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A Super-Roof Concept for New Towns in Extreme Climates

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INTRODUCTION

The habitat of man has evolved in stages from caves and other natural shelters to tepees and igloos, then to huts and cabins, and finally to the present-day scattering of houses and buildings. In this last stage, the structures individually offer their occupants protection from one or more uncomfortable aspects of the climate, but they are usually separated from each other by outdoor areas that are still at the mercy of the vagaries of the weather. Thus, during travel from one building to another, man frequently must endure the discomforts of rain, snow, heat, humidity, dust, and pollution. In the industrialized countries of the world, he has attempted to solve this problem by equipping himself with a private automobile that is weather-proofed, heated, and often even air-conditioned. But he now finds his environment becoming so congested with automobiles that it takes him longer and longer to get from one place to another and he must park his car farther and farther from the building he wishes to enter.

Economics and tradition make it difficult to alter this pattern of isolated structures and transportation by private automobile. But an examination of world population trends and of the habitability of various portions of the earth's surface suggests that new approaches to the problem of housing will be needed in the future. Consider first the Declaration of Delos Nine (1), in which it is projected that world population will "inevitably" reach seven billion by the year 2000 and that more structures must therefore be built in the next generation than have been built in the entire history of man. Consider simultaneously the analysis by Antonopoulou-Bogdanou (2) of habitability of regions of the earth's surface. Taking into account factors of elevation, climatic rigor, and water scarcity, he predicts that even with continued technological development only about one-third of the land area of the earth will be suitable for extensive habitation by the year 2060. It appears, then, that population growth is the irresistible force that is meeting the immovable object of fixed habitation patterns.

AN ALTERNATIVE APPROACH

One way out of this dilemma might be to give serious attention to the proposals of Fuller (3) and Zuk (4) for utilization of a transparent super-roof to enclose entire cities of the future. This idea has been explored previously by the author (5) as part of a proposal for a low-cost housing complex. It is expanded in this paper to the scale of a complete new town. The capability of climate control would allow construction of towns in areas such as Siberia or the Sahara where the natural climate is normally considered too harsh for urban habitation. Inside the enclosure there could be an "outdoors" that is free from unexpected precipitation, uncomfortable extremes of temperature, wind, and humidity, and air pollution. To justify the cost of the dome, the internal space will need to be used efficiently, with a population density somewhat greater than that which is usually considered desirable. This disadvantage could be mitigated, however, by planning the interior layout with careful attention to both the physical and spiritual needs of the inhabitants. As pointed out by Michelson (6), it is not the density itself but the way in which people are separated from each other and from the nonresidential parts of the environment that determines the extent of density-induced pathology in a society.

TECHNOLOGICAL CONSIDERATIONS

As a specific example, suppose that the town is to occupy a circular region with a diameter of 5960 feet. This gives a circumference of 18,700 feet and an area of 640 acres or one square mile, which is four times the area of the enclosure discussed in (5).

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With a proposed population of 40,000 persons, the gross density would be the same as in (5), i.e., 62 persons per acre or 154 persons per hectare (New York City's overall density is 94 persons per hectare, Tokyo's is 50). These figures do not seem unacceptable if it is visualized that the town would have a "multiple-level" design, with the result that the usable area would be increased and the net density decreased.

The difficult question of structural feasibility is not addressed in detail in this paper because it seems preferable to first establish the economic, ecological, and sociological desirability of a super-roof. It is probably safe to assert, however, that before a clear-span roof one mile in diameter can be designed, intensive research will be required into the behavior of very large domes under dead load (the weight of the dome itself), wind loads, snow and ice loads, earthquakes, etc. On the other hand, such a roof in no way appears to be an unachievable goal, any more than a suspension bridge with a main span one mile long was an unachievable goal.

A PROPOSED NEW TOWN

Figure 1 shows schematically some of the functions to which space must be allocated in the interior of the dome and around the exterior periphery (representing the interface with the external man-made environment). The fraction of the space devoted to each function and the actual physical arrangement of the parts of the town are left unspecified herein, but they should be decided upon in accordance with some reasonable set of design objectives for a new town. As an example, those advocated by the American Institute of Planners (7) are:

1. Variety of choice of housing for residents
2. Minimum cost
3. Attractiveness to economic investment
4. Diversity of activities
5. Flexibility
6. Expressive forms and coherent patterns

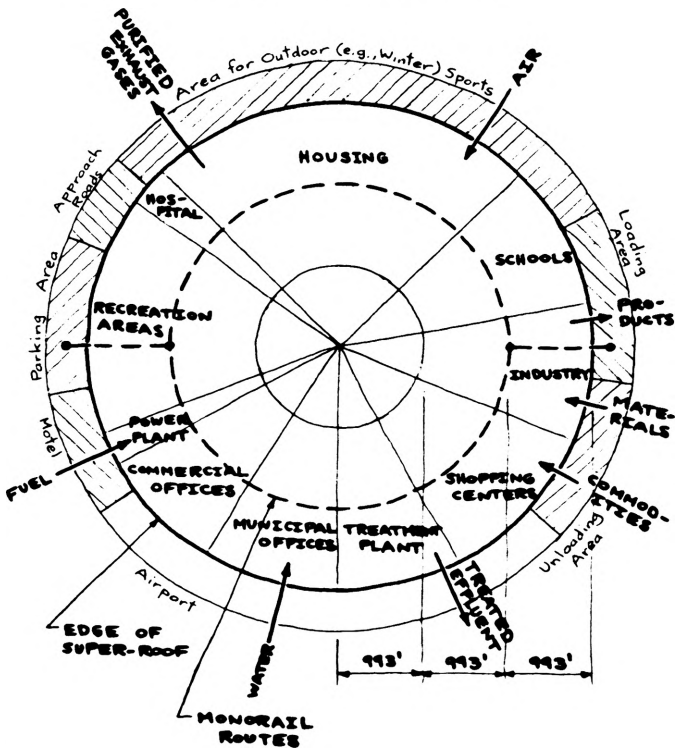

Fig. 1.

Other principles of planning for new towns have been formulated by the United Nations (8).

Figure 1 also shows some of the inputs and outputs between the town and the outside environment. It would seem desirable in some instances to have a town that is self-sufficient in an economic sense and in all cases to strive for minimum net pollution to the outside environment.

Because the town is completely enclosed, no internal-combustion engines can be tolerated inside. The transportation system could consist of a free monorail forming a loop inside the dome and connecting at two points or so with the outside periphery, plus numerous bicycle paths and footpaths. In addition to the transportation system, a modern communication system would be desirable. As one suggestion, an emergency health-care unit (including a physician) should be able to reach any point in the town at any hour of the day or night within five minutes of notification.

CONSIDERATIONS OF HUMAN ECOLOGY

To be successful, a new town must satisfy the spiritual as well as the physical needs of its residents. How to insure this at the design stage is a question for which the social scientists have not yet produced a definitive answer. Michelson (6) has examined in a penetrating way the relation between man and his urban environment. He has raised many questions, has answered a few, and has cast doubt on some cherished notions about criteria for successful housing. Above all, he makes a plea for more intensive research on the sociology of housing. Zehner (9) has reported on actual resident acceptance of the new towns of Reston and Columbia as compared with two less well-planned suburban communities. He has identified some consistent characteristics of successful housing such as good maintenance and low noise level, but, like Michelson, he discovers that many factors differ in their importance to different groups or classes of people.

CONCLUDING REMARKS

The concept of a self-sufficient town enclosed under a single transparent super-roof has been explored briefly in this paper. To establish its feasibility, more research is needed by the engineers, the city planners, and the sociologists. Once a better understanding of the possibilities is achieved, the concept could be adapted to floating cities, extraterrestrial colonies, and undersea habitats. In some of these applications, of course, the town must be not just self-sufficient but completely self-contained (i.e., everything needed is produced internally, and all waste is recycled).

There, then is the challenge. How will it be met?

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