Basis for an approaching of interactive works as dynamical systems.

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Abstract:

The following work presents an analysis of interactive works as the construction of relational interfaces in which the artist settles down bonds between parameters through the computer, using the possibility that the digital technology offers.
It is outlined the bases for the interactive work modelling as a dynamical system whose temporary evolution depends partly on the inserted programming in the interfaces.
Since the artistic action is displaced to the configuring of relations, the artist place is analyzed, as well as the spectator role and the artistic object conception.

Introduction:

Many artists, nowadays, use the computer as a part of their artistic creation process. CD's, Web sites, installations, etc. frequently use of the digital format as work substance.
Devices to sense physical variables submerge the spectator in participative environments where the interactive relations are settled down by means of computer programming.
The artist action is displaced from the artistic object superiority to the interactive forms modelling, connecting interfaces, building codes and designing the relations between the person actions whom becomes entailed with the work.

Modelling the interaction between the system components, it is a practice that many scientists usually do and fundamentally in physics and biology fields. According to the bond models between the parts are settled down, a way of further evolving system is defined. For example, when different criteria of interaction between particles are settled down in a system, its later evolution happens through successive states whose form is given by that particular way in which those particles interact like complete system and with the surroundings.

Like a scientist models the forms in which the bodies are related in nature, an artist who designs an interactive work, can settle down the bonds forms between the spectator – the environment - and the digital information materialization she or he handles. In this sense, artists and scientists, are alike in that their attitudes towards the world evoking the idea of the Platonic Demiurge where the art can again give characteristics to its devices imitateing the nature.

The present work is a starting point for further artistic exploration processes on the interactive field.

Work - environment – spectator relation. Background.

Any work presented in space establishes manifold relations with its surroundings and the spectators. The artistic object interacts with its physical and cultural-symbolic context that contains it.
If the work formal structure is altered in some of its different dimensions, the context is redefined. In the same way, changes made in the context produce a new work resignification.
This work - space interrelation does not have its counterpart when one thinks about the spectator – artistic objet relation. The spectator is affected by the work perception whereas the artistic object remains materially invariant because of the spectator passive attitude [I] .
This unidirectional form of relation has been questioned in many forms. During the 40s and the 50s, the MADI movement in Argentina and Uruguay, developed movable works that could be altered by the spectators. Examples of this are Gyula Kosice's wood articulated sculptures and the Arden Quinn's paintings. Even in Brazil, Lygia Clark's Bichos series (1960) tries to rescue the spectator like a subject one, changing its passive role, to propose him to manipulate a number of aluminium planes structures articulated by hinges, creating a simultaneous relation between the object, the glance and the tact. In the same way, Helio Oiticica again establishes an additional relation between the glance and the color. Since in his "Bólides" series or trans-objects the spectator can touch and move the box faces of different colors and textures by adding the tactile action on the objects [2] .

As in the former examples, in the actual interactive works, the spectator is an active part exerting its actions on the work in a direct way, so the artistic object needs the user action to be developed in space and time.
The successive transformations the work makes, produce a constant dynamic re-meaning. The author has only defined some of the possibilities, or initial rules of a game, which are triggered by the user actions.
For example, in Clark's Bichos series, a person can change the movable structures form, the hinges predefine the possible movements which are the rules defined by the artist whose possibilities could be limited, but the spectator actions, like active user, changes the formal variables of the work now.

Relation of parameters established by the artist. Spectator as relations trigger.

The artist models the way in which the work will be affected by the user participation. He or she configures the relations between different spectator actions and the work formal elements.

Lately technological devices to sense diverse spectator physical parameters are used allowing to establish relations which alter the work formal variables. Weather person position, movement, acceleration, weight, environmental variables or events that happen in the Internet, are some examples of parameters can change a work.
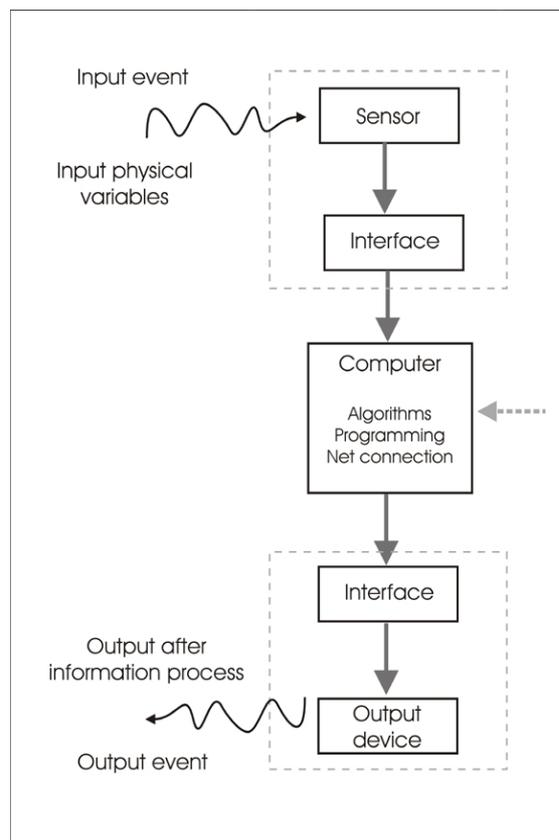

<div align="right">Figure 1</div>

The connection of technological devices to a computer allows to establish "relational bridges" between physical variables through digital technology. The outer world data obtained through sensors can be stored and transformed in many ways by means of algorithms and programs producing different output forms or information realizing processes. In scheme 1, there is a typical configuration of a basic connection which relates input – output physical events. The interfaces take incoming signals from instruments, which acting as sensors, transform them into computer compatible input electrical pulses. After that, information is digitally processed and transformed generating an output event by means of another interface.

Because the events that happen in space are represented digitally, they can be altered and transformed by virtue of algorithms which operate on a mathematical abstraction, in this sense, the spectator position can be transformed into sound, the sound of its voice into an image, an so on. For example, a sensor can transform a physical variable like the voice of somebody into voltages; in an

analogical-digital converter operates a later transformation which once entered into a computer, it can be handled by programs that follow certain decision criteria. The information is transformed again realizing into images, color or sound forms, etc. Therefore the complete connection and protocols chain defines an interface which ties the voice to images, colors, or sounds, due to some dynamics and criteria modeled in software [3].

In an input – output chain as it is shown in figure 1, successive connections between programming languages are structured moving the artistic action to the configuration form of such languages. The communication protocols conformation, the programming, the hardware interfaces connection, and the form in which these languages are concatenated, allow to think about the artistic act that gives "art state" to the relations stablished between the people action and the information realizing form.

It can be thought this performance points out user-information realizing connection as "artwork".

As in the communication protocols, which are a "form to do things", also in the protocols configuration form, or relational bridges conformation, lies the "artistic form".

The relations that structure the hardware and software connections, define the interaction forms that the artist settles down between certain user, or world variables, and the artistic object. Acting almost like a scientist, who is modelling nature in a system and playing with the way to relate its parts, the artist characterizes its work later evolution as a system too.

In this case, the attention is no longer directed to the formal aspects of the artistic object; it would be more appropriate to think about the artistic object like the "information realizing form", which is characterized by the connection established by the artist and driven or fed by the user.

In this context, it is constituted a system that ties people, connections, environments and the information realizing through successive transformations. All together constitute a sort of "work-system" with its own evolving dynamics.

Relations determined by the artist. Transformations and sets.

The user action, or any other natural event, can generate a set of parameters that the artist wants to relate.

Thinking in mathematical terms, one can define a relation that goes from an **A** input set to another **B** output set. The sets are at the entrance and exit of a hardware and software connection, and the connection itself is represented by the transformation. See figure 2.

This interfaces connection takes initial parameters and transforms them into another output variables. The user action puts into operation the binding transformations.

X = Y is a project of interactive installation for public spaces in which I have been working. A transfromation of people movement into projected texts is applied there. See figure 3.
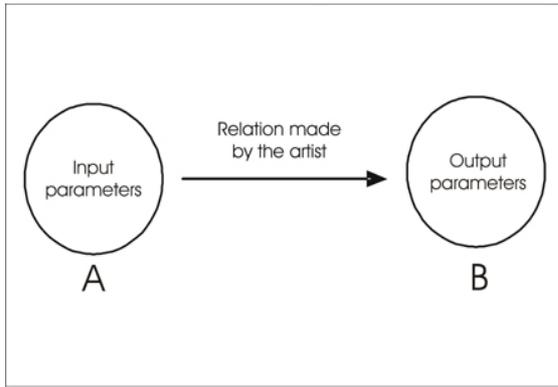
<div align="right">2</div>

Figure 2

Figure 5

In this work, the people trajectories are mimicked by characters paths projected on the walls. Words appear when there are crossings between the projected letters footpaths, or even when the ways of the people in space are crossed. See figure 4 [4].
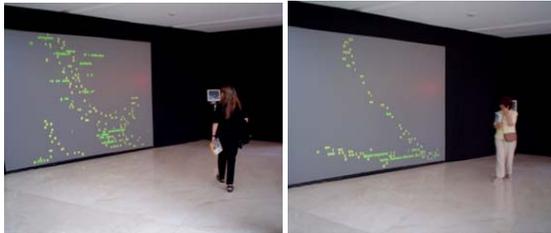

Figure 3.

In this installation, the (**x**) people positions and their (**v**) velocities conform the transfromation input variables set, these parameters are maped into an output set comformed of texts (T), a given color text (c), and projected text position (Tx) given by different inserted criteria of interaction in the software that defines the transformation. The interaction cycle closes through the user changing position and speed. The spectator relates to the text at a perceptive level and hermenéutical reading. See figure 5.
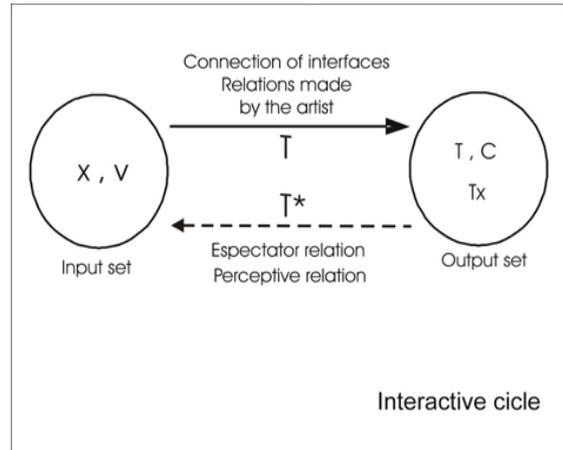

Figure 4.

The (**x**) person position and (**v**) speed in space firstly define the **A** set of parameters:

$$A = \{ \, x \, , \, v \, \}$$

A video camera – PC connection and a real time image analysis software sends data to another computer which is in charge to manipulate words and letters. All these connections constitute the hardware and software chain whose resulting interface is the user movements to projected texts translation.

So the relation goes to a **B** set conformed by parameters of the colored texts projected in space:

$$B = \{ \, T \, , \, C \, , \, Tx \, \}$$

The sets **A** and **B** are related of such a form that whenever the user moves, stops or runs, he or she activates the transformations time and time again taking the variables from the **A** set and maping them to the **B** set. Consequently, the interface configured by the artist can be defined as the following transformation:

$$T : A \rightarrow B$$

$$T \, (x \, , \, v) = (T \, , \, C \, , \, Tx)$$

User undefined transformation. Ambiguity and indetermination into the system.

An interface configured by the artist as it was described above, can be thought wether as the boundary of two common spaces, as the limit of two language structures, or as the place in which two systems interact. The computer screen is an example of this, since it defines the physical and methaphorical plane made of an image form or the place where the user space and system converge and transform themselves.

Inside of the computer, the successive structures are related from those of highest level to those of lowest physical level implying representation systems, languages structures and paradigms. The connections configured by the artist in this environment compose a language structure or architecture with that cultural and technological biases.

The sensor technology and hardware also induce to think the work space, where the actions take place, like a geometrized space, which once digitalized in a digitazing process with a programmed "form", shows concepts and theories implied by those technologies [5] .

Thus, as already it was said, this language architecture and interfaces the artist composes, define a certain transformation which is driven by means of the user performance.

However, the experience that the spectator develops with the work, expands beyond those relations established by the artist by means his or her connection protocols.

Each relation scheme built generates a way to perceive and perform the system, according to this, the symbolic space in which the "information realizing – user" interaction relates, is certainly very complex.

The experience, whom interacts with the work, stablishes manifold relations which are not those specifically settled down by the artist by means of interfaces, such other relations are ambiguous and difficult to predict. They imply phenomenological concerns beyond the reach and intention of the parameter set connected in the interaction [6] .

In the middle of this multiplicity of interactive relations, the artist configure connection tielines which define "a possible dynamics" between many of those that add ambiguity. The multiple user relations imply other "spaces" and unexpected transformations through phenomenological entailing.

In many cases, the searching for this ambiguity is intentional, trying to leave direct cause-effect relations, algorithms that demonstrate less reactive and more adaptive behaviors are introduced. Many works use genetic algorithms, artificial intelligence criteria, dynamical systems, etc. inserted in the work controlling software.

Note that the random programs often add indetermination but confusion; because without generating recognized "forms", they can be experienced singsong and irrelevant.

Although the interface connections imply control and determination, which are characteristics compatible to the computer functionality, it is in the user action where the system acquires indetermination fundamentally.

For that reason, we will be able to say that the user relation established with the work is not absolutely well-known, we can call $T*$ and it is represented in figure 3 by dotted lines.

My interest was particularly based on the searching for indetermination in the way the people act in public spaces places as well as natural processes with unpredictable behaviors involved.

In the case of the $X = Y$ installation, the people's movement is developed by the resulting tension between the geometrical design imposed by the architecture, or surroundings where the work is settled, and the game proposed by the installation projected trajectories. Therefore this "transit desorder" develops the proyected text dynamics in a nonlinear and unpredictable way.

So, we can think about a T defined transformation determined by the artist who ties parameters according to some inserted criteria in software. In the other hand, another indetermined $T *$ transformation operates with

the user action closing the interaction cycle, so that de unknown transformation is defined as:

$$T*: B \rightarrow A$$

Work evolution like form or state sequence.

When being satisfied a certain relation between the constituting work formal elements (color, background, figure, planes, etc.), a "state" of it is defined.

If one thinks about a space where the work develops as a system with dynamical interrelations, all the variables transform as the people interact, so the work passes through successive changing forms, or in other words, the work is happening through successive "states".

For example, in the Lygia Clark's Bichos, the successive states achieved by the pieces, are the diverse form the aluminium plates adopt according to the possibility that their hinges allow (formal bond conditions that the artist predefines), and the successive user movements entailing with the object. See figure 6.
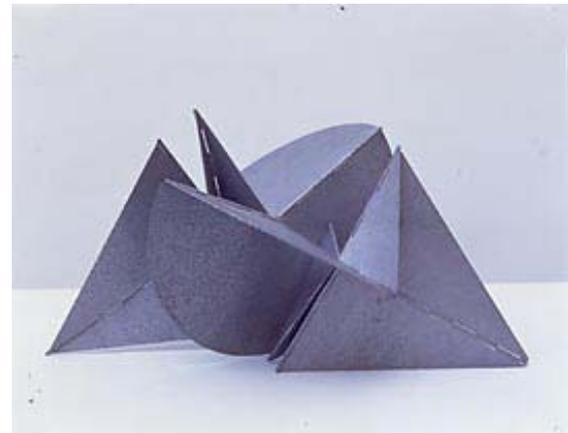

<p align="center">Figure 6.</p>

These states (E) could be described by means of a set of some angular values associated to the geometry of the pieces:

$$E\,(\alpha\,,\beta\,,\gamma\,,\theta)$$

Whenever the form of the piece is altered, it changes the angular values and a new state is defined.

In the case of $X = Y$ installation, the state that defines its form at every moment, relates the positions and velocities to the projected texts development, so that:

$$S\,(\,x\,,v,T,C\,,Tx\,)$$

At any t_0 moment of the installation, a user can be found in a certain position x_0 and walking with a speed v_0; whereas the text could be saying something like T_0, with a C_0 color, and projected in a Tx_0 position (it is supposed that these variables are of interest for us like work formal parameters); so that the installation is characterized by the S_0 state:

$$\mathbf{S_0} (x_0 , v_0 , T_0 , C_0 , Tx_0)$$

After the changing user actions (or not) their position and speed at a later moment T_1, the system transforms the initial $\mathbf{S_0}$ state, jumping to a new $\mathbf{S_1}$ state:

$$\mathbf{S_1} (x_1 , v_1 , T_1 , C_1 , Tx_1)$$

As time passes and the people interact, the system will apply the transformations successively and a sequence of unpredictable states changing in time will be had. So, the installation formal elements develop a sequence of evolutive states:

$$\mathbf{S_0 , S_1 , S_2 , ... , S_n}$$

The **T** transformation defined by the artist establishes what variable will change whenever the spectators activate them. The **T*** transformation, that the user triggers, is indefinite and impossible to model or to predict completely. According to this, the inserted interaction criteria in software partially model the states the work achieves like a complete system. The deterministic transformation configured by the artist plays with the indefinite user action. Changing the programming criteria naturally will produce changes in the work evolution, having another state or form sequences.

This scheme allows conceive the installation dynamic according to a dynamical system iterates itself in time [7] [8].

Thus, the work can have diverse evolutive behaviours, diverging, exhibiting chaos, converging to certain states or some particular attractor, etc.; the evolution will depend on that very particular tension produced between the **T** and **T *** transformations.

Here is this particular relation between transformations where it is possible to locate the artistic exploration process and action.

Recording and state representation.

The changing work variables can be registered at every moment.

According to our Clark's Bichos example, it can be registered the successive sets of angles the aluminium plates adopt, having in this way an object dynamics recording due to the user transformations.

Equivalently in X = Y, a set of trajectories, speeds and the projected texts variables will be had. The states the work is describes, can be marked in a coordinate system where a succession of points or trajectories is obtained, showing the work evolution. See figure 7.

In this example, the $\mathbf{S_1}$, $\mathbf{S_2}$..., $\mathbf{S_n}$ states are represented in a 3 dimension space with interest in the text (T), text color (C) and text position (Tx) coordinates.

Since the number of variables that can be taken into account in a work, a state can be defined in a many dimensions space. In X = Y, $\mathbf{S_n}$ is a 5 dimension state. So that the work evolution representation trajectories can be explored in formats beyond of the image, being able appear in sonorous form [9] [10], among others.
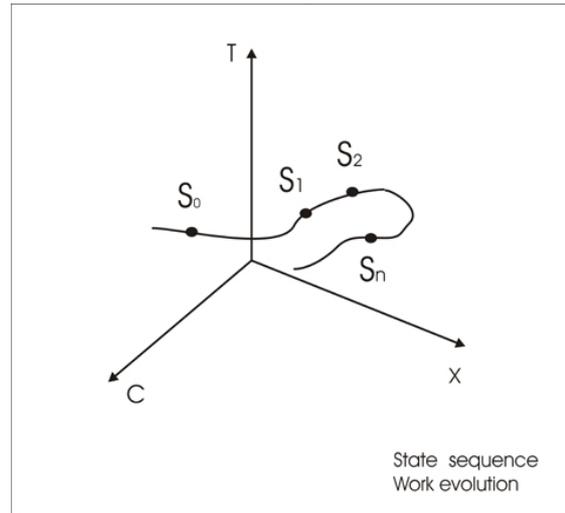

Figura 7

This kind of representations in phase spaces can show the proper characteristics of the work evolving form for a given transformations – user interactions.

Conclusions:

Like the Helio Oiticica's "Parangolé" (confused and shaken situation), far from considering them like objects, these pieces have to be conceived as "situations to be lived", that is to say, the work space was invaded by the actions. This work retakes and gives validity to those action forms modelled by the artist, clearing relevance to the object and the speech associated to it.

The artistic object yields, leaves its isolation, opens its edges and scatters in a game of interrelations in which the work idea is transferred to a "system" conception that incorporates to the spectator assets, the context, and the information materialization.

The artist structures hybrid technologies. Many devices designed sometimes for other aims, are put in tension by bounds configuring of languages and forming successive interfaces.

The artist is a sort of constructor of interfaces by structuring protocols like formal adjustment of his connections, defining a "general artistic form", whose later evolution in time is unpredictable and needs the user action.

Using digital technologies somewhere along the interface setup process, it would be more appropriate to think the "artistic object" like an "information realizing" or "the virtual accomplishment" possibility which is handled in those connections.

The work configurations as systems evoke the idea of organism with their own internal energy fed by the action of an actor, who together with the game rules embedded in programs and algorithms, determines the harmony of its forms and its evolutive dynamics.

The artist settles down "initial conditions" for the later form of the evolving system, changing the control conception of the work since its formal variables becomes unpredictable ones.

As it was mentioned here, approaching the set of relations considered in an interactive work development as dynamical system, the artist gives a particular evolution dynamics whose form can be altered changing the programming codes, that is to say, if the transformations which produce the changes in the system, are redefined, the work exhibits different states or forms being able to have different behaviours, happening through periodic forms, converging to some particular states or developing chaos.

This open the possibility for an artistic process in which the interactive characteristics are modelled, so that between user - interfaces and information realizing, a dynamics is developed which consequence of a particular interactive model and the formal elements of the information output.

Recording different variables that the installation is adopting as it develops in the time, allows work on its dynamical representation, being it an exploration process of the interactive artistic form that operates on the very relations and throwing criteria for its analysis and modelling.

This process can open the sensitivity to the work emergent behaviour in space and time and generates possible aesthetics of what is changeable, unpredictable and unfinished one.

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