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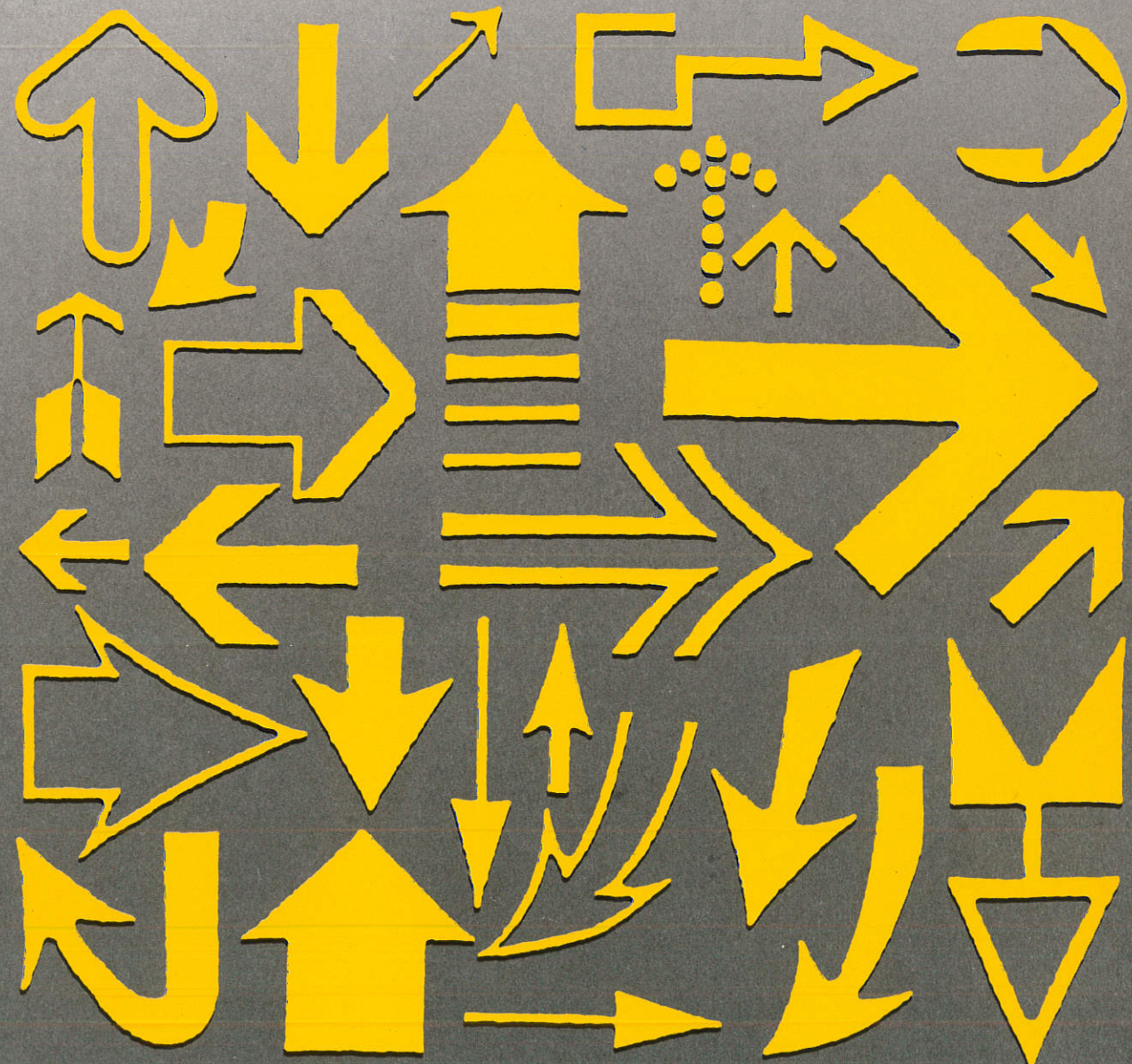
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An implicit large territorial-technical system: settlement systems

DENISE PUMAIN

SEVERAL THEORISTS, SUCH AS P. Vendryes, provide a very general interpretation of the finality (conscious or unconscious) of the great technical innovations undertaken through the course of history by human societies. The underlying trend behind these achievements is an attempt to reduce the uncertainties which threaten these societies' ability to maintain and reproduce. To a large extent, the risks to which societies are subjected come from their dependence on the unforeseeable variations of their immediate environment, on the fluctuations in the resources offered by the close territory, the site on which they are established. A considerable amount of energy is therefore spent by most societies to ensure control over distant sites, over a wider territory, and to develop communication between complementary resources provided by different sites (Reymond, 1981).

The concept of a large technical system is used to designate conscious attempts to control this process of creating communication links (Bijker, Hughes, Pinch, 1987). We wish to explore here the similarities between their functioning and that of a system which, although it is insufficiently or not consciously controlled, has none the less proved to be exceptionally efficient for the running and management of territories and especially for the lasting development of societies. We are referring to what is known as the settlement system, whose function is to link the territories of daily life to territories with a wider reach and which, by linking up the resources of increasingly distant sites, make it possible to go beyond the ecological limits to the development of human settlements. The settlement system thus appears as the major adaptation instrument of social organizations to the conditions offered by the surface of the earth, according to a process which tends to replace surface area and the natural environment by space produced by human societies.

THE CONCEPT OF THE SETTLEMENT SYSTEM

A settlement system is defined, in a given territory, by all of the inhabited nodes, hamlets, villages, towns and the communication networks, equipment and information that connect these nodes. The notion of territory is taken here in its administrative or political sense, as a contiguous portion of the earth's surface appropriated by a group, which signifies a degree of homogeneity of the socioeconomic conditions and overall control over possible circulation in the territory (Hubert, 1993). Networks are engendered by and enable multiple

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interactions between the inhabitants of the various settlement nodes, whether these be monetary (trade), human (migration) or informational. The environment of this system, initially and above all constituted by the agricultural and mining resources of the accessible territory, has, through history, become less and less limited by the natural environment, and increasingly built-up, as industrial and urban society has developed and has gradually become its own milieu.

The world's settlement systems are characterized by very strong properties, relatively invariable depending on the historical period or territory being considered. The first property is a very hierarchical structure, which translates into great differentiation of the size of the elements in the system, from a few dozen inhabitants in hamlets to more than 10^6 in today's large metropolitan areas. The general model which demonstrates this organization is an inverse geometric progression of the number of towns according to their size. Historical studies (De Vries, 1984 ; Carroll, 1992), or even archaeological studies (Fletscher, 1986), as well as the most recent international comparisons (Moriconi, 1993), all bear witness to the universality of this model in space and time.

This hierarchical structure is accompanied by a certain regularity in the spacing of the population units, generally even greater where large towns are concerned. The theory of central places (Reynaud, 1841, quoted by Robic, 1982; and Christaller, 1933), explains this configuration by the principle of centrality, which justifies the grouping in the same place of the production of services of the same level destined for a dispersed population in a complementary area (or zone of influence), whose center polarizes the clientele. The centers are hierarchical due to the existence of several levels of services defined by spatial range (the distance that the customer accepts to travel to obtain the service) and by appearance thresholds (determined by the volume of customers necessary for the profitability of the service offered). The zones of influence of the centers are superimposed as upper level centers generally offer all services of lesser reach. Competition between centers consequently leads to regularity in the spacing (distancing) of towns, and the hierarchy in the levels of services leads to a lesser number and greater spacing of centers as one moves up in the hierarchy.

The second very general property, not taken into account by the theory of central places, is a functional differentiation of the inhabited sites which, for sites of equal size, translates into specialization in the various activities of the villages and especially of the towns

belonging to the same territory. This specialization is sometimes linked to the services offered to the population such as they are taken into consideration by the theory of central places, but they far more frequently result from the concentration of activities whose production is not necessarily destined to a neighbouring clientele. Today, this is the case for most industrial activities, but also for some services, such as transport or business services. If the deposits in the mining basin or the amenities of tourist areas sometimes determine the grouping of towns specialized in the same type of activities, the localization of specialized towns is most often very sporadic and follows no regular pattern. Specialization in one or several types of activity defines the complementarity between towns in the same territory and partially conditions their growth. The major specializations emerge along with the greater cycles of technical and economic innovation (for example, that of the first industrial revolution, or of the development of electricity), in particular where they rely on unevenly spread resources (such as coal or ore deposits, or tourist sites). Most often, though, innovations have a dissemination process which conforms to the hierarchical organization of settlement systems (Pred, 1977). Even if innovations may appear anywhere, large towns provide a more favourable milieu for their emergence and, in any case, possess a more diversified social and economic base, from which innovations can be the first to benefit. Innovations are then spread to the rest of the territory, reaching the medium-sized towns, then the small towns, sometimes even the villages. This hierarchical dissemination process helps to maintain and amplify (in view of the initial advantage conferred by the early adoption of an innovation) the hierarchical contrasts in the structure of settlement systems.

The third important property is the very great interdependence of the evolution of elements belonging to the same system. Changes in the morphological configuration (urbanism), in the activities (industrialization or tertiarization), in the social composition (development of salaried employment, increase in qualifications), in the number of inhabitants (rural exodus, urban growth) very rarely appear in an isolated and sporadic manner in a single element of the system. On the contrary, the results of detailed analyses of the change occurring in all the towns of a given territory reveal a great homogeneity and simultaneity of the transformations taking place during a given period (Pumain, Saint-Julien, 1978). As change is of almost the same intensity everywhere, and the inequalities and differences existing at a given time between towns are maintained over fairly long durations. Everything happens as if, during a given period, towns

belonging to the same system undergo a simple translation in the space defined by their socioeconomic characteristics, the settlement system adapting to change without deforming its structure.

This dynamic property leads to a "meta-stability" of the functional and hierarchical structure of the system over periods which are respectively medium (economic, social or cultural specializations remain very strong for at least a few decades) and long term (inequalities in the size of towns, particularly in the upper part of the hierarchy, generally for several centuries). The resilience of the structure of the system is the result of its strong connections, provided by exchanges of goods and, above all, by exchanges of information, as well as by competitive attitudes and the imitative behaviour of localized actors, which ensure increasingly rapid dissemination of innovations. The speed with which the system can adapt to change has therefore become far greater than its own speed of transformation. This trend has become accentuated over historical time with the increase in the speed of communication, which tends to increase the spatial range of interactions within the settlement system and which also has the general consequence of reinforcing its hierarchical structure (Pumain, 1992)

SPECIFIC "TECHNIQUES" FOR THE TERRITORY

The settlement system holds a key position in what geographers sometimes call the "spatial system" (Pinchemel, 1988 ; Brunet, 1990). This pattern of the articulation of the main social finalities assigned to a territory effectively positions the functions of appropriation, production, circulation and management (administration) in the settlement system, which describe the relationships of any society with its territory.

THE FUNCTIONS OF VILLAGES AND TOWNS

While it is obvious that agricultural hamlets and villages are the places that group together the work force that guarantees agricultural production, the multiplicity of functions fulfilled by towns is established as soon as they are set up, and subsequently attested by the fact that it is impossible to give towns a simple and unequivocal definition. Thus archaeologists and historians are divid-

ed as to the main role of towns, the one that justified their appearance: were they initially markets, centers with an economic function destined to sell agricultural surplus (Bairoch, 1985), or high places of cult, embodying, in symbolic representations, a religious power (Weatley, 1969 ; Racine, 1993)? Or then again, centers of political power (Duby, 1985)? All towns, right from their origins, have probably fulfilled each of these functions to varying degrees.

The difficulty of limiting the notion of a town within a simple definition is another consequence of the diversity of the technical finalities assumed by towns. The first finality is to be a place of residence for a large, permanent group of a population, assembled in a confined area. The demographic, morphological and town planning definitions of a town underline the great dimension and the high density of these settlement aggregates, the spatial continuity of "hard" constructions and their organization by town planning rules and technical networks.

The town is also a place of production, since, as it groups together a large population on a limited surface area, it cannot produce sufficient food resources for the survival of its population. The social, functional and economic definitions of the town underline the fact that mainly non-agricultural activities are therein carried out, and that a diversified economic base will develop, thanks to a more or less continuous process of social division of work, technical innovation, and economic specialization. The great urban dimension allows businesses to achieve economies of scale and, above all, urban economies, thanks to the bringing together of different complementary companies, or even urbanization economies, resulting from the shared use of goods produced by the collectivity, the price of which is not internalized in cost prices, for example, of various public facilities, infrastructures, services, skilled workers, but also of advantages which are more difficult to measure like the urban heritage or the town's image.

Geographical definitions of the town insist on its territorial role. An urban center carries out central functions for a surrounding region; it is a center which polarizes relationships. As opposed to villages (or mining sites), which exploit on-site resources from their immediate environment, towns produce situational wealth, enhancing their position in exchange networks, the reach of their action in these networks depending on the size and the specialization of the town (Reymond, 1981). As a result, a town could not be conceived in isolation. It is always part of a network of towns; it is an element in a settlement system.

The settlement system plays an obvious role in the networking of the various activities performed in each of the population nodes. With regard to the territory, it thus fulfills a major function of control and connection. This function is expressed by such metaphors as "urban framework", which evokes the task of holding together all the various parts of the territory. Similarly, an analogy can be drawn between hydrographic networks and urban networks (Chorley, Haggett, 1969) which, thanks to their very hierarchical and ramified structure, "drain" or "irrigate" all parts of a territory. Not only the towns, but also the smallest villages are involved in this caretaker function, as is indicated by the conservationist role of maintaining humanized landscapes which the environmental protection policies willingly attribute to farmers and inhabitants of rural areas. Each node of the settlement system is an entity, increasing in complexity from the village through to the metropolis, but whose existence and evolution can only be understood beyond their belonging to that higher level entity that comprises the settlement system of a territory. If one limits oneself to interpreting the finalities fulfilled by a settlement system from the point of view of management and territorial development techniques, it is possible to put forward two conceptions, one static and the other dynamic, of the main functions of this system.

FROM THE TERRITORY OF DAILY LIFE TO THE TERRITORY OF POWER

The static point of view consists in underlining the role of the population system, at a given moment, within the articulation of the territorial entities on different geographic scales, in relating levels of territorial organization which do not have the same space-time dimensions. The population system thus makes it possible to manage the coexistence of at least two main levels.

The first is the territory that is frequented daily, represented by a town and its immediate environment (including the peri-urban residences of people commuting to their place of work, the catchment area of urban commerce, that can be grouped together under the heading "life basin"). The term territory here takes on a connotation that is less political and administrative, and more psychological and sociological, as most towns have lost, during the course of history, the ability to decree legal rules or exercise political power, which are today the prerogative of states. We still speak of territory because the community inhabiting the same node of population generally still owns the legal property of the

land and constructions, and also defines itself by various feelings of belonging to the place it inhabits. The strong value given to the central zone, and its compactness – it has the best accessibility and groups together a large proportion of the production function, particularly the most elaborate, modern forms, rejecting part of the residential function outwards to the periphery – is the main characteristic of the organization of these territories of daily life, and all the more so if they are large territories. This characteristic is also expressed in the very widespread existence of a density gradient between the center and the periphery, the peripheral dilution of the intensity of buildings and activities, the fractality of this urban structure, resulting from the compromise between the force of the constraint linked to the advantages of centrality and the necessary "need for spacing" ("two constructions cannot occupy the same space," Reymond, 1981), added to which is the secondary valorization of the non built-up, "natural" environment on the fringes of the urban center and of its advantages (Frankhauser, 1993).

The spatial extension of this territory of daily life remains very strongly limited by the duration of internal travel, the speed of which is itself slowed down by high density. Thus it has been observed, for example, that commuting times in France had remained practically unchanged between 1970 and 1990, while the average distance travelled had doubled. The average time spent travelling is roughly one hour per day, sometimes between one and two hours. Even though this time can vary considerably from one individual to the next, and according to the place, it nonetheless constitutes an invariable in the organization of the territories of daily life, and represents a heavy constraint on maximal spatial extension. The widespread use of automobiles and rapid transport techniques have allowed urban centers to spread to some degree, but the speed of travel within built-up areas is still far slower than that of inter-urban transport, and the extension of these territories of daily life today rarely exceeds a radius of 30 to 40 km around a center. Much larger urban areas, such as Los Angeles, remain anomalies.

The main functions of this territory of daily life represented by every node of the settlement system are habitat and production (of goods and services). These two major functions, however, are no longer, in most cases, regulated locally. For the most part, what determines their evolution is located elsewhere, in the nodes of the power network where decisions are made. In these networks, some power nodes are clearly identified, by a political or administrative capital, by the head office of a large multinational company, but it is most often

through multiple negotiation networks, competition or complementarity networks that modalities are determined for collection and exchange of goods, people or information, which guarantee the functioning of the territories at a higher organizational level: regional, national, or even supra-national.

It is the settlement system that makes these networks function. It is therefore according to the circulation modalities at this other level of territorial organization that the spatial framework of the settlement system is determined, and which is defined by the size and spacing of the towns. At this level, it is roughly the duration of one day's travel that determines the distance between the major nodes of the system, those which concentrate a degree of decision making power (see, for example the principal towns of the French départements at the beginning of the nineteenth century, the regional capitals, or even today's great European metropolitan areas). This daily temporality (always an estimation, difficult to determine accurately), accepted on average for relatively frequent negotiations, determines a far greater possibility of spatial extension for the territories of power than for the territories of daily life. Indeed, not only the duration which determines the spacing of nodes in the same territory, but also the speed of travel between the nodes, at a given moment in the history of transport techniques, are generally far greater than those which are possible within each node (Pumain, 1993).

To this remark on space-time duality, one could also add the same form of analysis for settlement systems as the temporalities invoked for large technical systems, which generally highlight the existence of two characteristic periods: the long term for installing infrastructures, and the short-term period in which the users are settled.

AN ADAPTOR IN AN EVOLUTIVE SYSTEM

Defining the essential finality of a settlement system in a territory as the articulation of two modes for societies to relate to their environment, each mode having its circulation speed and therefore its specific scale of geographical organization, implies putting this concept into a dynamic rather than a static perspective, and also taking into account the adaptation function of a settlement system, as well as the technical modalities of its achievement. This concept should be put back into an evolutive theory of towns and cities systems (Pumain, 1995).

The necessity for producing an evolutive theory to explain the properties of settlement systems is rooted in common sense, which continues to use the same terms for villages and towns, constructions whose contents and meaning have, however, been totally transformed over the centuries. This necessity also depends on the aporia of static theories which are unable to explain, for example, hierarchical structure except by pre-supposing hierarchical functional levels, or by putting forward redundant explanations like that of "agglomeration economies". More than for other social systems, it would be impossible to explain the similarities in the specific organization of population systems, their universal structure in various geographic milieux, the different economic systems and sociopolitical organizations, without mentioning, on the one hand, their shared territorial finality and without, on the other hand, relating this finality to other processes which are transcultural but nonetheless historical, namely urban transition and the contraction of space-time. The current structure of settlement systems is the product of these two processes, which have profoundly transformed the practical modalities of their main function and their technical meaning, which remains invariable, and which is the articulation of territories of daily life and territories of power. It can therefore be considered that the finality of settlement systems is to reduce local risks by connecting places to each other and by achieving continuous adaptation through the change in dimension of these two types of territory.

The current structure of settlement systems represents neither a state of balance nor an optimum established under the effect of some constraint. The concept can be understood only if it is seen in the process of urban transition. We thus designate the universal transformation that accompanies the move from an agricultural economy, exploiting mainly local resources, to an industrial and tertiary economy, founded on long-range exchanges. In countries with ancient settlement systems, like European or Asian countries, the same sites, the same population nodes, have been re-used by the economic and political systems ruling successively over the territories. The complete creation of new settlement sites, of new towns, is a very marginal process compared to the crushing majority of processes adapting already inhabited places to new functions. Settlement systems were initially composed of villages, of small dimension and little contrast, close to each other and relatively homogeneously dispersed within the territory. They became more dense, and their average size increased due to demographic growth. But, above all, they modified their structure: the population became more concentrated, the

differences in size between the various elements of the system increased considerably. However, even though the smallest elements of the system are of greatly diminished importance, due to the absolute loss of population during rural exodus (generally the case for villages), or due to relatively slower growth (generally the case for small towns), these inhabited places still exist, in the same way that today's big towns really are adapted elements belonging to the former settlement systems.

The spatial structure of these settlement systems, as well as their degree of hierarchization, today still depends on the modalities of circulation that were in application at the time they were set up. Thus, the average distance between towns and the intensity of the size contrasts over the national territory does not divide countries into developed vs. third world countries, but rather into countries of the old world and more recently populated countries (Moriconi, 1993). By way of example, the average distancing between two towns of more than 10,000 inhabitants is, in China or Europe, less than 15 km, whereas in North America it is almost 50 km. An index that measures the importance of hierarchical contrasts between the populations of these towns is less than 1 in Europe and more than 1,2 in North America. In all these systems, however, one notices over the long term a trend of accentuation of hierarchical contrasts, which can be explained, on the one hand, by the advantages gained by large towns from the hierarchical dissemination of innovations (reinforcement of the hierarchy from the top down) and, on the other hand, by the contraction of space-time, which allows bigger towns to short-circuit the clientele of the smaller towns in an intermediate position, inducing a "simplification" from the bottom up of urban hierarchy.

The gradual building of an increasingly hierarchical settlement system with increasingly marked contrasts between the size of its elements, is therefore a consequence, not of the optimal organization of circulation within a territory at a given moment (which condemns all static explanatory theories like those of central places or spatial economic balance), but of the gradual, historical adaptation of a system initially built in accordance with a certain circulation speed, that has transformed itself to allow faster speeds. In doing so, the system has also allowed societies to gradually free themselves from local ecological dependence with regard to the resources offered by their site, and it has also made it possible to reduce the risks and uncertainties threatening their survival and development, by considerably broadening possibilities of resource substitution and complementarity by calling on the resources of increasingly distant sites.

THE "OPERATORS" OF SETTLEMENT SYSTEMS

How has this essential finality been accomplished? Is it possible to identify operators who guide the evolution of settlement systems, or pilots or regulators of urban networks? In fact, when the concept of town networks was created by institutions that had the power to implement it, the representation requested from the system was always very partial, mainly military or administrative, and it is likely that the actions had hardly any decisive overall effect on the structure of the system. Usually, evolution occurred "spontaneously", which leads us to view settlement systems as belonging to the "self-organizing" category of systems.

CONSCIOUS OPERATORS

Among the institutions that may have been able to conceive networks of centers and intervene directly in their implementation, those responsible for the defence of the territory come first (Pumain, Robic, 1995). The building of a network of strongholds on the borders of the territory happened in France as early as the seventeenth century, under the impetus of Vauban. It was theorized as a system of military sites organized to protect the entire national territory at the start of the eighteenth century by De Cormontaigne (Guillerme, 1987). However, while defensive concerns arose at various times during the history of site management of many towns, the military function alone has never led to the complete organization of the urban network of vast territories, apart from some particular colonized areas. In most settlement systems, it still only appears today in the functions of a handful of specialized towns.

Political and administrative powers have doubtless had a more determining influence in the long term on the organization of urban networks, whose regularity they continue to reinforce. The principle of non-coverage of territorial administrative subdivisions, the efforts to obtain good accessibility for administrative centers, tend, indeed, to a regular spacing of centers of the same level, each one being placed in the middle of their circumscription. In France, for example, this is as true for the communal chief towns (Delamarre, Durand-Dastes, 1984), as it is for the prefectures (Ozouf-Marignier, 1992). The decision to give an administrative role to a center, however, only rarely plays a totally selective role

among all the towns existing at a given moment: the places were very often chosen because they occupied very good positions in the network for other attributes related to centrality.

It is certain, however, that, by means of the permanence that it often supposes and all the induced actions it leads to, the administrative function is a factor of selection and durability for those centers that perform it.

The differences in urban organization between centralized countries, where the importance of the capital city is often excessive with regard to the rest of the system, and that of countries with a federal structure, where there is far less difference in the importance of towns at the top of the hierarchy, directly reflect the presence of a politico-administrative operator in the organization of settlement systems. Statistical proof is provided by a systematic comparison of the form of urban hierarchies in more than a hundred countries worldwide (Moriconi, 1993). However, this survey also shows that, in order to manifest itself, the effect of the politico-administrative operator requires duration. It is therefore not so much the political organization of the territory itself as all of the induced effects it engenders and which accumulate in the long term, that help to structure the settlement system. The entire apparatus of the states is moving in this direction.

The defensive and administrative functions tend to cover the territory with a regular grid of strongholds or tax collection centers and re-distribution of decisions coming down from the top. Just like the military or politicians, tradesmen can also organize themselves with a view to covering a territory with a network of outlets or branches. However, it is very rare that the operators in question benefitted at the outset from such wide organizational powers as the two previously mentioned types of actors. Despite the current logic of distribution, of the hierarchical organization of certain services offered to the population by large businesses, it is clear that the operative process of trade activity on settlement systems obeys a different logic from that defined by the field of activity of a network operator. The coverage of a territory by networks of central places results from local micro-competition and not from some central command.

After the function of territory coverage – recognized very early on and assigned to the population system – came an explicit, parallel function of landmarking itineraries which turned the urban centers into stages, or regularly spaced points on a course at the rhythm of travel in a given epoch. This function does not exclude

the first because according to Mandeville, for example (1346, quoted by Deluz, 1989), this was the structure that had been adopted by the Gran Khan to govern his territory. The first postal routes confirmed this trend towards the linear organization of the territories of large countries, which wanted to find the means to link the center to the periphery as rapidly as possible in order to transmit information from the center to the frontiers, even if the rest of the territory remained under weak control. Urban network development theories, such as those of Kohl (1941) or Mackinder (1900), as old as those that formulate the idea of territory coverage by towns, highlight the role of transport in the spatial organization of the settlement system (Pumain, Robic, 1995).

The manifest role of the interaction between the formation of settlement systems and that of circulation networks does not mean it is possible to express the settlement system as a "network of networks". This concept could explain the functioning at a given time, but it is neither explanatory nor genetic, as it is the settlement system itself which, once constituted, determines the location of all of the nodes and paths of the networks set up subsequently.

SELF-ORGANIZATION

Whatever may have been, or may still be, the efficiency of the actions explicitly aimed at controlling a territory by means of a regular distribution of central functions, usually hierarchical, it can be taken as certain that they do not constitute the main determining factor in the structure and evolution of settlement systems. Intentional organizations would necessarily translate into a greater variety of forms, depending on the political regime and the economic system, and by more pronounced surges in their evolution.

The majority of decisions that are taken and whose effect is to act upon the structure of the settlement system – individual decisions to migrate, decisions to set up a company, to construct buildings – are taken outside any authority planning or concerted intention, and most often in total unawareness of the existence of a "system" materializing the interdependencies between places of settlement. Even in the most policed states, there is no authority whose role it is to maintain the proportions observed in the evolution of settlement systems. It is in spite of the diversity of the personalities of the actors, of their motivations and their actions, that the aggregation

of their behaviors produces regularities, as identifiable in the development of a town as in that of the settlement system. In reality, these "microscopic" actions are carried out under a strong constraint: the individual and collective actors that make up the social milieu of a town are not independent, but connected, mutually informed of each others' actions, and they are in competition with actors of other towns to reap the profits linked to the exploitation of innovations. The roads and relationships that unite the towns in a given system are also social networks via which information transits. One town could not evolve independently of other towns, without its assets being either contested or copied. Competition between local actors in towns, which is the corollary to the relatedness of urban networks, leads to competition between the towns of a settlement system and explains the meta-stability of the system evolving under this constraint.

The structure of differentiation of the elements of the settlement system is maintained by the multiplicity of the interactions between the actors that make up each element. Everything happens as if, whereas social networks are renewed by the migration of people and from one generation to the next, some urban know-how was perpetuated in the same places, which can only be understood by a series of feedback effects and constraints exerted by the places on the actors, and by learning processes demanding a fair amount of time before bringing significant results in urban competition.

This form of evolution recalls the phenomena of structuring already studied in various physical or living systems, and known under several names according to the origin: dissipative structures (Prigogine), or synergetic structures (Haken) (Pumain, Sanders, Saint-Julien, 1989, Sanders, 1992). The self-organization of settlement systems allows some analogies with the dynamics of open hierarchical systems, maintained under energy supply, likely to undergo bifurcations (Wilson, 1981), to quantitatively modify their structure and evolution under the effects of amplification of internal or external disturbances. In the history of settlement systems, an external disturbance could be an event like the great plague of the fourteenth century in Europe, which hardly modified the system at all despite the fact that it reduced the population by half. The industrial revolution locally or regionally transformed the system by the emergence of a new generation of towns. Local fluctuations are of many kinds, like the decision to establish a capital, or the appearance of an innovation in a given place. Many have no effect on the overall structure of the system, and only a few develop sufficiently to produce qualitative change.

Town systems are, however, open systems of a particular kind. The territorial framework in which each town functions (all the places with which it has most relations, for a given type of exchange), is of variable dimension depending on the size of the towns. External openness is more important for the larger towns of each system, and the long term accumulation of the product of these long range interactions explains the very general overdevelopment (in size) of these metropolitan areas compared to urban hierarchies of which they are the head (Jefferson, 1939, Moriconi, 1993). This remark underlines the fact that despite the many formal analogies between the settlement system and the dynamics of physical systems, and the value of model transfer for simulations (Allen, Sanglier, 1979, White, 1977), every precaution must be taken to make explicit in models the specific nature of the settlement system.

Another important difference with physical systems is linked to the cognitive dimension. The information concerning the structure of the settlement system (hierarchical form and specializations) is at least partially known to the actors, who can either conform to it or contest it. This reflexive aspect, including the representation of the system, even partial, in its development, quite clearly differentiates the settlement system from other self-organizing systems like some physical systems. This justifies the search for a specific, evolutive theory for these systems (Pumain, 1995) and the fact that some players are tempted to act directly on settlement systems.

IS INTERVENTION DESIRABLE?

In developed countries where urban transition is finished, where almost the entire population lives in towns, the dissemination of urbanization seems to have reached its final stage, of so-called saturation. One might think that the former modalities of evolution of settlement systems would be likely to change. Some people thus tried to interpret the reversal of migration trends between towns and the countryside during the 60s and 70s in the USA and at the end of the 70s and 80s in Europe, as a major bifurcation, the start of a trend towards "counter-urbanization" (Berry, 1976). Subsequent evolution has shown this interpretation to be erroneous. The renewed growth of rural areas is explained on the one hand by the spreading of the outskirts of urban areas, a spatial extension brought about by the dissemination of automobiles and improved accessibility, as well as by improved living standards allowing the

acquisition of individual accommodation. In addition, the renewed growth of some villages or small towns at that time signified the end of a phase of dissemination of modernization linked to strong post-war economic and demographic growth down to the bottom of the hierarchy and in the furthest corners of the territory.

The foreseeable evolution for current settlement systems is deduced, unlike their modalities, from their past dynamics, under the constraint of another contraction of space-time. Modern techniques make it possible to considerably accelerate the speed of inter-urban communications, and this process continues to extend its effects to an increasing number of towns (globalization). The only limitation to this process is the finite nature of the world, but the world's town system is still far from being connected to the available reserve of speed. The consequences of this "dromological" law on the structure of settlement systems are a reinforcement of their hierarchical structure, which starts at the top, the identified phenomenon since the end of the 1980s being "metropolization". There is nothing new about this phenomenon, it is merely the translation in the town system of their adaptation to a new cycle of innovations, numerous technical, social and cultural novelties accompanying the progress in speed of communications. The effects of this cycle will be disseminated hierarchically in the settlement system. The more the dissemination of metropolization is delayed in time and is spatially selective, the more it will contribute to the reinforcement of urban hierarchies.

Intervening in a self-organizing process is not easy. The local reactions of towns threatened by the effects of metropolization, whether it concerns the setting up of technical poles, of urban marketing or participation in local or European networks, have been very quickly copied and generalized to most of the towns in the system. The normal modality of evolution of these entities which constitute the population nodes is still competition and rivalry for the capturing of resources, and this is the case from quarrels between villages through rivalries between large towns for the acquisition of infrastructures.

The power of self-organization mechanisms is proved, on the contrary, by the difficulties experienced by governments, concerned with modifying urban organizations that seem to be incompatible with objectives of territorial equity, or that are trying to achieve improved economic efficiency or improved performance when faced with international competition. It is unnecessary to become weighed down on this subject about the uncertain effects of policies aimed at reducing the weight of the

Paris urban area, a typical example of a "primatial" town in a developed country. Similarly, at the other extreme of the urban hierarchy, one cannot be sure of predicting the success of DATAR's "towns network", destined to disactivate the economically disastrous effects of still lively local competition between medium-sized close towns which could be united in the same life basin.

Must we resign ourselves to accepting the unavoidable evolution of our town systems towards concentration in bigger and bigger, more and more sprawling metropolitan cities? Must we accept that the construction of the European Union will eventually mean the formation of a megalopolitan entity of some fifteen or twenty million inhabitants at the head of a European urban network? Knowledge of the modalities of the evolution of settlement systems does not imply resignation; it underlines the extent and force of intervention necessary to alter their course. Thus, if Europeans intend to preserve the heritage that small and medium-sized towns represent, and whose great number and high density characterize the settlement system, they must be prepared to implement interventionist policies which are strong, costly (at least according to current accountancy norms, which hardly evaluate harmful or positive effects on living conditions) and long-lasting.

CONCLUSION

The settlement system in a territory can be compared to a large technical system in the sense that it fulfills the functions of control, service and capillary irrigation of a territory, by articulating the two main levels of relational life: that which constitutes the territory of daily life, and that which forms political, cultural or economic territories. However, a functional interpretation of these systems cannot be limited to this static perspective, insofar as settlement systems evolve by constantly adapting the spatial structure of territories to the constraint of reducing the uncertainties of the immediate environment; this is the permanent objective of human societies.

Through the settlement system come both the invention of technical, social and cultural novelty, as well as the resolution of the risk of unbalance thereby created, thanks to the organization of the dissemination of these novelties. It is through the settlement system that most innovations and access to modernity are made available to the majority. The settlement system differs, however, from the great technical systems because it is self-organizing. In spite of very partial interventions, its structure

and evolution neither correspond to pre-determined objectives nor result from planned achievements or concerted decisions, and so far seem to have escaped all attempts on the part of the operators to control them. It is the competition between the actors linked to places that produces the main structural regularities and the formation of differences through the diffusion of innovation, while the very strong connexity of the system contributes to stabilizing its own evolution. The importance of creative mechanisms, the organizational complexity of the levels of towns and the adaptability of the system liken it more to living systems than to self-

organizing physical systems, whereas the reflexive and learning effects make it undeniably a social system.

With the mastery of large technical systems the temptation may grow stronger to govern the system. Initially envisaged within each element, on a communal, then metropolitan scale, will control over development reach the settlement system, by an appropriate technicalization of the concept of the system? The definition of relevant interventional means will no doubt have to wait for improved knowledge and more elaborate formal expressions of the space-time dynamics of settlement systems.

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The automobile system: a territorial adapter

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IT IS EASY to buy a device known commercially as a "universal adapter": this is an assortment of more or less sophisticated electrical plugs of various sizes, with transformers for different types of current; sometimes there are AC/DC transformers or rectifiers. This device makes it possible to obtain electricity for any type of appliance, from any network supplying electrical current of any kind. The apparatus is small and lightweight and forms part of the necessary travel equipment for the experienced international traveller, as many different national electrical standards still exist (David and Bunn, 1991). How else could one use a portable computer, electric razor, or electrical travel iron on a trip abroad, when neither the wattage, tension, or the shape of the plug correspond to what is found at home? The universal adapter is long-term insurance for the traveller, a general guarantee that under any circumstances he will have access to the indispensable element which electricity has become, a "comfort zone" whose boundaries are designated by the possibility of being able to plug into the network.

In this paper (which borrows from two recent works by the author; see Dupuy 1995a, 1995b), we shall demonstrate that the automobile plays an identical role of universal adapter in the service of the "travellers" we have become in a world undergoing enormous transformations. This is not to say that we are permanent globe-trotters. Rather, the multiple changes being produced in human society as a result of economic and social evolutions, would cause us to lose control of the space around us, lessening our potential for territorial appropriation, were we not a larger and larger group to own cars, which have truly become a type of universal territorial adapter. It is this role which explains, in my opinion, the incredible development of the automobile throughout the world.

We shall begin by tracing the history of the phenomenal growth of the automobile, recalling here for the record the dire forecasts of the 1970s that predicted quite another story. We shall then demonstrate how the automobile has found a place today in a comprehensive, more and more fully integrated system. The question here arises concerning the public-private mixed economics of this system, which for many has conferred absolute advantages on the automobile in terms of ensuring long-term territorial dominion. We shall closely examine two historic examples of the role of adapter played by the automobile: American suburbanization, and French rural urbanization, or "rurbanization". Other examples will show the extent to which the automobile is likely to play out its technical role of territorial adapter, thus

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