area and the value of landscape in it. The circles show the comparison between the areas which can be visited by people who own private automobiles and those who do not. These show that those not owning private automobiles can visit 27 or 80 units of value depending on the rating, versus around 200 or 600 which can be visited by those who do own private automobiles.

A. THE SUBJECT

We very often speak about transportation, but in doing so we exclude man's movement by his own natural biological forces, which is the foundation of every type of transportation and the most important aspect from the point of view of health, child development and human happiness. We cannot hope to develop into humane animals if we do not start thinking about man's movement and then about how it can be supplementary by mechanical transportation(Ref. 1).

B. THE PROBLEMS

Today, humanity faces many problems related to man's movement and transportation, and these can be classified in three basic categories on the basis of considerations about what is really important in our era.

The first category of problems is the loss of quality which existed in the past and this includes:

One: Pollution of the human space

Though in the past man was safe and in control of the space of his settlements from caves to cities, and this is why he created civilization in them, he has today lost control of the public space, of his streets and squares. It is in the streets and squares that we lose, as you state, 50,000 to 60,000 persons a year and we injure 4 million. We also teach our children that they are not free to cross the street and we transmit to them the message that they are no longer free citizens of the world. This message, that the machine is in control, may be the most harmful, one that we can give to our new generation (fig. 1).

Two: Pollution of the natural environment

This is true of land, water and air resources; it is true if we think of what we breathe, see, hear, smell, touch or taste. The development of this pollution in human settlements can be understood if we follow the evolution of energy in human settlements (fig. 2).

Three: Disruption of the social structure

Because of the unwise structure of highways, we broke the community structure and its normal functions within existing cities and created negative conditions for the new and expanding ones.

The second category of problems is the loss of equality in terms of movement which existed in the past and this includes:

Four: Loss of equality of movement

Though in the past everyone, with the exception of children under one year old and the very old and sick, that is all but 5-6 per cent of the population could move in every public space under equal conditions, this is no longer possible for any pedestrian versus any passenger of any machine (see fig. 1).

Five: Loss of equality in transportation

Though in the past even the richest man in the world, such as Croesus of Asia Minor could cover daily on horseback an area no more than ten times larger than the poorest citizen, a rich man today can cover an area which is thousands of times larger than a poor man's. Even a citizen with a family income only double a poor man's, but who owns a second-hand car, can cover an area 20 to 30 times larger than a man who does not own a car. The real choices in space are not as two to one as incomes indicate, but 30 to one, if the poor man can use a bus, and some hundreds to one if not (fig. 3).

The third category of problems is the *small return for the energy expenditure* that we get in transportation and this includes:

Six: Low efficiency of transportation systems

Through at the beginning of the nineteenth century the average American citizen spent 2000 cal. per day in order to move at a speed of up to four miles per hour, and at the beginning of the twentieth century he spent 3200 cal. per day in order to move at a speed of up to 20 miles by using metropolitan trains, he now spends an average of 12,000 cal. a day in order to cross his cities at an average speed of about 25 miles per hour, and his central cities at about 7-10 miles per hour.

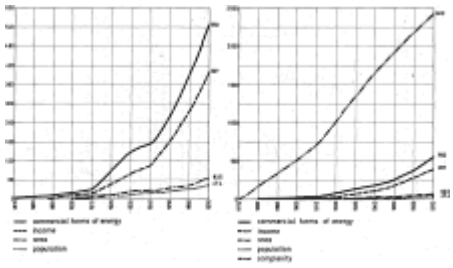

Fig. 4. left) Increase of forces in the Urban Detroit Area.
(right) Corresponding increase of complexity in the relations of people to space

C. THE CAUSES

The main causes of our problems which have to be understood are the following:

1. Humanity has experienced an explosion in population, an even greater explosion in urban population, in personal incomes and in commercial forms of energy available in urban areas. While the population of the Urban Detroit Area, for example, has grown 47 times in the last 100 years, its built-up area has grown 62 times, its income 397 times, its commercial forms of energy 550 times and its complexity at least 2412 times (Ref. 2) (fig. 4).

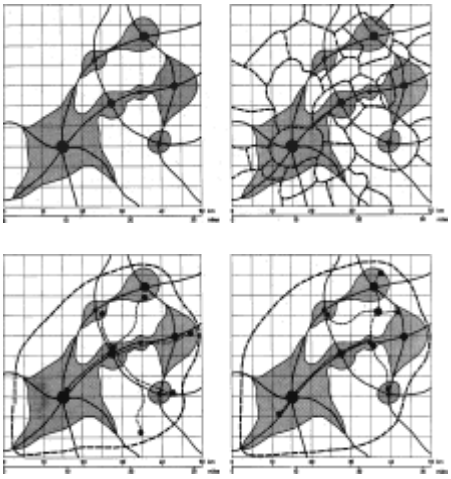

Fig. 5.up-left) Wrong conception of human settlements based on built-up areas.
(up-right) Wrong conception of human settlements based on administrative boundaries.
(down-left) The real human settlements as defined by an urban dweller.
(down-right) The real human settlements as defined by a "farmer".

2. Humanity has not been able to see the city as a whole system of life, and its policies in dealing with cities have been unwise. Action was left in the hands of those representing the knowledge of parts only of the whole urban system of life. The specialists became the decision-makers in their fields, while the city needed the specialist in leadership. How could we have successful industrial production in a factory where every specialist decided on his own equipment, but the manager was missing?

3. Humanity has not been able to re-adjust its physical and social structure in order to cope with the new settlements which have been built by modern man. We have only to think of traffic problems and of the decline of the city centre in order to understand our inability to readjust the physical structure. We also need only to think of the small area covered by the central city's administration in relation to the real city of man, as defined by his daily movement, in order to understand that for the first time in human history the urban animal is by far lager than its straightjacket. How can we govern it? Humanity cannot even define what a city is (fig. 5).

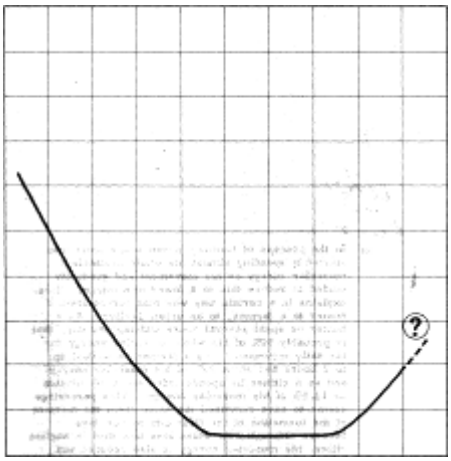

Fig. 6.Time spent on man's daily movement.

D. THE THEORY

Following the definition of the subject, the problems and their causes, we have to turn to the future and define our tasks, our policies and our programs for immediate action. In doing this we should not, however, repeat the grave mistake which humanity has made during the last century, that is, being unable to see the city as a whole system of life, and thus not readjusting its thinking and its actions in order to serve the city. We should not continue building without thinking of the city as a whole, without having a theory about our cities.

The first cause of the problems, that is, the explosion of forces will continue for the foreseeable future. Therefore this cause of the problem will remain, but this alone is not a reason for the problems. If man can be in control of the situation and look at the city in a proper way he can manage to govern it. To achieve this, we need a theory about human settlements, about what has happened, what is happening now, and what is going to happen. To form such a theory, we must carefully study man's long evolution from the time when he jumped down from the trees and started hunting in the steppes of Africa.

If we follow such an evolution properly, we can reach the following conclusions:

1. Human settlements follow certain laws which man has established through a long biological process by creating human settlements which serve his biological needs. We have to recognize that human settlements are a biological

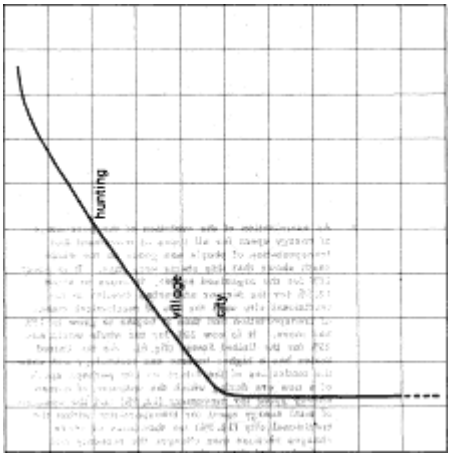

Fig. 7. Human muscular energy spent on man's daily movement.

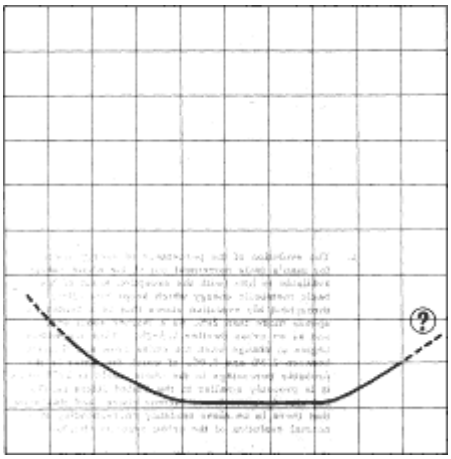

Fig. 8. Energy spent on total movement and transportation as a percentage of total available energy to man.

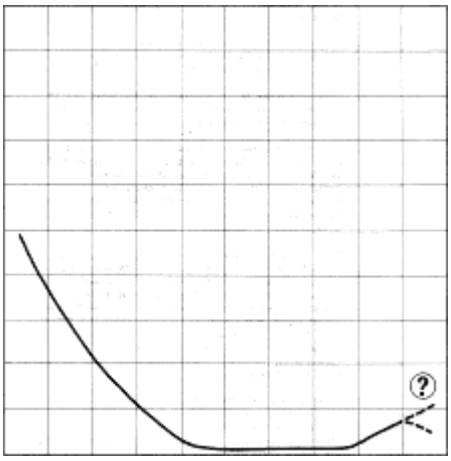

Fig. 9.Energy spent on daily movement percentage of total energy available to man.

extension of man, and for this reason they can be considered as large or macro-biological systems (Ref. 3).

2. It is clear that man moves daily as far as he reasonably can and that the basic characteristics of his settlements (which in every phase have almost always first been built without any overall plan) result from these daily movements. We can safely say that man moves in space on the basis of those patterns that best serve him. How else could it be? He can afford to make a mistake once or twice, but he will certainly not repeat it continuously. Changes in man's daily kinetic fields are therefore the clearest expression of his need for and experience of a better way of life under conditions existing on every occasion. It takes him some time to understand them but he always does in the end.

3. As time passes, man recognizes that certain new conditions have been created by his daily movement. It is then that he tries to organize the physical structure of his settlements in a way corresponding to the action he has already taken. If man has created by his action much larger settlements by adding many more houses to an existing village, he begins to recognize that he needs wider streets than in the village and he begins to widen them. He also begins to recognize the need of a larger square for the public market and he either enlarges the existing one or he creates a new one in the new areas of the expanding village. In another way we can say that following man's instinctive action to create a new type of settlement, man the engineer, man the builder takes over and tries to serve this new type of settlement.

4. It is later that man begins to think about the social and political structure of his settlements. Theseus is the symbol for the creation of the city of Athens but (whether Theseus is a real or mythical figure) we have no reason to believe that he invented Athens. It is much more probable that he institutionalized it after more and more people had started to build on and around the Acropolis. It was still much later that Hippodamus conceived the proper physical form of the city and that philosophers like Plato and Aristotle wrote about it.

5. Unlike the houses and the buildings of our settlements which follow a specific concept and plan (how else could people build a hut and put a roof on it?), the networks of man's movements seem to have grown by small continuous additions to an existing system, and only much later to were recognized and expressed by some concepts of the whole structure of the city. Throughout this effort, it seems that man always begins by building natural radial systems for his movements, irrespective of whether he deals with villages, cities, regions or the world. He then understands that his networks are not rational as they do not lead to the most economic use of the land, and do not give equal opportunities to everyone and to every location. As a result, man turns to the grid-iron system of networks

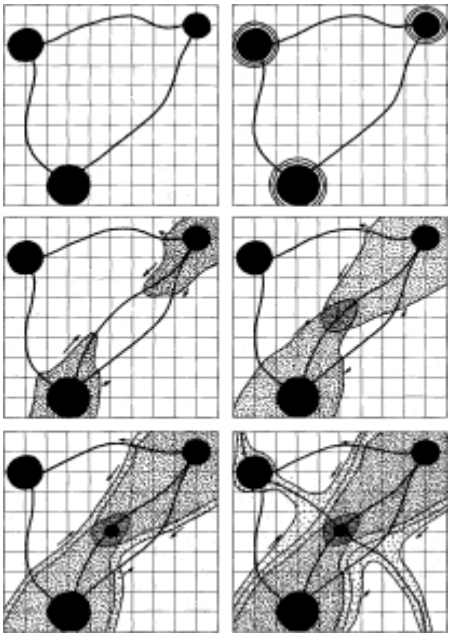

Fig. 10. Growth of a system:
phases A, B, pedestrian kinetic fields only
phases C,D,E,F, pedestrian and mechanical kinetic fields.

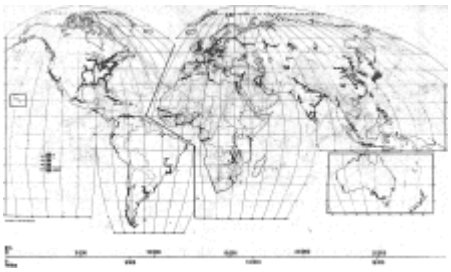

Fig. 11. Towards the universal city Megapolis in the year 2000 A.D.

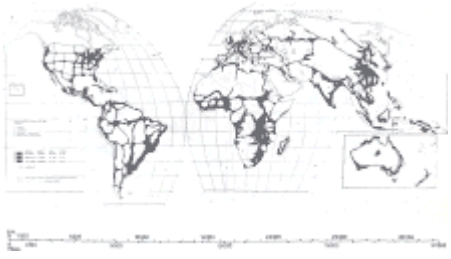

Fig. 12. Ecumenopolis in the world at the end of the 21st century.

which does not have these weaknesses. He has done so for his villages and his cities, he has done so for some rural areas by dividing the fields, and he has done so for some regions in times of colonization. At present, he is again beginning to see the weaknesses of the radial systems (Ref. 4).

6. The evolution of the maximum time spent by man for his daily movements shows that he started by spending many hours a day as a hunter. As a farmer he decreased his time spent to two hours a day, and as a citizen to half an hour. This seems to be his optimum, because he kept it for thousands of years until around AD 1800 when, under the pressure of growing populations and lack of means of transportation, he abandoned it. He now finds himself back at the point of spending as much time as when the hunter was turning into a farmer around 8000 BC (fig. 6).

7. In the process of forming human settlements, man started by spending almost his whole available muscular energy on moving and gradually tended to reduce this to a lower percentage. This explains in a certain way why man turned from a hunter to a farmer, to an urban dweller. As a hunter, he spent several hours walking per day, that is probably 50% of his whole muscular energy for his daily movement. As a farmer, he walked up to 2 hours and spent 25% of his muscular energy and as a citizen he spends today about 30 minutes or 12.5% of his muscular energy. This percentage seems to have remained the same from the moment of the formation of the first city to our days, because although man walks less now than in ancient cities, his muscular energy is also reduced and therefore the percentage remains the same. We can say therefore that in terms of personal biological energy spent for movement, the average healthy male citizen has reached his optimum in the city, where civilization has been created and develops (fig. 7).

8. An examination of the evolution of the percentage of energy spent for all types of movement and transportation of people and goods on the whole earth shows that this starts very high. It is about 20% of the organized hunter, it drops to about 12.5% for the farmer and urban dweller in the traditional city until the era of mechanical means of transportation and then it begins to grow to 15% and more. It is now 20% for the whole world and 25% for the United States (fig. 8). As the United States has a higher income and technology and shows the tendencies of the future we can perhaps speak of a new era during which the optimum of human energy spent for movement (12.5%) and the optimum of total energy spent for transportation within the traditional city (12.5%) for thousands of years changes because man changes the economy and the technology of the world.

9. The evolution of the percentage of energy spent for man's daily movement out of the whole energy available to him (with the exception again of his basic metabolic

Fig. 13. Ecumenopolis in Europe.

energy which keeps him alive) throughout his evolution shows that as a hunter, he spends more than 20%, as a farmer about 4-5% and as an urban dweller 1.5-2%. This percentage begins to change when the cities grow and fluctuates between 2.5% and 8.0%, of which the later is the probable percentage in the whole world in 1970 while it is probably smaller in the United States (4.8%), but also in some lower-income cities, and this shows that there is no clear tendency corresponding to a normal evolution of the urban systems (fig. 8).

We can now reach the following conclusions:

1. Man has always endeavored to create an optimum type of settlement, corresponding to the time and energy available to him.

2. The time spent for man's daily movement shows that he reached the optimum level of a maximum time-distance for urban dwellers of 10 minutes when he formed the first cities, and he kept it for thousands of years. This optimum is no longer kept in the cities of the present. As man does not easily change his optimum, something has gone wrong in his cities (see fig. 6).

3. Man reached the optimum of personal muscular energy he spends for movement and he kept it until the present (see fig. 7).

4. Man increases the percentage of the total energy available to him spent for movement and transportation in order to create a world economy (see fig. 8).

5. Man does not follow the same trend for his daily movement (see fig. 9) and this can be explained by the fact that for this he has the limitation of time (which is not the case for d. above), and also by the lack of a specific technology which could give him a system of movement corresponding to the possibilities of modern technology and economy.

6. It is quite clear that man *has not solved the problem of daily urban movement in a satisfactory way*: he spends more than the optimum time and does not use properly the energy available to him to satisfy the need for an optimum time. If he could spend much more energy for his daily movement (see fig. 9), let us say as much as the percentage of energy spent for total movement and transportation (see fig. 8), he could again reduce the time he spends (see fig. 6) to the optimum.

The processes of the formation of human settlements indicate that their growth will continue, not only as long as the population of the United States continues to grow (that is for at least two or three generations), but also as long as technology can provide better connections at higher speeds. These considerations, together with the analysis of

how the process of evolution takes place, lead to the conclusion that it is inevitable that human settlements will grow into continuous interconnected networks (fig. 10) within which we must expect increasing problems of man's movement and transportation, unless we act in time to face them in an organic way.

The history of human settlements has moved from camp to village, to city, to metropolis, to megalopolis, and now we are moving towards the universal city or ecumenopolis by the year 2000 (fig. 11) and at the end of the twenty-first century (fig. 12) (Ref. 5) whose anticipated shape can already be discerned in Europe (fig. 13), in the United States (fig. 14) and in the world.

Fig. 14. Ecumenopolis in the USA at the end of the 21st century.

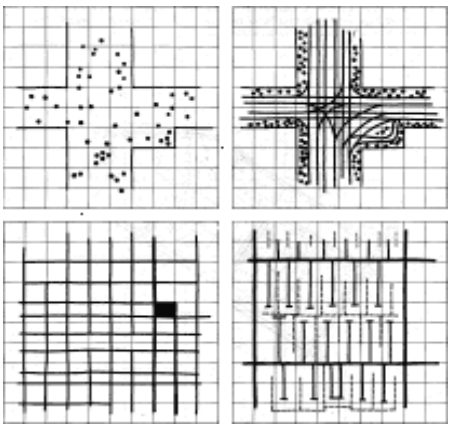

Fig. 15. (top left) Crossroads in the city of the past, the citizen is king.
(top right) The same crossroads in the city of the present the citizen is a slave.
(bottom left) Automobile traffic controls the city of the present.
(bottom right) There is an imperative need to separate the paths of Man from the paths of the machines.

E. THE TASKS

It is now our task to understand the action needed in the present phase of the evolution of human settlements as biological systems, in the light of their inevitable future. Our task can be described as the obligation to eliminate the problems which we face. We must avoid the loss of quality which we witness today and return to what we have called the quality of human settlements of the past. This includes the more specific tasks:

One: To avoid the pollution of the human space. This means that we have to create conditions allowing man to be in control of the space around him, in order to help himself develop in a human way.

Two: To avoid the pollution of the natural environment, that is, of land, water, and air resources, so that we can breathe clean air once again; recreate and save what is considered as a beautiful environment, hear an amount of noise which we can stand without suffering, smell what we like and touch or taste the elements of the natural environment which are clean and not polluted.

Three: To avoid the disruption of the social structure which has been caused by the systems of transportation.

In addition to this we have to re-establish equality which has been lost and this can be achieved in the following ways:

Four: Create an urban environment where people can walk freely and this means that we have to separate the paths of man from the paths of the machine, and this means even more that we have to gradually move the machine underground in the same way in which we have hidden the electric wires, which were first on the surface of our walls.

Five: Re-establish equality in terms of transportation by giving to everyone, rich and poor, young and old, the same opportunities to use the means of transportation.

This could done either by elimination of the opportunities given to those who can afford to have private means of transportation and drive them, or by making available the same types of machines to as many people as possible.

As the first is neither reasonable nor feasible, it is our task to make the means of transportation available to everyone and this means that we have to solve many economic and technological problems.

Finally, we have to face the problem of the smaller return for the energy expense and this means:

Six: Increase the efficiency of the transportation systems to achieve a much greater economy and much higher speeds within the urban area.

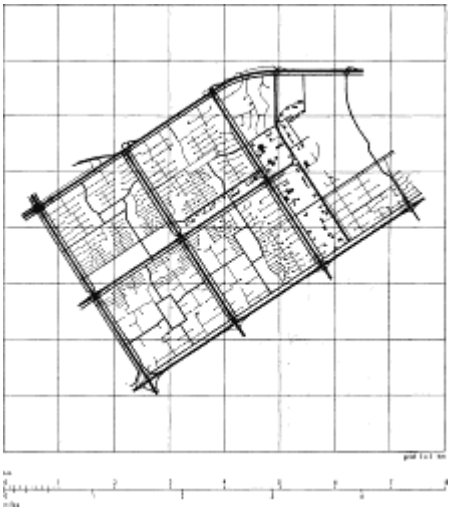

Fig. 16. Implementation of the principle of the cities for human development. These sectors correspond to dimensions of 1x1 mile. They are surrounded by high-speed highways, but traffic in them is at very slow speeds, decreasing to ten miles per hour in residential streets.

F. THE POLICIES

On the basis of the tasks already defined, the policies which can help the nation achieve its goals have to comprise all six basic points.

First: The cities for human development. The basic problem of the pollution of the human space, the pollution of the natural environment and the disruption of the social structure cannot be solved unless we recognize that we will again build cities for human development, which means cities where the citizens will be king, where man and not the machine will be in control of public space. This means the need for separating the paths of man from the paths of the machine and can be achieved in two stages. The first stage can be achieved by a new concept of a network for man's natural movement which does not cross the paths of the machine, but infiltrates within it. The pattern is as shown in figs. 15, 16, 17 and leads to communities the dimensions of which can reach up to 1x1 mile, as historical experience and present experimentation have demonstrated (Ref. 6). Such a policy will help avoid not only the problems of loss of quality, but also the fourth problem of loss of equality in movement and the sixth problem of low efficiency of the transportation systems.

Second: The major transportation regions (as defined by the Act) have to coincide with what is now tending to become the Daily Urban Systems. Man has again taken his decisions. At present, he moves up to a radius of almost 80 miles or beyond within urban systems (Ref. 7). These distances which are covered daily by a few people tend to become normal distances for more and more people. As

Fig. 17. Implementation of the city for human development in the urban renewal project of Eastwick, Philadelphia, now under construction.

Fig. 18. A tentative scetch of Daily Urban Systems (DUS).

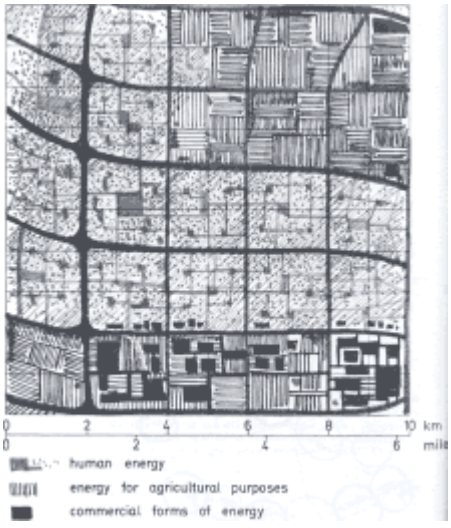

Fig. 19. The cities for the human development. Some of them are completely dedicated to urban action.

our policy should tend to cover the needs in the future of the next one or two generations, at least, we should reckon with regions of this size.

A preliminary study proves that there are 55 to 60 such Daily Urban Systems (fig. 18) which have to become the basic units for studies recommended by the Committee. Such a policy will help to solve the second problem of pollution of natural environment, the third one of the disruption of the social structure, the fifth one of the loss of equality in transportation and the sixth one of the low efficiency of transportation systems (figs. 19, 20).

A demonstration of how such a Daily Urban System can be prepared for its future and remodeled in terms of transportation, in terms of environment and in terms of natural and social structures which will serve man is given by the study of the Urban Detroit Area, conceived and guided by Mr. Walker Cisler, Chairman of the Detroit Edison Company for the last five years, and published in three volumes presenting the alternatives which we have and the programs which we have to carry out (Ref. 9).

This project, which could be considered the first to cover all problems of such a Daily Urban System, demonstrates that humanity once again is beginning to feel the grave mistakes brought about by the concentric systems which bring all pressures on our central cities. Humanity is entering the phase during which we will need to turn to the grid-iron systems which help man organize his countryside in a rational way. This was done in Thomas Jefferson's time by the establishment of the grid-iron system of townships and the grid-iron networks. This was abandoned later and has to be re-established again (fig. 21).

Third: A national transportation system. In order to maximize the advantages to be gained through the adoption of the first and second policies, we have to connect the unit of the city for human development, which is the smallest planning unit, with the major transportation regions or Daily Urban Systems in the national scale. This will lead to new concepts of transportation systems covering large distances. Between the national scale and the Daily Urban System there will be a need for regional coordination which can be achieved in such areas as the Eastern Megalopolis or the Great Lakes Megalopolis (Ref. 8) which have common interests and lead to common biological systems (fig. 22).

Such a policy will lead towards the solution of the second problem of pollution of the natural environment, of the fifth one of the loss of equality in transportation and the sixth one of the low efficiency in transportation systems.

Fourth: The creation of biological transportation networks. This means that all lines of transportation must

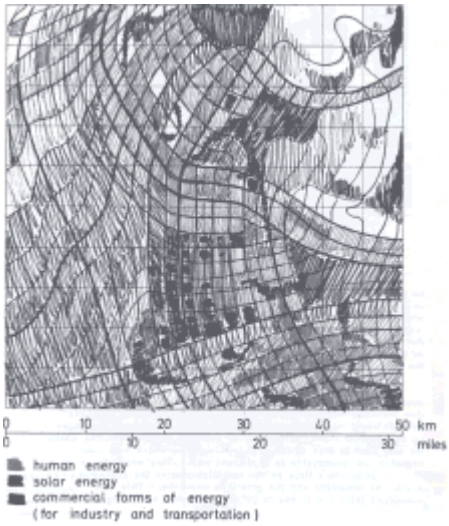

Fig. 20. Pattern of a Daily Urban System. It serves the purposes of man and respects the natural environment, but dedicating some parts to human life and energy, some to solar energy or agriculture and some to production or commercial forms of energy.

gradually go underground as speeds will have to increase. If speeds increase, there is no need whatsoever to connect man aesthetically with the landscape around him and no reason to waste landscape resources. The study of any biological system proves that all the lines of transportation have to go inside and not on its surface and that the higher the speed the deeper we go. This is demonstrated in the body of mammals by the fact that the speed in the capillaries is 0.5-1 mm/sec, in the veins its is 20 cm/sec, in the carotids 33 cm/sec and in the aorta 44 cm/sec or about 700 times more than in the capillaries (Ref. 10).

The biological transportation networks which, in the long run, will be buried deep in the earth can, at the beginning, just be separated from the paths of man, as already suggested in the first policy. The implementation of this policy will facilitate the solution of the first problem, that is the pollution of human space; of the second problem, the pollution of the natural environment; of the third, the disruption of social structure; of the fourth, the loss of equality in movement and the sixth, the low efficiency of transportation systems.

Fifth: Creation of technologically and economically optimum transportation networks. Overall concepts, overall coordination, integrated systems will no help unless every part of the mechanical transportation system can be technologically and economically optimum. Such a policy will contribute to the solution of the problems of the pollution of natural environment, and of the low efficiency of transportation systems.

All the above policies will not solve the fifth problem of loss of equality in transportation which is a very serious social and humane problem. As already mentioned in the description of the tasks, this equality can be achieved by the elimination of the advantages of those who have the mechanical means of transportation at their disposal, because of their income, age and health. This would be an unreasonable and impractical policy. Human evolution shows that after the technological revolution, equality is not achieved by the loss of advantages gained by the most privileged people, but by the wider spread of the same advantages to all those concerned. In practical terms, such a policy means that for the time being everyone who can drive should have a car. This might well mean subsidies for automobiles, giving every family the same opportunity for mobility.

Why should we have subsidies for housing and not for automobiles if mobility is as important for freedom in the city as the home is for quality of life.

In the long run, a wiser policy would be to achieve automated systems of transportation whish could serve anyone, rich or poor, old or young, healthy or sick. The only thing that would be required in such a system would

be the ability to enter a vehicle as we now enter an elevator, and push a button. This automated system will go side by side with the implementation of the underground networks (fourth policy).

Fig. 21. UDA - the development plan, a preliminary concept for the year 2000.

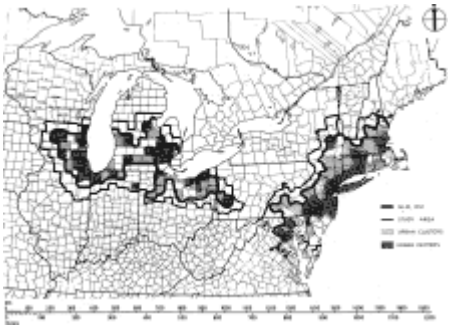

Fig. 22. The Great Lakes Megalopolis.

G. THE PROPOSALS

In order to achieve the tasks already defined by the implementation of the policies described, we have to move along the following lines.

1. We should establish the principle of the city for human development which will help everyone to have a much better life in a much better environment and define the conditions under which all existing parts of cities and their new parts can get the support of the Federal Government for the solution of these problems. The basic condition is the recognition of the right of the child to cross the street.

2. We should establish the Daily Urban Systems as the boundaries for the major transportation systems. These will be just one expression of the overall plan for a new type of human settlement, incorporating urban and rural regions, since there should be no distinction made between them in the future. This is no longer justified in the era of new technology.

3. We should establish the national transportation system and the conditions under which this will be connected with the Daily Urban Systems.

4. We should establish a policy of subsidies for the acquisition of automobiles, under the same principles on which support is given for the acquisition of private homes. In the meantime we should give full support to mass transportation systems corresponding to the existing technology and means of transportation, or the final ones as described in point 5 and 6.

5. We should undertake the research for the gradual transformation of our systems into natural biological ones, and define the special policies giving special assistance to those who will lead in this direction.

6. We should begin the research for the development of technologically and economically optimum transportation networks and define the special policies leading to their implementation.

7. We should begin the process of research for the development of an automated transportation system, which is the foundation of a better life for the future, and in the long run leads to the same goals as points 5 and 6.

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