Advanced OnLine publication
June 30th, 2012

Time Management by Living Systems.
A General System Theory of the Time Modularity of Living Systems:
Zeitgebers Interactions Design Conics Running Timelines.

Pierre BRICAGE
http://web.univ-pau.fr/~bricage/
UPPA, Pau, France

Bricage P. (2012) ***Time Management by Living Systems. A General System Theory of the Time Modularity of Living Systems: Zeitgebers Interactions Design Conics Running Timelines.*** "General System Theory & Methodology" IASCYS Workshop, ICCS'12 International Conference on Complex Systems, Nov. 5-6, 2012, Agadir, Morocco, 7 p.
http://www.armsada.eu/files/pblCCS12timeline.pdf

Time Management by Living Systems.

A General System Theory of the Time Modularity of Living Systems: Zeitgebers Interactions Design Conics Running Timelines.

Pierre BRICAGE
http://web.univ-pau.fr/~bricage/
http://iascys.org
UPPA, Pau, France
pierre.bricage@univ-pau.fr

Abstract— **The holistic approach of the description of a living system is based on the concept that the system participates not only to its evolution but also to that of all the sub-systems it contains and all the systems of which it is a sub-system (Fig. 1). No system can be defined as an independent, organizationally closed space but rather as an independent, autonomous closed "time and timer". Its time modularity is revealed by rhythms at different scales. The clocks of the system result from recalls of both external and internal time information. The watches, clocks and calendars, which are the actors of endogenous rhythms, are built as a result of the memorization of past responses of interaction (phase shift delays, entrainments, breakages) between its endophysiotope and ecoexotope. The system needs to be both a clock-maker, a watch-maker and a wake-maker. So modeling has to take into account "simultaneously" the concepts of [1] -temporal window: "*Before the time, that is not the time. After the time, this no longer is the time.*", -time latency and time shifting: "*It is necessary to give some time to the time.*", -compartmentation of the time: "*There is a time for each event. And each event is located into its time place.*", -nonlinearity and non-summation: "*The temporal Whole is both more and less than the sum of its Parts.*" and -interactions between time and space: "*The arrow of the time structures the clocks of living systems. But, the living systems structure back the arrow of their time.*" [2]. Calendars are tools for forecasting gates (allowed time zones of a cycle through which an event may emerge) and fixing a time horizon (a fixed point in the future at which a processes will be evaluated or be assumed to end or start). The time knowledge needs the design by the living system of a range of skills and tools used to manage time when accomplishing specific tasks to survive. It appears that timelines are designed as ellipses, projected on a plan or a Moebius strip, labeled with dates alongside and events labeled on the points where they would have happened. The emergence of a new blueprint runs through the juxtaposition and embedment of previous systems. The new time Whole is both more and less than the sum of its Parts (Table 1), it merges through the simultaneous metamorphoses of the Parts into the Whole. But each subsystem maintains its space-time identity into the Whole of which it is a partner. The partial autonomy of each partner is allowed through the maintenance of individual or collective, spatial and temporal boundaries. These interfaces structure the spatial and temporal integration of the parts into the endophysiotope (ENDO) of their whole, and of the whole into the ecoexotope (EXO) of its survival. The transition from one level of organization to an adjacent and superior one is the result of the building of a new, spatial and temporal, network. In this new orderly spaced-timed system all braces are allowed and each partner owns a special place, both through the time and into the space. The integration of the parts, and simultaneously of the whole, merges through the building of Associations for the Reciprocal and Mutual Sharing of Advantages and DisAdvantages (http://armsada.eu). This allows, in a no-change ecoexotope (Fig. 6), the maintenance of both the requisite variety of the partners and the unity of the whole [3]. If changes of the endophysiotope or ecoexotope, this is the only way to make a new networking mode of organization and integration. These associations merge through the interactive fitness between the capacity "to welcome" of the ecoexotope and the capacity "to be welcomed" of the endophysiotope of each *parcener*. Failures of medical treatments and pathological processes can be explained in terms of "irregularities" or breakages of the time architecture. Inside a system, the time can stop, move with different speeds, jump from one step to another, but it will never turn back. When a step is in the past you need to turn forward a complete cycle to reach it again (anthocyanin adaptive synthesis, asthma crises, rhythms of peroxidase capacities, glycaemia regulation, awakenings times, forest equilibrium).** (10 figures, 2 tables)

Key words: conics, holism, rhythms, time design, timeline.

I. Introduction

Whatever is its organization, a living system is integrated into an ecoexotope (**EXO**), from which it is not separable and in which it is welcome. The interactions with this ecoexotope shape the morphogenesis of its endophysiotope (**ENDO**), which "capacity to be welcome" results from its spatial and temporal, modular organization. Its survival and ontogeny result from interactions between the EXO and ENDO [2]. The graphs representing these **spatial interactions** are conics [4]. That means that the space of a whole system is both more and less than the sum of the spaces of its subsystems parts (Fig. 1). But the EXO and ENDO temporal structures are usually different. Is the time of a system made of juxtaposed and embedded times of its subsystems, like the space is [5]?

II. The Arrow of the Time is an Oriented Ellipse

A. Ecoexotope & Endophysiotope: the Artificial Time of the Observer is not the Intrinsic Time of the Observed Subject

Usually the evolution of a system is represented with using the time of the observer: looking at the glycaemia of somebody we say the glycaemia and insulinaemia runs in parallel and the insulinaemia and glucagonaemia in opposite (Fig. 2). Using the simplest (first order) adjustment we say the correlation is a line.

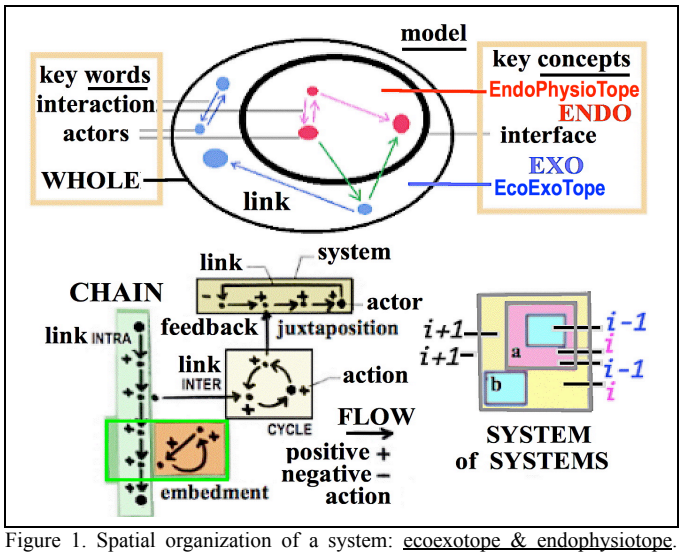

Figure 1. Spatial organization of a system: ecoexotope & endophysiotope. Every living system is first a wholeness but made of actors that are juxtaposed and embedded in subsystems and in interactions (**link**). So the endophysiotope of a system ***i*** is always the ecoexotope of survival of a subsystem ***i-1*** [4, 5].

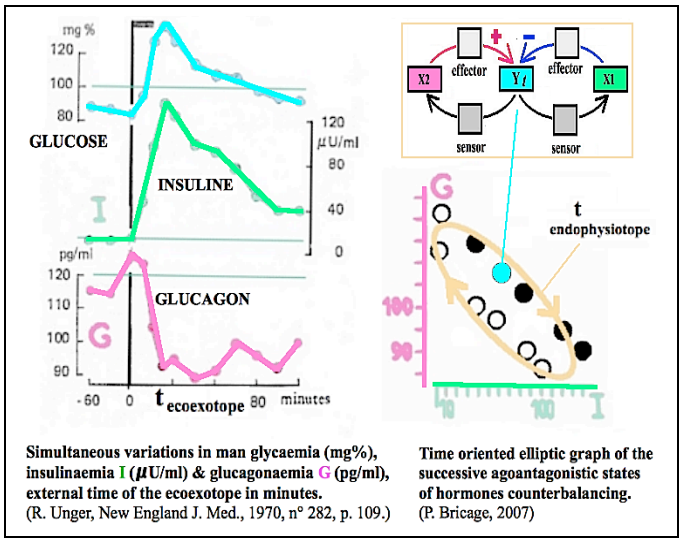

Figure 2. Glycaemia calendar: a systemic constructal law with 2 actors [6]. On the left the 2 phases process: first a rapid change then a long slow return.

But if looking at the sequence of the values we see that the evolution is different, depending on the phase -of the 2 phases process- in which we look. The real time link is an ellipse (second order cybernetics); the time of the ENDO is running along it, always in **a unique way, without turning back**.

B. Different Endophysiotope Calendars Run Simultaneously

Looking at an asthma crisis (Fig. 3), using the EXO time of the observer (in which the day is longer than the night), we see the histaminaemia and adrenalinaemia runs in opposite. With the simplest (first order) adjustment the correlation is a line. But with the sequence of the values we see that the ENDO time calendar is an ellipse too. But the time is moving along 2 different ellipses, in a unique way, without turning back, but with opposite ways, depending on the interaction. The night phase in that calendar is relatively 3 fold greater than the day one. That explains why the crisis is so stressful for the patient.

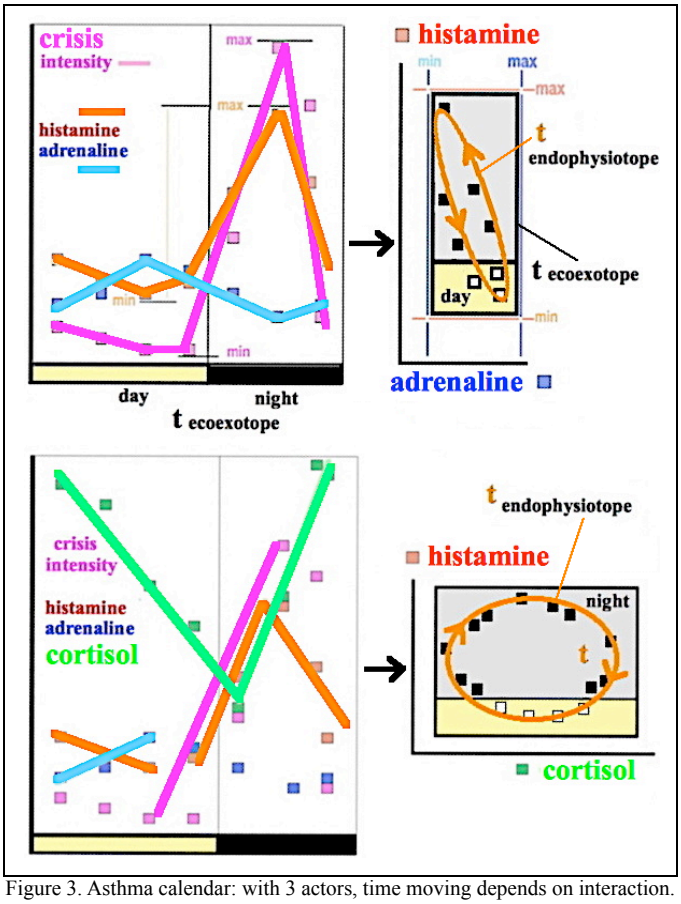

Figure 3. Asthma calendar: with 3 actors, time moving depends on interaction.

C. Entrainment of Metabolic Chains of the Endophysiotope by the Temperature Changes of the Ecoexotope

Looking at the anthocyanin pigments in Lathyrus leaves [7] (Fig. 4), we see that from one day (of the time of the observer) to another, the tri-substituted products (which are synthesized from the di-substituted ones) are increasing with the increase of the temperature daily difference (TdD). After a first order adjustment of the cloud of values the correlation is **a line**. But with the values sequencing we see that the ENDO time calendar is **an ellipse** too. The line is its axis. The temperature changes of the EXO structures the way and the speed of running of the ENDO time. The **time is irregular**, in a no-change EXO it can stop, but it never turns back.

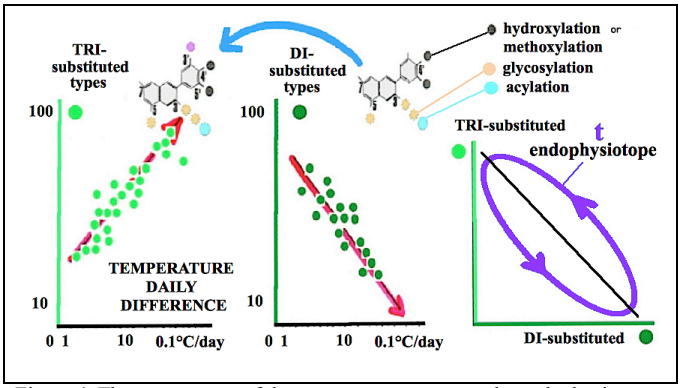

Figure 4. The temperature of the ecoexotope structures the endophysiotope.

Thanks so much Prof. O. Halli, President of Ibn Zohr Univ. Agadir, Morocco, for invitation. Thanks Prof. Robert Vallée (WOSC) for data and comments.

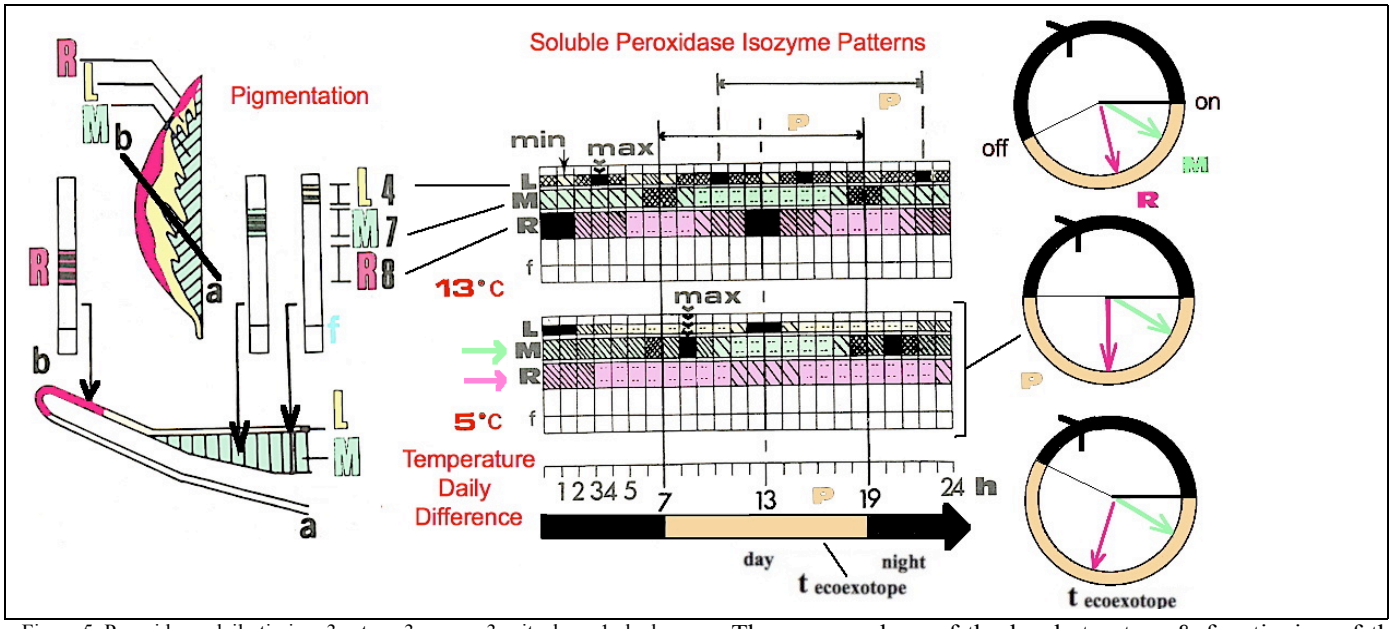

Figure 5. Peroxidases daily timing: 3 actors, 3 spaces, 3 zeitgebers, 1 clock. Left: half-leaf section **ab** of *Pedilanthus tithymaloides L. variegatus*, with the palisade layer in green, the epidermis in yellow. Peroxidases families: **M** (chloroplasts linked), **L** in white then yellow epidermis (low temperature daily difference), **R** in red sectors (anthocyanins synthesis at high temperature daily difference), acrylamide gel electrophoresis separations. Middle: daily patterns of peroxidase capacities (optimum conditions), **min** minimum, **max** maximum 13°C or 5°C constant temperature daily differences. **P** photoperiod (constant light 12 h, night in black). Right: 24h watch. Zeitgebers: **on**/**off** light on/off, first arrow: fixed timed event (**M**), second one: variable timed event (**R**).

III. The Space Structures the Time and Reciprocally

A. Various Ecoexotope Zeitgebers, Different Alarms and Watching Systems but Only One Endophysiotope Clock

From one day to another the maximum enzyme capacities of the isoperoxidase activities in Pedilanthus leaves [8] (Fig. 5), are timed -either by the light on (whatever the temperature & the day length): family M, -or by the temperature peak (whatever the day length): family R, -or the TdD: family L. The daily metabolic expression of the peroxidases activities, with the synthesis of anthocyanins like in Lathyrus (Fig. 4), is fixed by the thermoperiod: the hourly position of the maximums of intensity depends on the temperature daily difference. Everything takes place as if the number of possible events within the ENDO: -the graduation of the timetable (family L), and -the intensity of an event, i.e. the number of rung knocks indicating the hour (family R), depended on the temperature of the EXO. The EXO zeitgebers structure the ENDO clock (clock making) and its hours of enzymes bursts (wake making). The time is irregular but never turns back. The plant is a pericline chimera so the growth of the leaf tissues is linked directly to the temperature and the light changes and indirectly to the enzymes activities. The spaces of the ENDO structure the local ENDO times and **reciprocally**.

B. Ecosystem Evolution: Timing of a Run Through the Time

Look at the spatial and temporal organization (Fig. 6) of the food chains into a forest (bois de Pau, France) [9]. The forest health is evaluated with 4 parameters NIV, DIV, DEN, ENV. They are markers of the local structure & functioning of the food chains. Where the variety of the plant species is too low (ENV < 4) or too high (ENV > 6) the forest is endangered because the deciduous trees are the keystone species [10] of the ecosystem. There are 2 metastable steady state equilibria (ENV = 4 & ENV = 6) at which NIV is the lowest, allowing the **mutual** survival of the preys (the trees) and their predators (the insects) and the best survival for the Whole. *"To survive that is first to eat and not to be eaten."* [3], *"For the one to survive, the other one must survive first.", "At the end, soon or late, every being is eaten"* [10]. The global survival of the forest is allowed only if a minimal area of healthy potential reproductive trees will survive: **a threshold** number of local spaces where the trees biodiversity **remains between** 3 and 7. We can follow year by year, place to place, the changes of the number (ENV, DIV) of the local actors. If the system is in balance, we can observe no change during several years. We can observe a system's answer, but to an aggression from outside the system, only when a human intervention has taken place (deforestations, plantations, or both). Suppose the actors (ENV) joined gradually (1 by 1) -to establish a forest through colonization of a naked space and whatever is the order of integration of each new actor-, or at the opposite dissociated gradually (1 by 1 also) -if the diversity of the local actors is too high (ENV = 7, 8), for the survival of the whole, previous actors must be eliminated (retrogression)-. The constraints of the survival of the actors, the story of the development or the retrogression [3, 8] of the whole, evidenced by ENV changes, is represented by the relation between DEN and DIV of the ravagers populations. The graph is not an ellipse. Why?

C. Endophysiotope Timing in a Through Space Run

In a fixed earth place, the annual graph of the time equation is a curve called a solar analemme. Every point of this curve represents a position of the sun but photographed every day at the same hour. Its shape depends on that hour of recording (http://fr.wikipedia.org/wiki/Analemme).

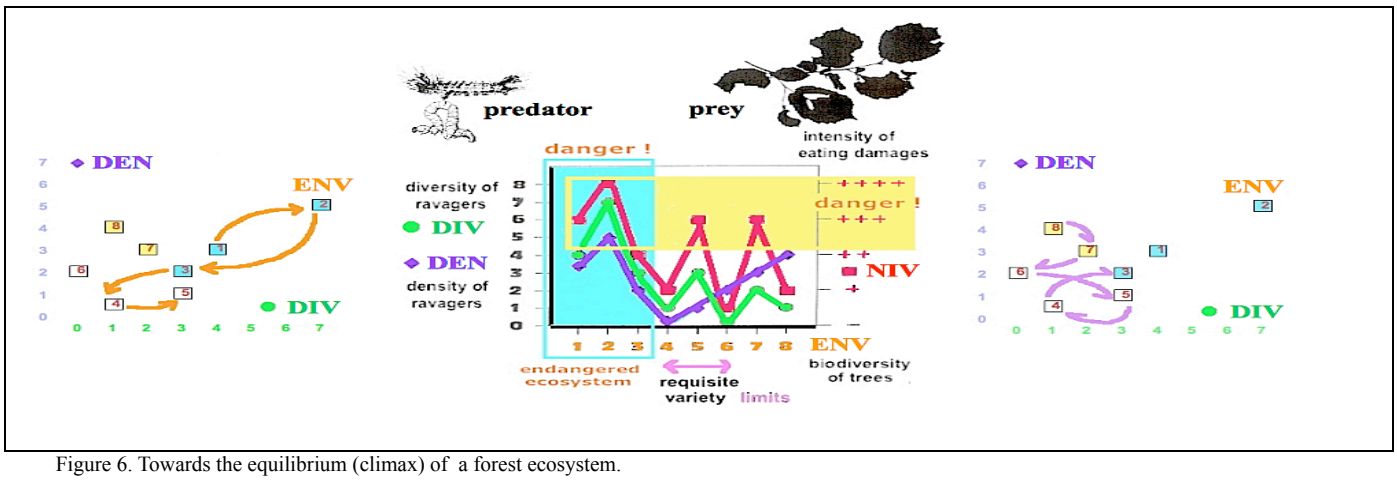

Figure 6. Towards the equilibrium (climax) of a forest ecosystem. Middle : eating intensity NIV (foliar areas reduction: - 5%, + 20%, ++ 40%, +++ 80%) (e.g. leaves of hazel tree), species diversity DIV & density DEN (1x, 2x, 3x …) of caterpillars (e.g. *Lymantria dispar* and *Erannis defoliaria*), local plant species ENV. Left: the step by step story from a place where the diversity of the local actors (ENV = 1, 2, 3) is insufficient for the survival of the WHOLE, unless a new ACTOR is integrated (the arrow indicates the way of the development) towards the to reach "as quickly as possible" equilibrium, the zone of metastable states (ENV = 4, 5, 6) where the differentiated forest survival is allowed without change or with a moderated one (1 actor). Right: the opposite supposed step by step story from a planted forest towards the equilibrium, the calendar of retrogression of the system, if the actors (ENV) dissociated gradually, whatever is the order of elimination of a previous actor.

The durations changes of the longest and shortest night cycles of a man daily sleep follow lunar calendars in the shape of analemmes (Fig. 7) [11]. They are evidenced by the factorial analysis of the correspondences between the durations of the cycles and the dates of the lunar cycles (moving in perigee or apogee, moving in ascent and descent). Everything fits as if the sleeper was a fixed point looking to the moon and following with his eyes the lunar trajectory (lunar analemme) as a earth fixed camera follows the visible trajectory of the sun during the course of the earth around it (solar analemme). In the factorial plans, the intersection point of the axes and the stacked or juxtaposed analemmes fits with all the other days of the timetable. Everything runs as if the physiological time of the ENDO, in that point, stops while the time of the EXO runs ahead regularly. During the movings from ascent to descent or inversely, and on apogee or perigee, for few days before and after, the local ENDO time re-starts, accelerates then stops again. The ENDO time exists only when the EXO time is changing. It is the movements of outside actors in the EXO space that create the inside ENDO time. The interactions between the EXO and ENDO spaces create the internal time into the ENDO. Why is the trajectory **an analemme** like is the one of the forest running towards its climax (Fig. 6)?

IV. Modeling of their Time Template by Living Systems

The time WHOLE is both more and the less than the sum of its time PARTS (Table 1). What is true for the space [12] is true for the time! The usual time trajectory, of a living system ENDO moving in its ECO, on a plan of projection (x, y), is a conic ($Ax^2+Bxy+Cy^2+Dx+Ey+F = 0$), a calendar according to which **forecasted events are ordered** (Fig. 2, 3, 4).

A. What is the timeline an ellipse?

The sine wave -or sinusoid- is a graph of the repetitive oscillations occurring in biological processes (like glycaemia under regulation) and in signal processing. In the affine plan, with orthonormal axes, the resultant of 2 oscillations (Table 2)**,** whose variations are antagonist, gives an ellipse as a periodic configuration (Fig. 2, 3): the ellipse[1] is the simplest Lissajous figure formed when the horizontal and vertical motions are sinusoids with the same frequency. A circle is an ellipse. In Euclidean geometry, ellipses arise as images of a circle under parallel projection and the bounded case of perspective projection, which are intersections of the projective cone with the plan of projection. An ellipse is defined as the bounded case of a conic section, or as the set of all points of the plan such that the sum of the distances to 2 fixed points is constant. Each focus of the ellipse is associated with **a line** parallel to the minor axis called a directrix. In geometry, by projective duality, an ellipse is defined also as the envelope of all lines that connect corresponding points of 2 lines which are related by a projective map. This definition also generates hyperbolas and parabolas. However, in projective geometry every conic section is equivalent to an ellipse. A parabola is an ellipse that is tangent to the line at infinity, and the hyperbola is an ellipse that crosses it. An ellipse may be defined with a circle or a composition of 2 circles as directrix. It is a special case of the hypotrochoid. The image of an ellipse by any affine map is an ellipse, and so is the image of an ellipse by any projective map such that the line does not touch or cross the ellipse. An ellipse is also the result of projecting a circle, ellipse or sphere (3D), on a plan (2D), by parallel lines. An ellipse has 5 degrees of freedom, defining its position (where the calendar is), orientation (the way the the arrow of the time is oriented), shape (the strength of the link between the actors), and scale (depending on the level of organization). Circles or parabolas have less degrees of freedom. The general solution for a harmonic oscillator in two or more dimensions is **an ellipse**. As it is the case of any object that moves under influence of an attractive force that is directly proportional to its distance from a fixed attractor (Fig. 8), time is running under the influence of **an attractive field**.

1 http://en.wikipedia.org/wiki/Sinusoid
http://en.wikipedia.org/wiki/Ellipse

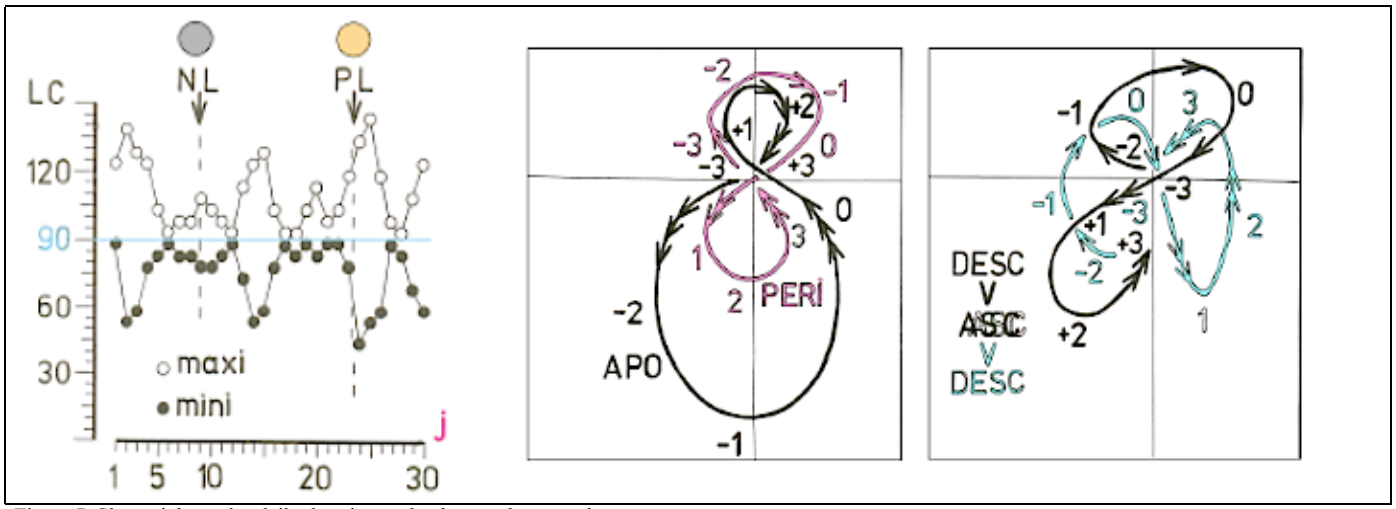

Figure 7. Sleep night cycles daily durations calendars are lunar analemmes. Left: **LC** the shortest (**mini**) and longest (**maxi**) durations (in minutes) of all the cycles of a night sleep -mean: **90** minutes-, during a **30** days duration -with a lunar cycle (**NL** new moon, **PL** full moon)-, without change of location of the sleeper. Middle: correspondences multifactorial analysis projection map, with the times of the lunar cycle **APO/PERI**, **–3, –2, –1** the 3 days before apogee or perigee, **+1, +2, +3** the 3 days after, **0** apogee or perigee. All the other days are fused together in the axes intersection point. Right: projection map with the times of the lunar cycle **DESC/ASC**, **–3, –2, –1** the 3 days before the change, **+1, +2, +3** the 3 days after, **0** DESC/ASC or ASC/DESC change. All the other days are fused together in the axes intersection point.

B. What is the timeline an ellipse or an analemme?

A conic section is the intersection of a plan and a cone. The observed conic depends on both the plan of projection and the position of the observer. By changing the angle and location of the intersection, we produce a circle, an ellipse, a parabola, a hyperbola, or in the special case when the plan touches the vertex a point, a line or two intersecting lines.[2] In the projective plan, with the directrix in the infinity, a conic, whatever it is in the affine plan (ellipse, parabola, hyperbola), is always an ellipse. The equidistant curves between two internal circles are ellipses. Depending on the juxtaposition or encasement of the times, we look **an ellipse** or an analemme (Fig. 8, 9) in projection on a Moebius strip (Table 2). If you reflect an ellipse in a circle you get on egg curve, two juxtaposed egg curves look like an analemme. The shape of an analemme, as that of a conic, depends from the point of view of the observer [13]. Temporal series may be created by longitudinal cuttings of the Moebius strip.[3] A line drawn starting from the seam down the middle of **a Moebius strip** will meet back at the seam but at the other side. If continued the line will meet the starting point and will be double the length of the original strip. This single continuous curve by projection looks like an ellipse or an analemme [14]. The loci of the centers of circles tangent to two circles with different radius are conics. A circle seen in perspective is a conic. It is an ellipse, a parabola or a hyperbola as the observer is outside or inside the circle. An observer who looks at a parabola can see **an ellipse**!

2 http://en.wikipedia.org/wiki/Conic_section
http://www.mathcurve.com/courbes2d/conic/conic.shtml
http://math2.org/math/algebra/conics.htm

3 The Moebius strip is a surface with only one side and only one boundary component. It has the property of being non-orientable. It can be realized as a ruled surface. http://en.wikipedia.org/wiki/Möbius_strip

C. Times are juxtaposed and embedded like spaces are

The constant time of a physical watch is different from the variable time of a living clock which is contingent both to the genetic and epigenetic contexts [5]. When the functional state of the ENDO does not change, time does not flow (Fig. 7). A model in which the time flows faster or slower depending on the speed of changes was proposed by Robert Vallée [15, 16]. When time is running in **a second order manner** (Fig. 8) phenomena of explosion or implosion can be described by conics: hyperbola, parabola. The time can be thus modeled in the same way as the space [4]: the time, as the space, can be at the same time more and less that the sum of its parts (Table 1)!

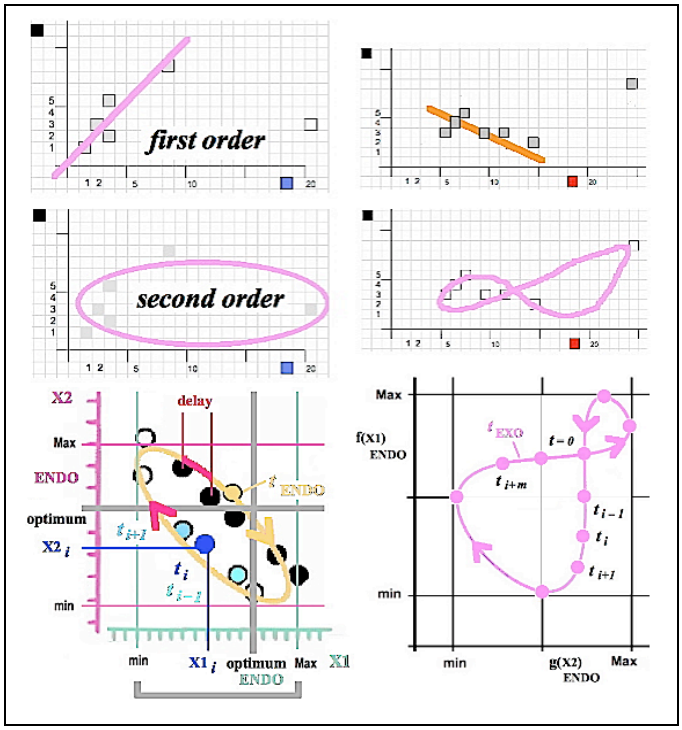

Figure 8. From first order to second order cybernetics. Top: line (linear adjustment) -first order relationship-: agonism, amplification (left) e.g. FSH and LH in menstrual cycle; antagonism, negative feedback (right) e.g. FSH and oestrogens in menstrual cycle. Middle: ellipse (left), analemme (right) -second order timelines-. Down: ellipse ENDO timeline built by 2 antagonist ENDO actors -glycaemia- (left), control of the functioning of 2 ENDO actors by a recalled analemme EXO timeline -man sleep- (right) [14].

TABLE 1. The WHOLE time Y = **T** and its ***i (i = 1 to n)*** PARTS **X*i*** = **t*i***.
The simplest fields of interaction are graphed as CONICS.

The WHOLE is both more and the less than the sum of its PARTS.

T = K or ***ti*** = K***i*** **independence** of the parts ***ti*** and the whole **T**

$T = \sum (ki \cdot ti)$ the WHOLE is limited by the PARTS, **limiting factors** of the whole, or

$ti = k'i \cdot T$ the PARTS are limited by the WHOLE, **limiting factor** of the parts.

The *welcome capacity* is limited by the *to be welcomed capacity*, reciprocally the *capacity to be welcomed* is limited by the *welcome capacity*.

$bT = \sum (ai \cdot ti) + K$ ***"The whole is bigger than the sum of the parts."*** (Confucius)
but it can also be the sum of its parts,
sometimes it is smaller, but mostly "it is different"!

Line **in 2D (n= 2)** $a1 \cdot X1 + a2 \cdot X2 = K$ (which is a conic)

X*1*, **X*2*** are the building actors, ENDO **T** is running in a unique way along the line.

The WHOLE is more and less than the product of its PARTS.

The simplest graphic **2D** representations are always conics or assembly of conics.
The usual space trajectory of a mobile in a field of gravity, is a conic.
The same for "the time trajectory" of a living system ENDO moving in its ECO.
Its projection on the plan (x, y) is a **CONIC**: $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$
x, y are the building actors, ENDO T is running in a unique way along the ellipse.

Circle $Xi^2 + Xj^2 = K^2$ (in the plan of projection **X*i*** , **X*j***)

Parabola $Xi = k \cdot Xj^2 + K$

Hyperbola $Xi \cdot Xj = K$ the WHOLE is the product of the parts
(***welcome capacity***) x (***capacity to be welcomed***) = K,
$(X1+X2)\cdot(X1-X2) = X1^2 - X2^2 = K$ **in 2D (n= 2)**
the WHOLE is the product of the sum and the difference of the parts

Ellipse $(X1+X2)\cdot(X2+X1) = X1^2+X2^2+2X1X2 = K$ **in 2D (n= 2)**
the WHOLE is the square product of the sum of the parts.

TABLE 2. Emergence of the WHOLE time **Y** from its time PARTS **X*i***.

- graph of a **repetitive oscillation X** (1 actor):
sine wave or sinusoid
$X(t) = A \cdot \sin(\omega t + \phi)$

A **amplitude**
What is the peak deviation of the function from its centre position.

ω **angular frequency**
How Many oscillations occur in a unit **time interval *t***.

φ **phase**
Where in its cycle, *t* = 0, the oscillation begins.

- parametrising of **2 antagonistic juxtaposed** running oscillations *X1, X2* (2 actors):
$X1(t) = a1 + A1 \cdot \cos(\omega_1 t + \phi_1)$,
$X2(t) = a2 + A2 \cdot \sin(\omega_2 t + \phi_2)$
ellipse if a **same EXO zeitgeber** is synchronising the 2 ENDO waves:
$\omega_1 = \omega_2$

- parametrising of **3 agoantagonistic juxtaposed and embedded** running oscillations *X1, X2, X3* (3 actors):
Moebius strip
$X1(t) = (a + A \cdot \cos(\omega t/2)) \cdot \cos(\omega t)$,
$X2(t) = (a + A \cdot \cos(\omega t/2)) \cdot \sin(\omega t)$,
$X3(t) = A \cdot \sin(\omega t/2)$

Whatever is the level of organization, within the ENDO (Fig. 2, 3) or within the EXO (Fig. 5, 7), time waves (Fig. 10) structure space volumes and mutually spatial waves (Fig. 9) structure timelines (systemic constructal law) [2, 5]. The time and the space are not *"a priori"*, they result from interactive processes, they are built by interactive systems and for their **mutual** organization [1, 3]. They are, from emergent scales to emergent scales, emergent properties of systems of systems (Fig. 1, 9). At all scales, as well for the physiological ENDO time as the cosmological EXO time, we have to distinguish between the artificial reference time, which allows to write the equation of evolution of a system [15], -i.e. its possible ENDO adaptation to random EXO changes, the changes of what it was originally or what it undergoes- and its internal ENDO time, which does not flow if the state of the system, does not change. As long as it did not feel it, nothing comes real for the system. The general solution for a harmonic oscillator is **an ellipse**.

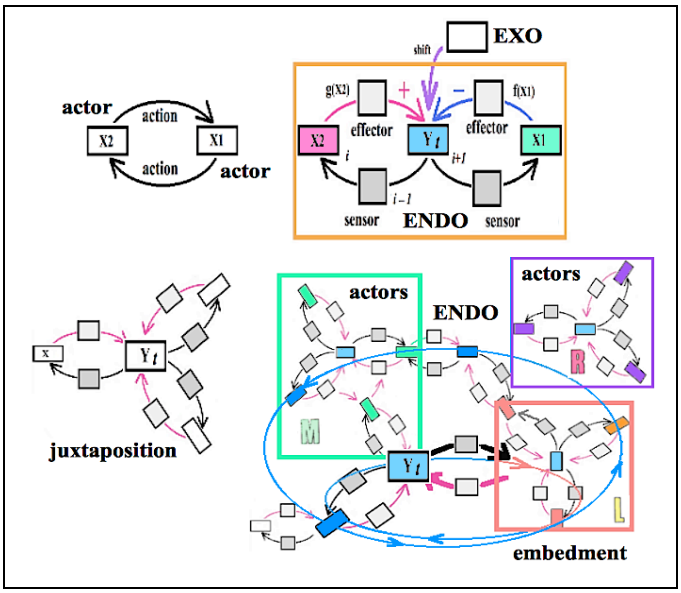

Figure 9. Timeline building by juxtaposed & embedded actors.
Actors (top left): **X1, X2**, systemic constructal law: X1 action causes on X2 an effect which is at the origin of an X2 action which is the cause of an effect on X1 and so on [4, 6]. Top right: before an X action a signal must be sensed by a **sensor** which is usually at an inferior level of organization (e.g. ***i-1*** molecular level, if ***i*** cell level of the actor and ***i+1*** organism **ENDO** level): example of 2 antagonist actors (+ hyper , – hypo), **Y** controlled factor at ***t***, **shift** Y change as result of an **EXO** action (glycaemia). Down left: **juxtaposed** actors (asthma). Down right: juxtaposed and **embedded** actors (L, M, R cell peroxidases).

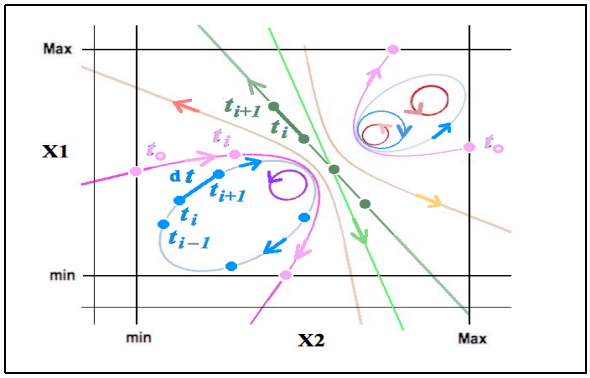

Figure 10. Timelines of juxtaposed & embedded timelines.
Actors: **X1, X2** (Fig. 8), systemic constructal law. Adjacent successive times: ***0***, ..., ***i-1, i, i+1*** of a same timeline ***t*** of a controlled system (of at least 2 actors) at a defined level of organization**.** The time interval ***dt*** may be constant or not. Timelines are juxtaposed and embedded like spacevolumes are. Timelines (i.e. 2 **ellipses**) may merge giving rise to a new timeline (e.g. an analemme).

V. Conclusions

ENDO rhythms (Fig. 10) display oscillations along cycles of finite duration, at different scales [2]. They are driven by, or composed of, at least 1 calendar -the "timing"-, 1 watch -the "timer"- and 1 clock -the "timed" alarm-. All self-sustained, adjusted to the local EXO (entrained) by zeitgebers (the most important are the daylight and TdD), they are irregular, made up of "sounds" (tic-tac), when time runs, and "silences", when time stops. The ENDO time builds itself "by walking" into the ENDO space: space and time are co-creating themselves mutually. From a projective point of view, there is only a single conic, because the conics are images by homography. With elliptic timelines, the geometry of the time is **gauge-invariant**.

As the Egyptians anticipated it 3000 years ago, the time is the union of 2 complementary aspects: -"eternal durations", **global** embedding times (hyperbola, parabola, line), once run, and -**local** "cyclic times" (ellipse, circle), finite, juxtaposed, repeating locally, -both being able to contain other juxtaposed and embedded cyclic times for which they constitute emergent "eternal" times, depending on the scale, but all linked together globally. An empirically found law [2] expresses this relation between the **time scale** -"the generation time" i.e. the period of a revolution (a cycle of acquisition of the sexual maturity) i.e. the time duration from a generation to the next one- and the **spatial scale** -"the 3D size" i.e. the volume of the grown-up stage (of a "moving" system, at the end of growth)- :

V_A 3D size
t_g generation time

$$V_A^2 = C \cdot t_g^3$$

Whatever the level of organization, a system is a manufacturer (a watchmaker) and a user of calendars of functioning for its emergent ENDO. It contains, maintains and uses at the same time a set of watches (which measure different times), a set of juxtaposed and fitted clocks (which indicate hours for change) and a set of juxtaposed and fitted calendars (which contain time ordered programs) [17, 18]. To build its time allows the system to forecast the next events to come in its space-time. This "implementation" is made without any *a priori* project, without other purpose than a single constraint "survive to live on".

Is the time which allows to channel random events towards a reproducible global behavior? Is the global randomness which, thanks to the local **requisite variety** (Fig. 6), creates the arrow of a unique, local and global time? Time is an emergent concept. What we perceive as being the time reflects only the relations that the various sub-systems of the Universe (Fig. 1) maintain between them [2]: -**time** is the order, the causality, **-space** is all the possible times [4]. As well as the causalities are in **loops**, times are in loops too. The time as the space is a macro-scopic arrangement of **ergodic, fractal,** micro-states [19]. Whatever the scale is, a referent **quantum** is needed: a quantum of space, time and action [4]. The quantum laws apply to all the scales, even if their appearances are unnoticed. Space and time are one: the space creates the time and conversely the time creates the space [2]. Timelines are ellipses, trajectories of an object that moves under influence of an attractive force that is directly proportional to its distance from a fixed attractor. Timelines orbits have centers of attraction -with a fairly simple equation of time motion- due to "a time force field" [20].

References

[1] P. Bricage, "The modelling of the time modularity of the living systems: the time delay, the time duration, the time lag, and the rhythms." 6th European Systems Science Congress, Paris, France, Res. Systemica, http://www.afscet.asso.fr/resSystemica/Paris05/bricage2.pdf, Sept 19-22, 2005, n° 5, 10 p.

[2] P. Bricage, "Métamorphoses et phylotagmotaphologie du vivant." L'évolution du vivant a-t-elle une direction ? Colloque Association des Amis de Pierre Teilhard de Chardin, Paris, 13 nov. 2009, 109 p. http://www.armsada.eu/pb/bernardins/phylotagmotaphologie.pdf

[3] P. Bricage, "The cell originated through successive outbreaks of networking and homing into Associations for the Reciprocal and Mutual Sharing of Advantages and of DisAdvantages, between the partners." 6th European Systems Science Congress, Paris, France, Res. Systemica http://www.afscet.asso.fr/resSystemica/Paris05/bricage3.pdf, Sept. 19-22 , 2005, n° 5, 11 p.

[4] P. Bricage, "Sémiologique graphique de l'espace-temps-action du vivant: bilan épistémologique et praxéologique de sa modélisation systémique, co-déterminisme global, prédictibilité locale et imprédicativité glocale. L'approche systémique des lois systémiques du vivant". Journées AFSCET, Vers une nouvelle systémique ?, Andé, France, 16 mai 2010, 35 p. http://www.afscet.asso.fr/Ande10/pbETAvivant10.pdf

[5] P. Bricage, "The evolutionary shuttle of the living systems." 5th European Systems Science Congress, Hersonissos, Greece, Res. Systemica http://www.afscet.asso.fr/resSystemica/Crete02/Bricage.pdf Oct.16-19, 2002, n° 2, 6 p.

[6] P. Bricage, "Les boucles constructales en sciences de la vie." Journées AFSCET, Intelligence des systèmes & action collective, Andé, France, http://www.afscet.asso.fr/pbAnde07boucles.pdf 2-3 juin 2007, 6 p.

[7] P. Bricage, "Multiple molecular steps and pathways of in situ anthocyanin biosynthesis in Lathyrus macrorhizus Wimm." -I. The leaf steps and pathways. pp. 106-107., -II. The glycosylation-acylation network. pp. 108-111., - III. The end-product population pattern. pp. 112-126. 1rst International Coll. Lathyrus, Chemical aspects, IBEAS, Pau, France, 1985, Sept. 9.

[8] P. Bricage, "Isoperoxidases, markers of surrounding and physiological changes, in situ in leaves and in vitro in calli of Pedilanthus tithymaloides L. variegatus: cell compartmentation and polyfunctionality, control of activity by phenols, specific roles." 1986, pp. 261-265. Molecular & Physiological Aspects of Plant Peroxidases, Univ. Geneva, Suisse (ISBN 2-88164-001-X).

[9] P. Bricage, et al., "Évaluation des cortèges des Lépidoptères défoliateurs d'un bois de feuillus (bois de Pau)." Ikartzaleak, 1989, n°13, pp. 5-26.

[10] P. Bricage, "Associations for the Reciprocal and Mutual Sharing of Advantages and DisAdvantages. The way to be resilient and self-sustainable, the living systems are running through." 54th International Congress of the International Society for Systems Sciences ISSS, "Governance for a Resilient Planet", Waterloo, Ontario, Canada, http://journals.isss.org/index.php/proceedings54th/article/view/1491 July 18-23, 2010, 11 p. http://armsada.eu

[11] P. Bricage, "Are the lunar, radiative and position, cycles responsible for the entrainment of the periodic awakenings of the man night sleep?" Biological Rhythms: From Cell to Man. Polytechnica, Paris, France, 1993, pp. 183-190.

[12] P. Bricage, "Thinking & teaching systemics. Bio-systemics in higher education: a multi-trans-disciplinary wholeness, -an holistic-cybernetic point of view, -a viable system modelling." Teaching Systems & Cybernetic Sciences in Higher Education, the International Academy for Systems and Cybernetics Sciences, 1st Scientific Workshop & General Assembly, Chengdu, Sichuan, PR China, October 24-27, 2010, 14p. http://www.armsada.eu/files/pbricageChengdu2010txt.pdf

[13] D. Schwarzenbach, "La forme de l'analemme." Orion 1983, n° 196, pp. 86-87.

[14] P. Bricage, "Influence de la lune sur les rythmes biologiques ?" Bull. Soc. Astronomie Pyr. Occ., 1997, n° 116, pp. 71-75.

[15] R. Vallée, "Time and dynamical systems." Systems Science, 2001, Vol. 27, n° 1, pp. 97-101.

[16] R. Vallée, "Temps et systèmes." 5th European Systems Science Congress, Hersonissos, Greece, Res. Systemica 16-19 October 2002, n° 2, 7 p. http://www.afscet.asso.fr/resSystemica/Crete02/Vallee.pdf

[17] A. F. Sarrazin, et al., "A segmentation clock with two-segments periodicity in insects." Science, 2012, Vol. 336, n° 6079, pp. 338-341.

[18] P. Vandeginste, "Modéliser le vivant.", La Recherche, 2012, n° 464, pp. 47-49.

[19] P. Bricage, "Pour survivre et se survivre, la vie est d'abord un flux, ergodique, fractal et contingent, vers des macro-états organisés de micro-états, à la suite de brisures de symétrie." L'évolution, du vivant au social. Journée AFSCET, I.I.A.P., Paris, France, 1er déc. 2001, 11 p., http://www.afscet.asso.fr/ergodiqW.pdf

[20] P. Bricage, "Le Jeu de la Vie. Systèmes vivants : les enjeux du temps, le temps des enjeux. Modélisation des temps internes d'un système vivant." Journées AFSCET Jeux et Enjeux : Systèmes, Modèles et Jeux, Andé, France, http://www.afscet.asso.fr/Ande12/pbAnde2012texte.pdf, 9-10 juin 2012, 44 p.

ICCS'12

IEEE Conference

Professor Lorenzo Ferrer Figueras

International Conference on Complex Systems

November 05-06, 2012
Agadir, Morocco

Mediterranean Space of Technology and Innovation organize The International Conférence on Complex Systems (ICCS'12) in partnership with Ibn Zohr University in memory of the late Professor Lorenzo Ferrer Figueras, ex-president of the Spanish Society of General Systems.

The ICCS'12 will provide a high-level, international forum for scientists, researchers, industrial professionals, and students who will present state-of-the-art research results, address new challenges, and discuss trends in Computational Intelligence, Cybernetics, General Systems Theory, and their applications in diverse fields.

All papers will be included in IEEE digital library

and extended version of selected papers will be published in special issues of International Journals

The topics of interest include, but are not limited to:

- Fuzzy Set Theory and Fuzzy Systems
- Fractals, Chaos Theory and Chaotic Systems
- Artificial Neural Networks
- Genetic and Evolutionary Algorithms
- Adaptive Agents and Multi-agent Learning
- Multi-agent Social Simulation and Cognitive Modeling with Agents
- Agent-Based Modeling and Simulation
- Agent and Multi-agent Architectures
- Game Theory, Strategic Decision-Making in Competitive Environments
- Modeling and Control Systems
- Diagnosis and Fault-tolerant Control Systems
- Hardware-Software Co-Design, Embedded Systems
- Complex Biomedical Engineering
- Complex Dynamic Systems and Globalization
- General System Theory and Methodology
- Complex Social and Ecological Systems
- Economical, Political and Juridical Systems
- Socio-Cultural and Behavioral Modeling
- Mathematical Methods in Cybernetics and Systems Theory
- Sociocybernetics and Mathematical Sociology

IMPORTANT DATES

Submission deadline	: April 30, 2012
Notification to authors	: June 30, 2012
Final version due	: July 28, 2012
ICCS'12 Conference	: November 05-06, 2012

CONTACT INFORMATION

Mohamed Nemiche
Phone : +212-(0)-666 293 046
E-mail : nemiche@uv.es

www.iccs12.org

Honorary Chair
Omar Halli, President of Ibn Zohr University , Agadir, Morocco.
Aleix Garau Montané, the Spanish consul general in Agadir, Morocco.

General Chairs
Mohammad Essaaidi, President of IEEE Morocco Section.
Mohamed Nemiche, Ibn Zohr University, Agadir, Morocco.

Honorary Advisory Board
Rafael Lostado Bojo, President of the Spanish Society of General Systems, Spain.
Pierre Bricage, Secretary General of the International Academy for Systems and Cybernetic Sciences.
Gerhard Chroust, Secretary General of the International Federation for Systems Research (IFSR)
Daniel Dubois, Director of ASBL CHAOS, University of Liege, Belgium.
François Dubois, President of the French Systems Science Organization, France.
Wei-Chiang Hong, Oriental Institute of Technology, Taiwan
(Editor-in-Chief of the International Journal of Applied Evolutionary Computation)
Rafael Pla Lopez, Vice-president of the Spanish Society of General Systems. Spain.
Mohamed Mansour, Ex-President of the Swiss Society for Automatic Control, Switzerland.
Gianfranco Minati, President of the Italian Systems Society, Italy.
Matjaz Mulej, President of the International Academy for Systems and Cybernetic Sciences.
Robert Vallée, President of The World Organisation of Systems and Cybernetics (WOSC).

Technical Program Chairs
Rafael Pla Lopez (University of Valencia, Spain)
Youssef Zaz (Abdelmalek Essaadi University, Tetouan, Morocco)

Technical Program Committee
El Houcein Aassif, Ibn Zohr University, Agadir, Morocco
Mustapha Ait Rami, University of Valladolid, Spain
Jilali Antari, Ibn Zohr University, Agadir, Morocco
Luis Antunes, Porto University, Portugal
Saúl Ares, Spanich National Center of Biotechnology-Madrid, Spain
Mohamed Bakhouya, Aalto University, Finland
Nabil Benamar, Moulay Ismail University, Meknés, Morocco
Samir Bouaziz, University of Paris Sud, France
Bernadette Bouchon-Meunier, CNRS, France
Mohamed Boutayeb, University of Nancy, France
Hassane Bouzahir, Ibn Zohr University, Agadir, Morocco
Pierre Bricage, University of Pau, France
Mohamed Chadli, University of Picardie Jules Verne, France
Brahim Chaouki, Ibn Zohr University, Agadir, Morocco
Ahmed Chitnalah, Cadi Ayyad University
Gerhard Chroust, J. Kepler University Linz, Austria
Danail Dochev, Institute of Information and Communication Technologies, Bulgaria
François Dubois, National Conservatory of Arts and Crafts, Paris, France
Abdellah El Fellahi, Abdelmalek Essaadi University, Tetouan, Morocco
Lahoucine El Maimouni, Ibn Zohr University, Agadir, Morocco
Moulay Driss El Ouadghiri, Moulay Ismail University, Meknés, Morocco
Abdelhafid Elouardi, Paris XI University, France
Mohamed Essaaidi, Mohamed V Souissi University, Rabat, Morocco
Khalid El Yassini, Moulay Ismail University, Meknés, Morocco
Mohamed Fayad, San Jose State University, USA
Joan Vila Francés, University of Valencia, Spain
Jaafar Gaber, University of Technology of Belfort-Montbéliard, France
Juan Martín García, Polytechnic University of Catalonia, Spain
Jean-Marc Girault, University François Rabelais, Tours, France
Kevin Guelton, University of Reims Champagne-Ardenne, France
Frederic Hamelin, University of Nancy, France
Cesar Hervás, University of Córdoba, Spain
Wei-Chiang Hong, Oriental Institute of Technology, Taiwan
Miguel Lozano Ibáñez, University of Valencia, Spain
Abdellah Idrissi, Mohammed V University Rabat, Morocco
Zine El Abidine Alaoui Ismaili, Mohamed V Souissi University, Rabat, Morocco
Hicham Jakjoud, Ibn Zohr University, Agadir, Morocco
Hicham Jamouli, Ibn Zohr University, Agadir, Morocco
Mohamad Khalil, Lebanese University, Tripoli Lebanon
Salah-eddine Krit, Ibn Zohr University, Agadir, Morocco
Yuri Kuprin, St. Petersburg State University, Russia
Rachid Latif, Ibn Zohr University, Agadir, Morocco
Ignacio Martínez de Lejarza, University of Valencia, Spain
Ahmad Lotfi, Nottingham Trent University, United Kingdom
Francisco Parra Luna, Complutense University of Madrid, Spain
Driss Mammas, Ibn Zohr University, Agadir, Morocco
Noureddine Manamani, University of Reims Champagne-Ardenne, France
Mohamed Mansour, Swiss Federal Institute of Technology, ETH Zentrum, Switzerland
Antonio Marquina, University of Valencia, Spain
Marcelino Martinez, University of Valencia, Spain
Gianfranco Minati, Polytechnic University of Milan, Italy
Yassine Mofid, University François Rabelais, Tours France
Antonio Caselles Moncho, University of Valencia, Spain
Matjaz Mulej, University of Maribor, Slovenia
Ahmed Nait-Sidi-Moh, University of Picardy Jules Verne, France
Mohamed Nemiche, Ibn Zohr University, Agadir, Morocco
Mario Paolucci, Institute for Cognitive Science and Technology-Rome, Italy
Alexandre Philippot, University of Reims Champagne-Ardenne, France
Luis Antonio Quintero, EAFIT University, Medellin, Colombia
José Ragot, Centre de Recherche en Automatique de Nancy, France
Muthu Ramachandran, Leeds Metropolitan University , United Kingdom
Abdul Raouf, University of Management and Technology, Lahore, Pakistan
Amjad Rehman, Faculty of CS and IT UiTM, Malaysia
Juan Carlos Mico Ruiz, Polytechnic University of Valencia, Spain
Sattar B. Sadkhan, University of Babylon, Iraq
Juan Gómez Sanchis, University of Valencia, Spain
Alexei Sharpanskykh, University Amsterdam, Netherlands
Emilio Soria, University of Valencia, Spain
T.S.B. Sudarshan, Amrita School of Engineering, Bangalore, India
Abdelouahed Tajer, Ibn Zohr University, Agadir, Morocco
Enrique Herrera Viedma, University of Granada, Spain
Joseph Yamé, University of Nancy, France
Jianqiang Yi, Institute of Automation, Chinese Academy of Sciences,Beijing, China

Organizing Committee

Younes Belahsen, Tarik Berroug, Fouad El Ouafdi, El Houssaine Farkane , Salah-eddine Krit, Lahoucine El Maimouni , Taoufiq Moueddene, Mohamed Nemiche, Mohamed Oudada, Sally Shafto, Hamid Zidouh	FP Ouarzazate
Jilali Antari, Moha Ikenne	FP Taroudant
Rachid Latif, Hicham Jamouli, Abdelouahed Tajer	ENSA Agadir
Rafael Pla Lopez, Antonio Caselles Moncho	SESG, Spain
Mohamed Essaaidi	ENSIAS Rabat
Pierre Bricage	IASCYS
Youssef Zaz	FS Tétouan
Nabil Benamar, Moulay Driss El Ouadghiri, Khalid El Yassini	FS Meknés
Rachid Ait Ouarraou	