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UNDERSTANDING URBAN FABRIC WITH THE OH_FET MODEL BASED ON SOCIAL USE, SPACE AND TIME

1. Introduction

The study of a city over long time spans (*longue durée*) is based on knowledge of the topographical elements and their relationships with each other from the beginning of human settlement to the present day. As archaeologists, our aim is to work on the processes of change of the town. To that end, we must look at the heritage, inertia, trajectories and dynamics of each object making up the town. These can be looked at under three headings: social use; location and surface area; duration and chronology.

Our procedure is part of a conceptual approach which concerns historical sciences, geomatics and informatics on account of its simultaneous consideration of the *longue durée* and multiple temporalities. The objective is to put forward a way of modelling "historical objects" (cfr. *infra* § 2), the subject matter of our study, which will help create geo-historical databases from which it should be possible to:

– provide a vertical and horizontal perspective of the phenomena (What happened at a particular time? How did a particular place evolve?);
– produce as many inventories as possible;
– express the change of state (and thus the inherent process);
– preserve the specific nature of each place, i.e. its social, temporal and spatial mutations;
– avoid redundant information, in order to facilitate data analysis and management;
– represent a single reality in a variety of ways (depending on the accuracy and quality of information available).

The proposed modelling is the result of three key steps in our procedure. The first step involved formalizing the objects of the historical landscape (Galinié, Rodier 2002). This consisted of a strictly social approach to the town (Heighway 1972; Biddle, Hudson 1973; Lepetit 1988; Galinié 2000). The main aim was to characterize the objects making up the urban landscape in the *espace support* (Pumain 1993, 137-139). The methodology used is linked to the methods of archaeological classification and to the culture of relational databases.

The second step involved investigating the spatial properties of the urban objects. This involved a geographical modelling of the archaeological entities (Galinié *et al.* 2004; Saligny 2004). It was based on a geographical approach to urban space (Galinié 2000) with a view to analyzing the spatial dynamics. It corresponds to the appropriation by archaeologists of certain geographical concepts and the use of GIS.

The third step involved isolating time within the time-space process so that it is no longer subject to space (Rodier, Saligny 2007; Rodier, Saligny, in press). In some way, this involves the reappropriation of time by archaeologists/historians in the analysis of spatial dynamics. The objective is to analyze time and space separately. The approach is based on an analogy between the modelling and treatment of space and time.

Looking at recent work by archaeologists on spatial dynamics, their understanding of space is based on work by geographers, and they have quite naturally tackled the subject in the same way (Nuninger *et al.* 2006b; Nuninger *et al.*, in press; Gauthier, in press). The results obtained represent considerable progress both from the methodological point of view and from that of understanding archaeological phenomena. Nevertheless, by systematically making time subordinate to space, it is not possible to see the multiple temporalities of the historical objects. It thus seemed important to develop an independent approach to space and time in order to observe both time-space and space-time processes.

The principle which was selected is thus one of modelling time according to the same rules as space, in order to move, still by analogy, from the *temps support* which is the linear, fixed time in which the historical objects are recorded in the same way that they are localized in space, to the dynamics expressing temporalities which are essentially empirically observed.

The tools for analyzing these temporalities still have to be developed, but first it is necessary to formalize the independent approach to space and time. This change of perspective seems to us to be an important step in order to base the study of dynamics on analyses in which time and space have the same value, and whereby the input is the object studied and not one of its characteristics, i.e. function, time or space.

2. The Historical Object (OH)

The Historical Object (OH, *Objet Historique*) is our unit for recording and analyzing urban organization and change in the *longue durée*. It can be defined as being unequivocally distinct from other items, based on the same criteria as the geographical object in relation to the scale, time frame and materiality of the data brought together within the notion of time-space granularity (Langlois 2005, 311; Saint-Gérand 2005).

To study the urban fabric over large time spans (Galinié 2000), the historical object is the analytical unit of the former urban space, a church, a cemetery, a marketplace, etc. It is determined by its interpretation, its location

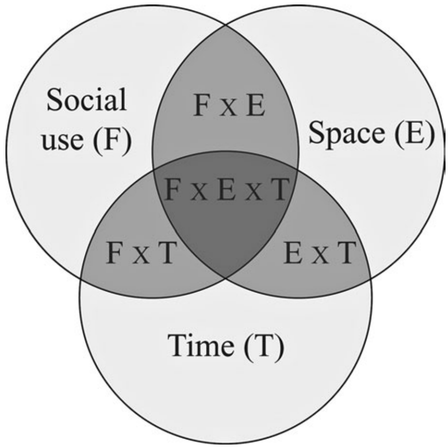

Fig. 1 – The three sets: social use, space and time.

and its surface area, and its dating and life span. This definition corresponds to Peuquet's three W's (What, Where, When) (Peuquet 1994, 447-451) which is frequently used (Egenhofer, Golledge 1998; Lardon *et al.* 1999; Thériault, Claramunt 1999; Ott, Swiaczny 2001; Panopoulos *et al.* 2003). Over and above simply characterizing the historical object by attributing to it each of these three criteria, the object is defined on the basis of the three sets, Function, Space and Time, of which it is the Cartesian product (Fig. 1).

There is a reiteration process specific to each set, linked to the method of interpreting the archaeological data, which is both inductive and hypothetico-deductive (Rodier, Galinié 2006). Each of the three processes follows the specific logic of the set to which it belongs. Nevertheless, the continuous overlapping of the three sets is such that each process is conditioned by the other two. Donna Peuquet (1994, 448) expressed this by: "when + where → what; when + what → where; where + what → when".

The social interpretation of a historical object is made by choosing a function in a thesaurus. The historical object's dating, or rather temporality, and its location, or rather how it occupies the space, have a direct bearing on this choice. Certain social uses in the thesaurus are determined by a specific space (canonical cloisters, burial area, etc.) and others by their chronology (*domus*, parish churches, etc.).

The temporality of a historical object is characterized by the date of its appearance and disappearance. Even when the temporal continuity of a function is ensured, a change in place (relocation), a significant morphological change or a change in social use all constitute a temporal break and involve one historical object becoming another.

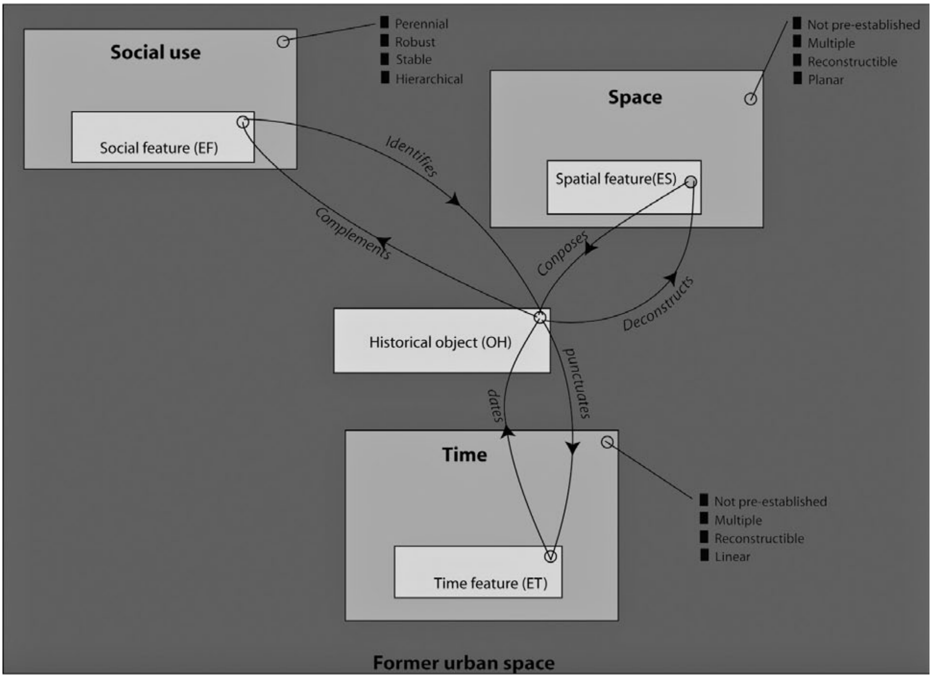

Fig. 2 – The process.

The location and form of a historical object are determined by the social use (necropolis, a building for entertainment) and chronology (necropolis, defence systems). Moreover, the way space is divided up is determined by the temporal and social use definition of the historical object (the study space has not previously been divided up on a grid system).

The principle used to understand the urban space involves a systemic approach whereby the town is seen as a set of complex objects. The town system used to study the urban fabric over large time spans is composed of three sub-systems relating to the historical objects from the level of excavation to that of the former urban space: function (social use), space (location, surface area and morphology) and time (dating and chronology).

This systemic approach can be used to identify an OH, each sub-system providing a possible key. The first step is always to define a framework for study and time-space analysis, on which the temporal, spatial and social resolution will be based. This is the choice of the scale of perception of the phenomenon to be studied (Saint-Gérand 2005). Next, within this framework, the process of interaction between each sub-system and the OH modifies and/or enhances the definition of the OH itself (Fig. 2):

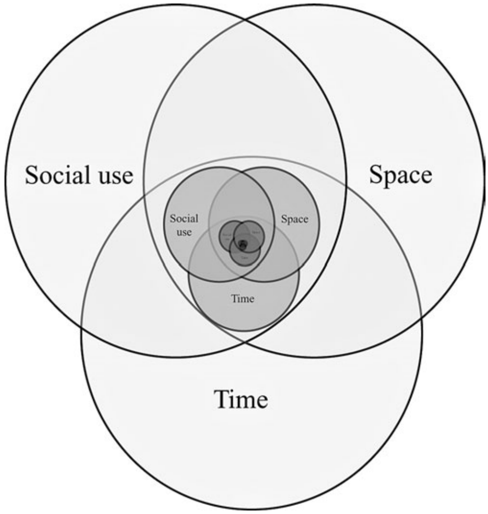

Fig. 3 – Overlapping.

– Function is defined as perennial, stable and robust. It enables urban objects to be identified as a social feature (EF). Conversely, identifying new OH's will allow new functions to be added.
– The definition of a historical object and its location linked to its geometric deconstruction is expressed as a spatial feature (ES). Space is composed of ES and by default can remain empty. In this process, Space is defined as not pre-established, multiple, reconstructible and planar, and it is dependent on the construction or deconstruction of historical objects and their position in time.
– The definition of a historical object and its dating linked to its chronometric deconstruction is expressed as a time feature (ET). ET will date historical objects, and conversely, the historical objects will punctuate Time: the use of ET will differ for each study case, highlighting the accelerations or decelerations of time (time pattern). In this process, Time is defined as not pre-established, multiple, reconstructible and linear, and it is in fact dependent on the construction and deconstruction of historical objects and how they are situated in Space (appearance/disappearance).

This reiteration process (Fig. 2) corresponds to a level of analysis which can overlap another, each time forming a similar model but at a higher or lower level encompassing or encompassed by another level. Each of these overlapping levels leads to a specific definition of the object. Moving from one to another corresponds systematically to a change of resolution within each of the three sets: function, space and time. At each of these levels, which fit into each other like Russian dolls (Fig. 3), there are corresponding descriptors for each system.

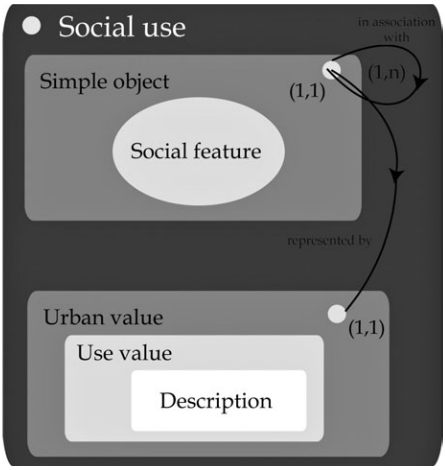

Fig. 4 – Social use model.

Each set is described according to its own model, and then incorporated into a global model, with the main objectives of:

– formalizing data from multiple and heterogeneous sources;
– differentiating function and geometry: dissociating historically relevant social use and geographically relevant spatial features;
– converting the chronology into time features.

3. Social feature (EF), an item from a hierarchical thesaurus

The first step in drawing up the reference documentation, which is historical in nature, is to define and formalize the topographical data. In the field of urban topography studied over large time spans, the information which is useful for its documentary potential comes from three types of sources (Galinié 2000, 18-24; Galinié, Rodier 2002): material elements, underground or standing; written records; iconographic representations.

There are numerous examples of functional groups to be found in the contemporary archaeological or historical bibliography, stemming from urban geography (Heighway 1972; Van Es *et al.* 1982; Lepetit 1988). We use the one which was drawn up and tested by the Centre National d'Archéologie Urbaine of the French Ministry of Culture which has been used successfully since 1990 to process topographical data of preindustrial towns[1]. The func-

[1] See the directory of field operations in an urban environment on the CNAU website: http://www.culture.gouv.fr/culture/cnau/fr/index.html.

tional interpretation of each material element is made at two levels: the use value and the urban value. For example, a building is interpreted as a workshop (use value); from this it can be assumed that there was an artisan sector and a production- or transformation-activity sector (urban value). This dual-level interpretation corresponds to a change of scale (Boffet 2002, 229).

The model chosen for function is the hierarchical thesaurus (Fig. 4). Its resolution through a three-level hierarchy (urban value, use value, description) is based on the planned scale of perception. The EF is an item in the thesaurus. The function of the OH is defined by a single EF. One EF can be used by several OH. The thesaurus is limited to the chrono-cultural area studied. Not all the items of the thesaurus are necessarily required. The thesaurus can be expanded by the creation of a new OH (Fig. 4).

4. The spatial feature (ES), an element of a planar topological graph

Space is the most formalized of the three sets. In GIS, space is structured on the model of a planar topological graph without isthmi[2] (Berge 1958, 206-217) into which spatial features (ES) are inserted. ES are created according to the way the Historical Objects (OH) are defined. Space is continuous, limited by the definition of a study area. It contains voids, i.e. empty spaces left when the ES have been removed.

Once the OH have been characterized by transforming the data into EF, their spatialization must be expressed in ES. The proposed spatial modelling (Galinié *et al.* 2004; Saligny 2004) is based on the principle of the non-redundancy of features. It consists in identifying on the one hand the OH as archaeologically interpreted objects, described as "complex", and on the other hand, the spatial features (ES) as "simple" objects with localized geometry, a simple object forming part or all of a complex object. In this model, space is continuous; it can in some places be unoccupied. In a given place, there can be one and only one ES, but this can play a role in as many OH as necessary.

Modelling consists in deconstructing information, even if it means going counter to our global view of a place. It is the dividing up of space by

[2] *Planar topological graph without isthmi*: a graph G is planar if it is possible to represent it on the plane in such a way that the vertices are distinct points and the vectors are simple and disjoint curves except on their extreme points. A planar topological graph is the representation of a planar graph G on the plane. In a planar topological graph, one face is by definition a part of the plane limited by the vectors in such a way that two points of the face can always be linked by a continuous line which meets neither the vertex nor the curve. Two faces are adjacent if they have a common vector. Two faces are opposed if they share a common vertex without being adjacent. A planar topological graph without isthmi is a planar topological graph without a *pendant vertex* (definition taken from F. Pirot, *Glossaire*, in *Systèmes d'information géographique, archéologie et histoire*, «Histoire & Mesure», 19, 3/4, 2004).

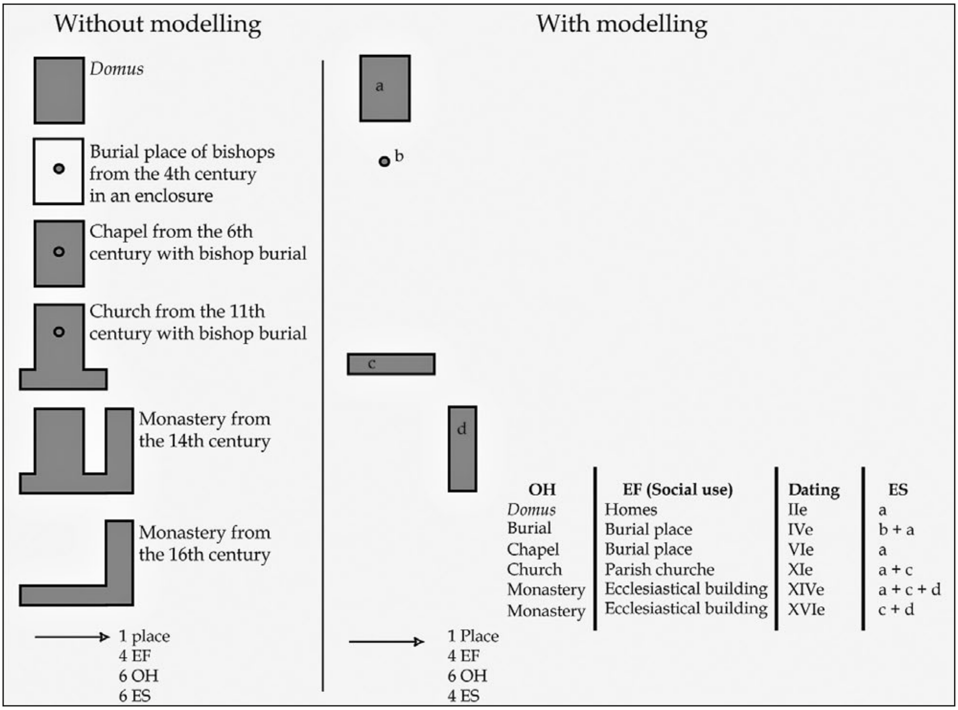

Fig. 5 – Example of converting an OH to an ES (Galinié *et al.* 2004).

the accumulation of OH which defines the ES. An ES, or the addition of an ES, associated with an EF, will define an OH at a given moment of time. A historical object can be made up of one or more ES. One ES can belong to one or several OH. Likewise, due to the possible overlaps, one place can be made up of one or several OH, while one OH will belong to one, and only one, place.

Fig. 5 provides a detailed example showing the type of successive changes which can be found in many towns in France, based on a variety of modalities.

The objective of the proposed modelling is to create spatial features on the basis of their morphological transformation, and not of their social definition. This means dividing up the place into entities (ES) which are not defined by a date and/or social use. In our example, the ES which have been created correspond to spatial realities, to materialized and well-localized forms which take on a detailed historical meaning due to their successive time-space links in constructing OH.

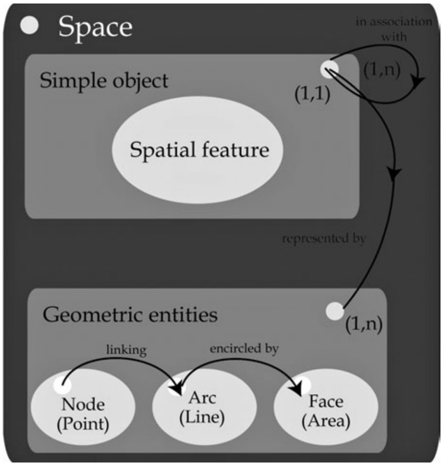

Fig. 6 – Model for space.

It can thus be seen that creating an ES is dependent on the temporal aspect of the elements characterizing a place: the latter is split up into as many ES as there are identifiable "structures" which appear or disappear.

This division reflects a spatial reality (appearance, stability, disappearance) in time, and not a social reality. The latter is obtained from the play between the relationships and attributes of each of the ES which will form complex objects: the OH.

The difficulty linked to this destructuring of space is to free oneself from the interpretative historical value when defining the ES (Fig. 6).

5. Time feature (ET), the element of time

We propose modelling time by analogy with space, using the same type of object in order to free ourselves from the continuous and linear *temps support*, but above all so as to no longer make time subject to space. However, as long as it is confined to the role of attribute, it cannot be mobilized globally but only specifically to each feature class and repeated for each of them. Time should therefore be considered as an entity class in its own right. This idea is based on the work of James Allen (1984) on artificial intelligence which formalized the 13 topological relationships between time intervals, circumscribed by dates (Fig. 7).

We eliminate all forms of intersection between two intervals from these 13 relationships, in order to retain only the ones which are non-redundant:

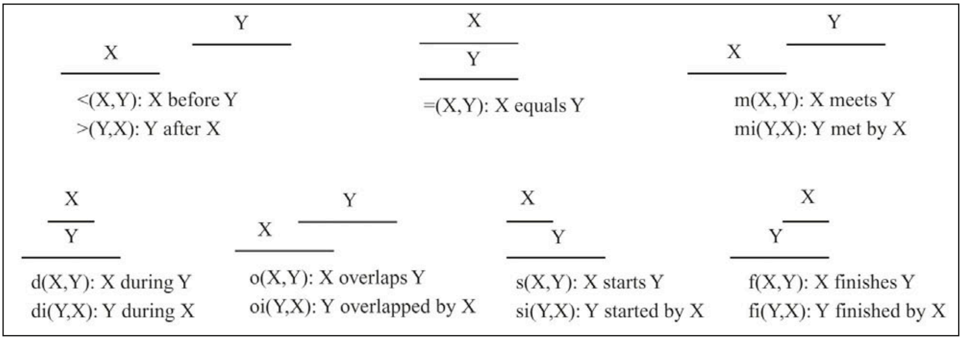

Fig. 7 – Allen's time relationships.

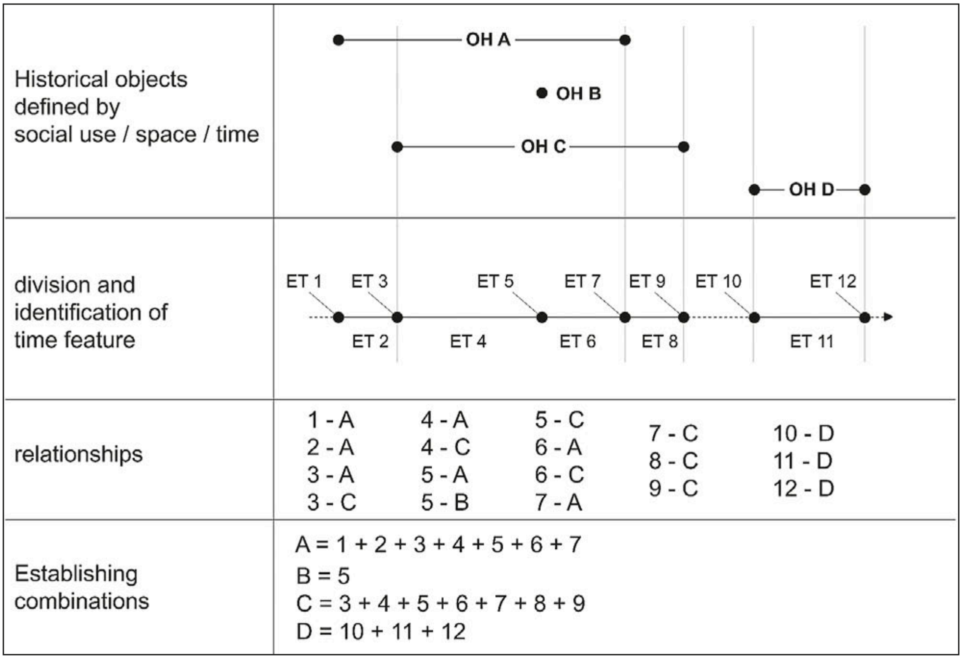

Fig. 8 – Deconstruction of the historical object and construction of ET.

<(X, Y): X before Y
>(Y, X): Y after X
m(X, Y): X meets Y
mi(Y, X): Y met by X

Once the redundancies have been eliminated, all notions of time span, century and period can be reconstructed from this model. Like the ES, the ET

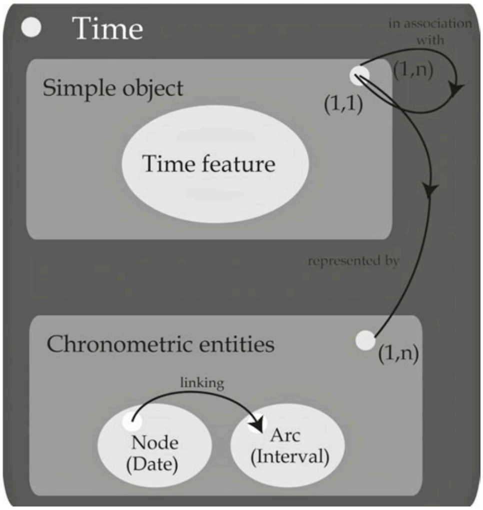

Fig. 9 – Time model.

are disconnected from social and spatial interpretation. The time span and number of ET for a period of time determine a frequency. Observation of how these are distributed should allow time patterns to be analyzed.

We consider that no temporal redundancy should be seen here. Like space, time is continuous. Sometimes it may not be used. At any given moment, there can be only one ET, but it can be used by as many historical objects as necessary. The time resolution chosen for ET determines the dating of the historical objects. Continuous time is circumscribed by the chronological markers of the studied object. ET thus belong to a set with a known number of elements. The ET used by historical objects constitute a sub-set which, when removed from the whole of the ET, reveals time gaps.

The ET is neutral and defined by the smallest possible time unit for dating the phenomenon studied. A temporal feature can be a date or an interval. ET are defined by the division of time through the accumulation of OH (Fig. 8).

The time model (Fig. 9) is linear and, like space, topological. Here, time is assimilated to a space with one dimension. This formalization of time into instants and intervals was described by Philippe Muller and Vincent Dugat (2007, 34-35). By contrast, we propose deconstructing time into as many ET as necessary to constitute the historical objects (Fig. 8). To this end, as for space, the historical object must be deconstructed in order to transform it into a time feature.

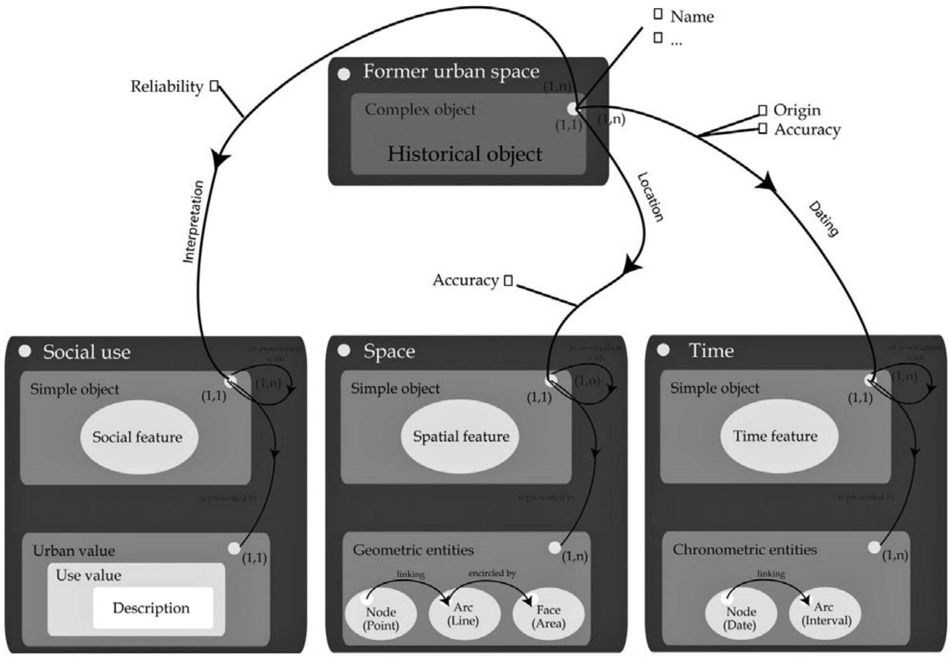

Fig. 10 – OH_FET model.

6. The global model: OH_FET

The organization of these three features around the OH make up the global model: OH_FET of former urban space for studying the town over long time spans (*dans la longue durée*).

The relationships between the social use, space and time sets and the historical object determine its interpretation, localization and dating respectively. These relationships are qualified by their attributes: reliability of the interpretation, accuracy of the localization, origin and accuracy of dating (Fig. 10).

Even if, like time, there is no pre-determined resolution for space, and while the social use set is not finite (the thesaurus can always be added to), the scale of perception selected for the phenomena studied does determine a scale for each of the sets.

With this organization, it is possible to place the historical object in the centre of the model, interacting with its three components, while making social use, space and time independent of each other.

7. From model to analysis

The aim of the conceptual formalization is to be able to analyze and model data in order to further our understanding of the observed phenomena. Modelling time by analogy with space implies that the analysis of time is based on similar concepts to that of space, with the following equivalences:

Spatial analysis	**Temporal analysis**
Localization	Dating
Distance	Time span
Relative position	Relative chronology
Spatial interaction	Temporal interaction

By temporal interaction, for the moment we understand the analysis of patterns and frequencies. While geographical models of spatial interactions have been used to process archaeological data (Nuninger *et al.* 2006a), there is no equivalent for analyzing time. And yet, analysis of these interactions provides a way of reading these patterns and indicating the accelerations and decelerations, the contractions and expansions of time which are observed empirically by archaeologists. Identification of these patterns is likely to convey the state of knowledge by highlighting the source effects. However, it also provides the possibility of focusing observations on the transition from one state to another, i.e. concentrating on the change of state rather than on the state itself.

The originality of the procedure lies in its impartial approach, which means that rather than starting from the mapping of a phenomenon it can be approached equally from a social, spatial or temporal standpoint (Fig. 11). The heuristic value of this modelling lies in the shift from the description (What, Where, When) to the understanding of the phenomena (Peuquet 1994).

The OH_FET (Fig. 11) provides three distinct inputs, F, E and T, and six outputs, F, E, T, F x E, F x T and E x T, plus F x E x T. Among the six outputs, three (F, E and T) show the distributions, and the other three show the variabilities: social use-space or space-social use (F x E), social use-time or time-social use (F x T), and space-time or time-space (E x T). At the heart of the system, the additional output, F x E x T, does not indicate any process of change but rather the state of the OH and the historical topography. The dynamics can be studied by analyzing, singly or in pairs, the social, spatial and time dimensions. Fig. 11 illustrates the six possible analyses: three unidimensional, i.e. space (E), time (T) and social use (F), and three bi-dimensional which are the Cartesian products of social use and space (F x E), social use and time (F x T), and space and time (E x T). The three dimensions are unseparable, and the six types of analysis proposed do not allow one part of the system to be studied independently of the rest: each result represents an aspect which helps understand the whole. Each of these analyses provides different but complementary information to help understand the dynamics of the system.

This can be summarized as follows:

Where F is social use, E space, and T time.

A historical object (OH) is an element of the Cartesian product of the three sets, F, E and T, including one triplet (f, e, t), with $f \in F$, $e \in E$, $t \in T$. The course of the phenomena studied is determined by changes in each of these sets, resulting in a change of OH.

$OH \in F \times E \times T$

Based on this principle, OH corresponds by definition to a given state characterized by one element of each of the sets. The accumulation (union, usually indicated as $\cup$) of OH at a time t_0 or during a time span $[t_1;t_2]$ is a state of the historical topography of the space studied. Strictly speaking, this state is an element of the $F \times E \times T$ parts as a whole. This can be written as:

$Etat_{t_0} \in \mathcal{P}(\mathrm{F} \times \mathrm{E} \times \mathrm{T})_{t=t_0}$

or

$Etat_{[t_1;\, t_2]} \in \mathcal{P}(\mathrm{F} \times \mathrm{E} \times \mathrm{T})_{\mathrm{t} \in [\mathrm{t}_1;\mathrm{t}_2]}$

For convenience, we can write:

$$\bigcup_{\mathrm{t}=\mathrm{t}_0} (\mathrm{OH})_{\mathrm{t}}$$

or

$$\bigcup_{\mathrm{t}=\mathrm{t}_1}^{\mathrm{t}=\mathrm{t}_2} (\mathrm{OH})_{\mathrm{t}}$$

Studying the dynamics from various historical sources is based on the creation of n states at given times t, and then comparing these states. It involves the difference between a state at t_1 and a state at t_2 (Frank *et al.* 2001, 22). The result takes the form of a mapping of the changes representing disappearance, stability and appearance. For convenience, this can be written as:

$State_{t_2} - State_{t_1} = change\ of\ state$

The aim of the proposed model is to be able to analyze the process of the change of state revealed by the Cartesian products of pairs of sets, i.e. the transformations.

$F \times E$ = *social use – space or space – social use transformations*

$F \times T$ = *social use – time or time – social use transformations*

$E \times T$ = *space – time or time – space transformations*

With the OH_FET it is possible to:

A – Reproduce *all the possible states*, i.e. all the mappings at every possible date, instead of having prior pre-defined states, "snap-shots" leading inevita-

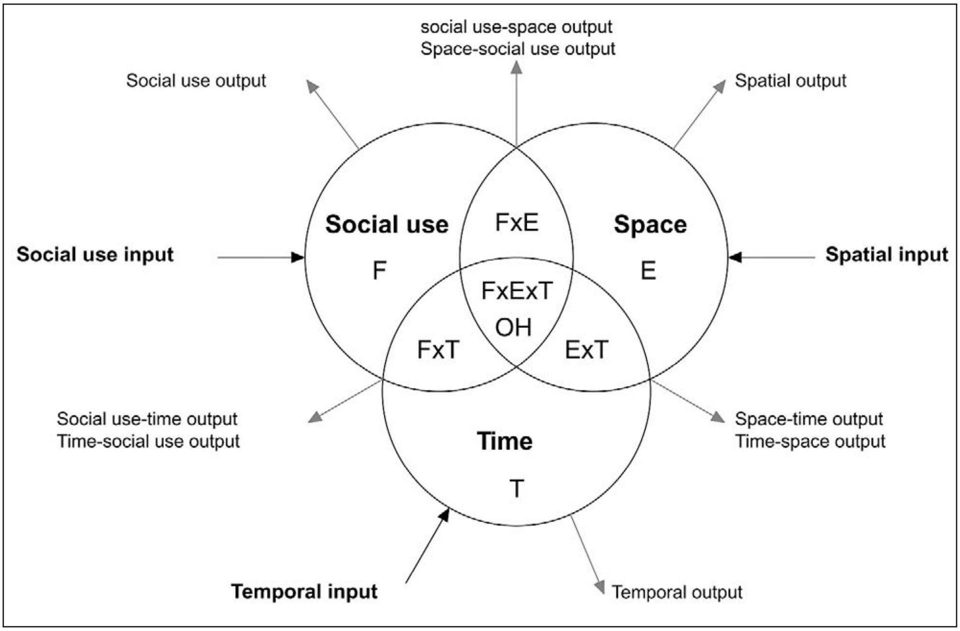

Fig. 11 – Diagram showing the model and inputs of the analysis of the dynamics.

bly to a bias in the way the phenomena are viewed (since part of the time of these phenomena is not recorded in these cases).
B – Analyze and observe *all the possible changes of state*. This involves looking at a difference between two states, but as all the states are possible, changes can be observed at time steps which are very varied rather than induced by default.
C – Understand the *transformations*, i.e. the process of change of state. It is this objective that is essential in order to understand the OH_FET system and model. The principle that the three intrinsic characteristics of the object studied – social use, space and time – are distinct entities, makes it possible to group them in pairs in order to observe the factors affecting change and to estimate the role or predominance of one over the other.

In this way, by modelling and working on each of the three aspects used to describe historical information, i.e. social use, space and time, we can produce new elements of analysis with which to observe:

– the distribution of functions: the number of times each social feature is used to form the historical objects;
– the use of space: the number of times each spatial feature is used to form the historical objects;

Fig. 12 – Map of the continuation over time of social uses.

– the use of time (source effect?): the number of times each time feature is used to form the historical objects;
– the variability of social use in space;
– the variability of social use in time;
– the variability of space in time;
– the variability of time in space.

From these inputs, it is possible to provide an overview of the possible analyses. Far from trying to present them all, the following examples highlight some of these analyses which have been carried out as part of a thesis[3] focusing on the formation of the urban fabric which developed on the site of the ancient amphitheatre of Tours between the 5th and 18th centuries:

– The spatial-social analysis illustrates the distribution of historical objects (OH) in the continuum of time-space: this approach does not provide any historical information as such. It highlights the time of the social information and thus appears as an indicator of reliability for further spatial analyses.

[3] B. Lefebvre, *La formation d'un tissu urbain dans la Cité de Tours: du site de l'amphithéâtre antique au quartier canonial (5e-18e s.)*, PhD, University of Tours, 2008, online: http://tel.archives-ouvertes.fr/tel-00349580/fr/.

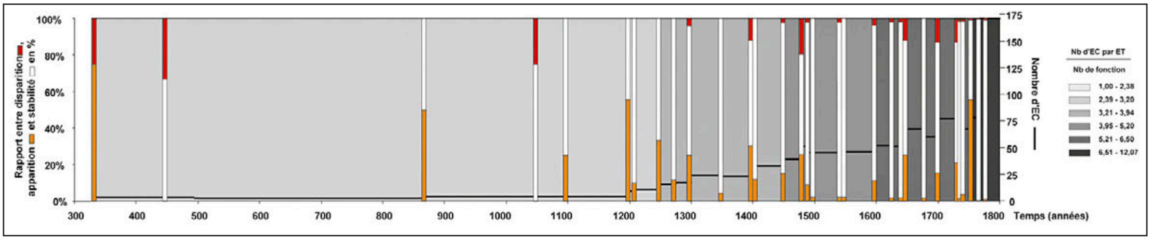

Fig. 13 – Diagram representing the time pattern of the site of the amphitheatre in Tours between 350 and 1800.

– The spatial analysis enables the use of space to be mapped. This type of investigation illustrates the totality of the changes of state on the basis of the three fundamental properties of the historical objects (OH). However, the underlying causes of these transformations cannot be determined if they relate to space or social use.
– The space-social use analysis furthers the aim of distinguishing between the changes in social use and in space. Three aspects can be explored: the diversity of social uses (the number of functions represented by each ES), their continuation over time (Fig. 11), as well as their functional transformations in space (the number of times the ES undergo a change of state (Fig. 12).
– The social use analysis consists of counting the absolute number of times that social uses occur within a selected time and/or space, without consideration of either the order or the rate of their appearance. This provides information about the change in social uses, irrespective of whether these uses are the same or different.
– The temporal-social analysis helps understand the trends in social use over time, i.e. the social behaviour of the historical objects. It shows changes in the diversity of social use and the way each use is represented in time.
– The temporal analysis refers to the number of times that ET are involved in creating the OH and allows several types of analysis. Studying the distribution of the ET allows the time patterns of the system to be understood (although it is not possible to identify whether they are spatial or functional in origin); from the extent of their involvement, it is possible to determine whether the OH tend to merge or split up.

These different analyses lead to an overall view of the social, spatial and temporal structure of the selected OH. For example, the time pattern can be represented globally, illustrating the structure of time (Fig. 13).

The OH_FET model, based on towns over large time spans from historical objects which can be identified from sources and which constitute the state of our knowledge of historical topography, is a systemic approach: the urban space is the Cartesian product of Social Use, Space and Time.

The choice of the OH-FET model is extremely demanding in terms of creating and implementing the corpus of data on the one hand, and elaboreting a historical position on the other. However, it is the only model which, due to its systematic analysis of the data, makes input possible without any of the three dimensions overriding the others, and output which enables transformations to be investigated analytically. Interrogation of the data structured with this model makes it possible to identify states, to observe the distribution of social, spatial and time features individually, to measure changes of state, and to quantify and represent the transformations.

To this end, the aim for the future will be to develop tools which:

– structure the information as proposed by the model, without one dimension – Time, Space or Social Use – being the attribute of another, and
– enable the automatic production of new analyses on the basis of this structure.

Réseau Information Spatiale et Archéologie – http://isa.univ-tours.fr/

Bastien Lefebvre, Xavier Rodier
Laboratoire Archéologie et Territoires – UMR 6173 CITERES
Université de Tours – CNRS

Laure Saligny
Maison de Sciences de l'Homme de Dijon – UMS 2739
Université de Bourgogne – CNRS

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ABSTRACT

The proposed principle for understanding the urban fabric is based on considering the town as a set of complex objects, taking a systemic approach. The town system used to study the urban fabric over large time spans is composed of three sub-systems relating to historical objects from the level of the excavation to that of the former urban space: function (social use), space (location, surface area and morphology) and time (dating, duration and chronology). The historical object is the analytical unit of the space studied. It is the Cartesian product of the three sets, Social use, Space and Time, from which it stems.

On the basis of this process, the Historical Object (OH) is broken down into three types of simple object, functional (EF), spatial (ES) and temporal (ET). The thematic approach to the OH in an urban environment is based on social use, organized according to a hierarchical thesaurus. Space, the most formalized of the three sets, is structured on the model of a planar topological graph without isthmi. Time, always considered as continuous and linear, will be modelled by analogy with space using temporal topology defined in the field of artificial intelligence. The relationships between these three sets each characterize an interaction (social use-space, social use-time, time-space, or function-space-time). In addition to reconstructing the OH, they allow urban changes to be observed by analyzing the distributions and mapping of each of the entities singly or two-by-two.

The originality of this procedure lies in its approach whereby it is possible to start not from the mapping of a phenomenon at a time t1 and comparing it to that at a time t2, but to look at it in the same way whether its input is social use, space or time. The heuristic value of this modelling lies in the shift from description (what, where, when) to understanding the phenomena of change (how, why).