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Name Vladimir Rodin

Typology and Conformity to Natural Laws of "Chaotic City" Development (Tokyo, New York)

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Attractor - the term is taken from contemporary physics and used here to denote distinct elements of structural stability in the urban complex dynamic system.

Introduction

In 1980 B. Mandelbrot developed Fractal Geometry. Fractals were found in nature: coastlines, clouds, snow flakes, trees, the functioning of human lungs, blood circulation, etc... (Feder,1988). Chaos theory, which is emerged on the basis of fractal geometry, states that Chaos is the principle that ultimately reintegrates and refreshes all existing forms of life. "Chaotic behavior" is an integral principle of functioning within nature (Coping with Chaos, 1994). Archetypal examples of "chaotic" behavior are the weather and the stock market. Principle characteristics of a chaotic natural system are existence of complexity (unpredictability), self-similarity (not self-sameness), self-organization around points of attraction and the existence of Fractal Nature (fractal dimension) (Feder,1998).

At the initial point of our investigation of the development of "Chaotic Cities" we were interested in finding out the logic hidden in the all too chaotic layout of Tokyo. We established that Tokyo's visually chaotic development conforms to the Natural Laws. We can compare Tokyo's layout with the development of natural systems in which the presence of chance, plans, fates and solutions reflect a fractal dimension (V.Rodin, E.Rodina, 2000). If the city is functioning, its development should have natural "chaotic" characteristics. In the second stage of our research, we decided to find out if "Chaos" exists in the development of New York, especially in Manhattan the part of the city famous for its regular urban pattern. During the research project, we made use of generalization of spatial urban systems, group analysis and the analytical method.

Tokyo

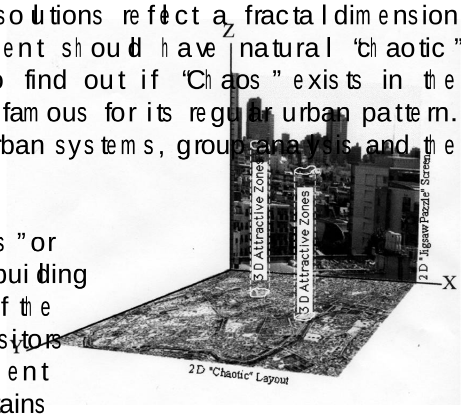
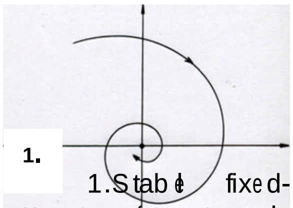
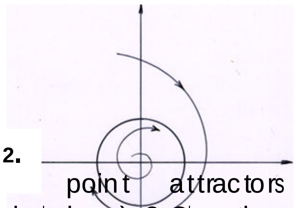
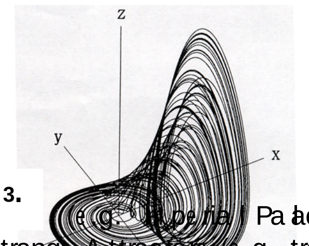


Fig.1 Tokyo's urban structure

Conditionally we can divide Tokyo into a zone of so-called "stable chaos" or 2D "chaos" within the plane of the street pattern, and a 3D "chaos" of building mass. The rate of modification of the latter is much higher than that of the former. In fact, the 3D of urban space appeared to be "invisible". For visitors and inhabitants, 3D urban space appeared as 2D planes with advertisement boards. Similar to a natural system, Tokyo's chaotic environment contains a self-similar element of repeating advertisements and functions. The "virtual" structural organization of Tokyo's "invisible" 3D building mass shows the presence of the second main characteristic of Natural System - self-organization around 3D Attractors. 3D urban attractors organize the city mass and help inhabitants to orientate themselves in the city (Fig.1). A virtual matrix of the city contains zones of attraction, attraction zones containing attractors inside; those attractors in turn contain smaller attractors, etc... Each person has a different "internalized route" containing a "virtual" itinerary within the urban mass to the urban attractors. The urban structure of Tokyo's attraction zones can be compared to the Russian toy "Matreshka" doll that contains within it similar smaller dolls, but in different costumes. Generally attractors have topologically distinct forms of dynamics: stable fixed points, limited-circle attractors, semi-periodical attractor zones, etc...(Feder,1998). Within Tokyo's urban development, the main types of attractors distinguished were:

1. 
2. 
3. 

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1.Stable fixed-point attractors (e.g. Imperial Palace). 2. Limited-circle attractors (e.g. temples and shrines). 3.Chaotic or Strange Attractors (e.g. train stations, commercial zones, entertainment zones -Kabuki-cho). 4. "Frozen" or Dead Attractors – zones that were intended by the urban planning committee to be attractors, but which in fact became abundant zones (e.g. Metropolitan Area in

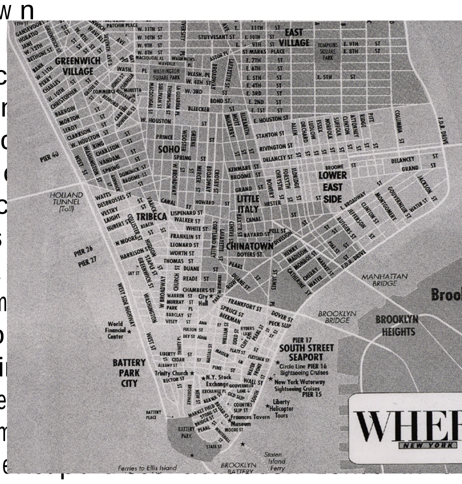
Shinjuku, Daiba).

It was interesting to discover that the place of attractors in the city has hardly changed with time. For example, we discovered that the old city of Tokyo (Edo) lay almost entirely within the circle created by the present-day Yamanote line –the main attraction zone in Tokyo. Edo, historically attractive to surrounding villages, turned into the main commercial and entertainment attractor on the Yamanote train line. The Yamanote train line is the only border within the city that can be clearly distinguished ;borders between the attraction zones in Tokyo are unclear. With changes in world-outlook, the various types of attractors changed their meaning for people. It is important to emphasize that different social groups have different types of attractors. An intersection of interests in attraction zones creates main Attractors within the city.

New York/Manhattan

Similar to the Yamanote Circle zone, Manhattan itself is a big limited attractor within New York City. It is hard to find "Chaos" in Manhattan's "standard regular" urban structure, but it is "chaotic" in a virtual sense, in its spirit. "Chaos" we can observe in self-organization and migration of different cultural communities. Natural Laws in the scenario of the city development are represented by self-similarity in service functions and in the organization of cultural communities. The structure of attractors within Manhattan is different from that of Tokyo. Whereas in Tokyo, the principle attractors are train stations incorporated into the big commercial zone, in New York the main attractors are streets themselves (e.g. Fifth Avenue, Broadway). There is no need (as in Tokyo) to create a virtual route to attractors ; routes are attractors themselves in Manhattan and they in turn contain smaller attractors, etc...The difference in attractor structure comes from the fundamental difference in thinking about space. The Japanese approach has more affinity with area (hence the importance of "totem mat" and the floor of the building and the "machi" as an area unit of organization of the city). Western approach has more with the line (the sequential ordering of buildings along city streets) (Yoshinobu, 1987). Within main zones of attraction in Manhattan (Mid-town, East side, Downtown) we can distinguish the following types of architectural attractors: Stable fixed-point attractors (e.g. Times Square, Fifth's Avenue, Broadway), Limited-circle attractors (e.g. Central Park), Chaotic or Strange Attractors (e.g. various cultural zones in Downtown, commercial zones of Mid-town).

It is hard to distinguish borders between zones of attraction in Downtown (Fig.2).Tourists search for Little Italy in Tribeca and for Soho in Greenw



Village, while local habitants try to answer the typical question of exac where Little Italy starts. There is no precise sign or architectural elemer (except the Arch on Washington square), that distinguishes the entranc to a district. It might be not a bad idea to create some types of archite ural attractors, which will also have the meaning of a gate to a distric It is important to mention that a city in general can be represented as a multi-layer structure which develops along the time axis, the socia axis, and the architectural axis. In New York, the axis of cultural com munity distribution and development does not correlate with the axis o t of the buildings were built in the beginning of the 20th century, but i s "migrated" within Manhattan and New York in general; this phenome e between the community that originally built the buildings and the com j. Harlem). In Japan population and architectural style are congruent, e International Global Style. In both two cities, New York and Tokyo, we can observe self-similarity and self-organization around points of attraction. In Tokyo it is self-organization of urban mass around fixed-point attraction zones, in New York it is self-organization of the social mass within stable urban structure. Indeed social complexity contributes to the penetration of "chaos" (consequently of life) in to the "standard regular" urban structure of Manhattan. Both cities have complexity: Tokyo in its urban structure, New York in its social structure. It a paradox that the social order of Japanese society exists within the "chaotic" urban pattern, and the social "chaos" of New York exists within the strict order of an urban grid-work pattern. We found the existence of the fractal dimension within Tokyo's street pattern ; the fractal nature of the development of the social communities in New York is still a question for us.

The Discovery of fractal dimension in Tokyo's 2D urban Structure

In our analysis of the zone of "stable chaos" within the 2D chaotic plane of Tokyo's street pattern, we used a formula obtained by Hack during his study of 400 rivers in Virginia and Maryland (Feder,1998). He received the following ratio between the length of the longest river above a given location and its drainage area

$$L = CS^{D/2} \qquad (1)$$

where D is fractional and ranges from 1 < D < 2.5.

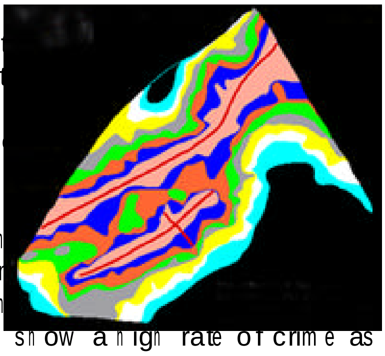
D is an index of fractal dimension. The D fractional can characterize an irregula pattern. For the "standard regular" urban structure (Midtown Manhattan, Fig. 3 a well-known formula of fractal dependence of the line from the area

$$L(d) = C d^{1-D} (A(d))^{D/2} \qquad (2)$$

is true with D-integer, for example D = 2.

We applied formula (1) to an estimate of the ratio between the longest street in the limited "chaotic" urban zone and the area that it occupies (Fig.5,6). Unexpectedly, we found the existence of the fractal dimension during the investigation of the 6 "most chaotic" zones in Tokyo: Shinjuku D=3.24 Shibuya D=2.34 (Fig.5), Ikebukuro D= 2.54, Ueno D=2.4, Nakano D=1.66, Aoto D=2.8 (V.Rodin, E. Rodina, 2000). Shibuya, Nakano and Ueno show the same index of the fractal dimension as rivers in Hack's study. Of course, our inves gation is entirely qualitative rather than quantitative. Coefficients were calculat with a fairly large margin of error because all calculations were done manually. is possible to create a computer program to provide a quick and precise result estimate of the fractal dimension of city streets.

Fig.4 Shibuya - street order



The creation of a computer program

At the present time we have created a test version of a computer program th map and defining areas with a high index of fractal dimension, and of reco planning and reconstruction. Such areas are considered negative because th navigate and escape from in case of emergency. In most cities these territories show a high rate of crime as a result of bad illumination, lack of people, distance from the main roads and police stations.

The work of the program performed as follows: for dynamic graphic programming the Sprite system is used. At the initial stage, on the map of the city we mark out the Background (the static part of the map): all dwellings, industrial enterprises, squares, parks, etc... A special color is assigned to them. All basic lines of communication (roads, highways, foot and bicycle routes) are uncolored. Then the dynamic Sprite in the form of a square (after the program development we transformed it into the form of a snow flake) follows communication lines on the map (Fig.6), distinguishing the street order and calculating the area occupied by the streets within each order.

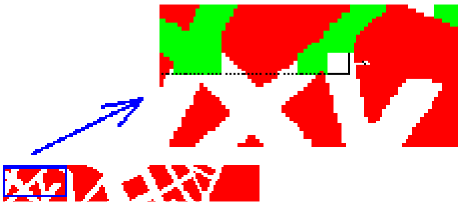


Fig.6 The work of Sprite System

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