Reality-Informed-Design (RID),

A framework for design process

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Abstract
The "action" of design is an integration process, in which values, information of different kinds and data leads to a physical object of "design". This integration process is non-linear and multiple objectives aimed, producing complex requirements to computer programs. RID systems intend to develop a new tool for the design process, using an evolving structure in the perspective to introduce basic levels of "self-awareness" in the design process to relate analogue and digital tools. This paper proposes an interpretation of the design process, a model for it and the first ideas for a possible new generation of "self awareness" design software.

1. Design process

In the design process we not only integrate information (data), equally relevant are the consideration of values, intuition, imagination and chance. To achieve a fruitful integration between the rational and the emotional or intuitive world, let us aim to bound both realities in one meaningful, comprehensive, self-awareness of the integration we are aiming for. Consequently meaning, purpose, usefulness, comprehensiveness and "self awareness" are what we integrate throughout a design process. The application of mathematical models on the process of design helps us to understand his inner structure and most important, gives the opportunity to find out the way "self awareness" could be achieved.

One of the traditional models applied on design are the optimization models. Optimization models lend a useful perspective to describe the design process. The sequence of design actions integrating non linear variables to be solved, obtaining finally a designed object, can be compared to an optimization process, specifically a logic-deductive process. An enormous tradition of mathematical (and computational) methods support this way of proceeding. The gradient or hill-climbing[1] methods, search for a solution using an iterative and heuristic approximation to an optimal. They explore the space of solutions using a neighbor search method, and an evaluation function that describes the aim of the search. In the design process we can find a similar behavior in the search for alternatives of design, but the "evaluation function" or "design objective" tends to evolve and include new data during the process, and to be unknown in some cases. This "unknowness" is where we should look and find the "self awareness" in the design process.

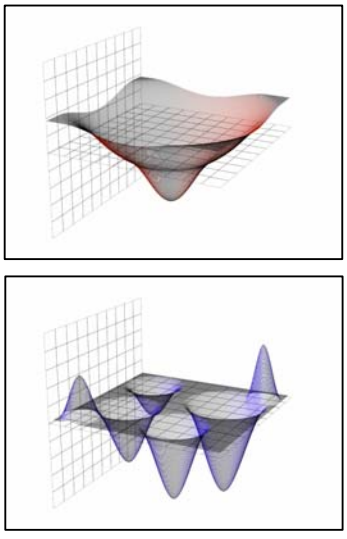

Figure 1.- Global versus local" optimals"

Another important fact about optimization is the way to solve local and global optimality problems in cases of high combinatorial complexity. In this cases we have multiples optimal points in the space of solutions, and is possible to get trapped in one local optimal, obstructing the search to continue to the global

[1] Stuart J Russell & Peter Norvig , "Artificial Intelligence: A Modern Approach" (2nd ed.), (Upper Saddle River, NJ: Prentice Hall, 2003) pp. 111-114.

optimal. This is usual to see in design process when the designer chooses a course of action in one specific aspect of the design possibilities, not including simultaneously others that are forgotten in the next steps. Consequently the final object of design does not include all the variables needed to be "complete", and it is a "local optimal". The meta-heuristics like genetic algorithms[2] and tabu search[3], use a mechanisms to avoid getting stuck in local optimality, the mutation included in the genetic process or the diversification of the search. These stochastic mechanisms are very similar to the explorative, random search systems used when a designer cannot advance in the process of design. Only creativity and innovation will then play the role of "self awareness" as a function to avoid "dead ends" in a design process.

If we apply optimization methods to the design process, it would become an "automated" design searching to find the best way to solve a specific problem at a time. I propose to focus the optimization analysis not on the object of design, but on the process of design itself. So, the optimization process applied to the design process would be generic and open, not restricted to a specific design object. If we center our optimization efforts on the process of design, some interesting consequences would appear:
A) Quantitative and qualitative variables can co-exist in the process, because is not necessary for them to be combined, it only needed to establish a "quantified relation" between them, similar to a "weight matrix of relations".
B) The optimization process should be less deterministic, and more explorative. So, this "fuzzy" mechanism would be easy to integrate in the different parts of the process of design in an effective way to come to a point in which this integration represents an "awareness" of the process in itself.
c) If the process of design is the optimization objective rather than the design object, one of the main concerns of this process will be to integrate analogical and digital process in a coherent way to achieve consciousness of the process in itself.

If we understand the process of design as a sequence of design acts, incorporating the phases and variables of design generating design decisions through validation patterns. Each one of these steps is composed of a series of design acts adequate to that particular process and designer. The optimization of the process of design will be the organization of tools to support the design acts of the designer (scripts, and others) in order to enhance the process of design. But this mechanism will have to be adapting end evolutive, because the definition of the process is impossible to be known in advance (a priori). This "a priori" definition can only be guaranteed, if the process itself develops a "consciousness" to avoid determinism in it.

Genetic programming[4] states that is possible to define a "program synthesis or program induction", that means to generate an evolving process in which a specific program for a specific task, can be generated and not directly programmed. So what we could understand as a static list of instructions to develop procedure, transforms into a group of actions who evolve genetically in an automated fashion in order to develop that task. In the same way, we could understand the optimization of the design process as the genetic design of the process itself. But to do this we have to understand the "code of design", and the variations of the process in order to evolve it.

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[2] Vose, Michael D.,"The Simple Genetic Algorithm: Foundations and Theory", (Cambridge, MA.: MIT Press, 1999).
[3] Fred Glover and M. Laguna, "Tabu Search", (Norwell, MA.: Kluwer, 1997).
[4] John Koza, "Genetic Programming: On the Programming of Computers by Means of Natural Selection", (Cambridge, MA.: MIT Press, 1992).

2. Design code

The "design" pattern that has emerged from dynamical models like fractals, are attractive, autonomic and complex pattern composition. These design patterns are self-supporting deterministic design dynamics representing mathematical equations in a very fashionable way. I propose to look at the design process as a dynamic system composed of the equilibrium of three phases, through which the process passes in an a-periodic cycle. Each one of these phases represents an interacting equation of the design process. In the form of a "strange attractor"[5] it is impossible to know in what order is going to pass from phase to phase, we can only be sure that its going to stay inside that approximated trajectory. I don't mean only to be sure that it is "going to stay inside", more than to enhance and to reaffirm that the process in itself overcomes "dead ends" and short cut determinism. We need to guarantee that the process stay open to creativity and innovation to be aware of the need to provide a continuous "push on" process and ever find much more alternatives than the evidence of a restrictive dynamic towards obvious ends. These three phases are composed of a group of actions (or scripts) related to the type of phase of design in which they are involved. These three phases can be characterized as:

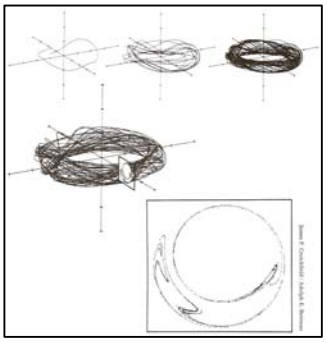

Figure 2.- StrangeAttractor

2.1. Increasing complexity phase

In this phase a design act is confronted to a validation process in which the number of validation patterns is higher than the design alternatives. Consequently the probabilistic solution space grows, and the design process upgrades his complexity. This phase uses an evolutionary exploration to generate new alternatives.

2.2. Stability phase

This phase is characterized by equilibrium in the number of acts of design and validation patterns. In which sequential iterations develops design alternatives that explore deeply into every parallel possibility of the design object. In this phase is possible to use a genetic optimization system, and the parametric development between the different alternatives of design to create synergy between the parallel improvements. This phase creates a "memory" of the decisions taken, developing time-free associations in which every possibility affects all others. In this phase, from the created memory, we should evolve the "self awareness" function of the design process.

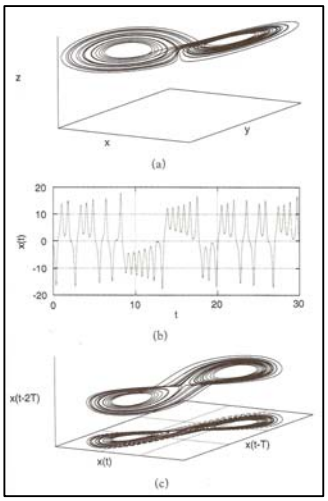

Figure 3.- Lorenz Attractor

2.3. Inductive-Associative phase

In this phase the reduction of alternatives of design takes place. This is achieved by association or grouping of similar or equivalent alternatives of design, or by direct choice of the designer. The direct choice of the designer, once interacting with the "self awareness" of the process makes possible to start endless new design cycles. This reduction of possibilities can be the end of the process, or it can also be a start for a new cycle.

In this model we can assume the roles of the two principal actors involved, the algorithm must maximize the numbers of validation patterns obtaining them from the reality and from

[5] "Strange Attractor" as the reference for a non periodic system in which unpredictability is contained in a limited "space of probabilities".

the process, and the designer must minimize the design alternatives, by association and induction. And a second implication is that the model cannot be expressed trough a linear equation, it has to be represented non-linear and dynamic equation that depends on states of the process. What we know for sure is that the design process is far from being a simple integration of rules (or restrictions) in a linear process of increasingly data inputs. In fact, the world around us is far more multiform, multilateral, meaningful and very much more comprehensive. Changes in our surroundings are dynamics which evolve constantly. What we call "reality", is not the same after one minute, or one second, or even after one nanosecond.

This model should be new in the sense that it don't need to reconstruct and adapt every time that the external conditions change. It should have enough responsiveness, sensitivity and "self awareness" capacity to adapt to changing patterns and the process in itself should lead this dynamic. Design "interface" should be able to integrate changing patterns in a predictive way of what we expect that the process of design will achieve. The model proposed corresponds to this dynamical form. The three phases develop in a non sequential form in the design process, depending on the characteristics of the process itself. Every phase is composed of multiple design acts and actions specific to that particular phase. And the process can jump from one phase to other at any moment depending on the decision of the designer.

3. Designer

First we have to realize that "complexity" is not an outside phenomenon that we can observe. We are part of that phenomenon, we have been "designed" as a constitutive part of it, and his complex patterns are part of us as we are part of them. The action of design is wrongly seemed as an action developed by some individuals in specific moments to interact with the context and change it. If we look at the process used to decide a trajectory during a route decision in every-day life, the components of: analysis, evaluation, decision and dynamic evaluation of the decision taken during the course of the action which feedback the process, are very similar to the ones used in the design of an object. The differences are the subject of the process and the complexity of the variables. So almost every way in which we interact with the reality uses some or all of the components of this process.

What I am saying is that "design acts" are a constitutive part of the consciousness of every living organism, and that the designer cannot be separated from the design process and the "awareness" of this process in itself. So if we intend to understand the process, first we have to overcome the practical separation between designer and design act (or process).

The visual process, which is very easy to assume as an eye-object relation defined by physical data, reveals that only 20% of the electric impulses that activate the visual cortex of the brain, come directly from the eye, the rest comes form other parts of the brain [6] (and some feedback from the same brain spot). This can be understood as a need to interpret vision before actually seeing. And that what we call "vision of our surroundings" is mostly vision of ourselves interpretation of the world. ¿And what is all of this 80% of "inner vision"? Basically a self construction of the reality developed during our life, our "visual" memory, which represents the "self awareness" of the visual organic function respect to the visual process. Some authors refer to this as a protection system of the brain against the enormous amount of data received by the visual process, which is filtered by a memory of "what I recognize and understand", excluding data not learned yet. But since one of the main relations that a designer establishes with the design object is through the visual perception, we can call "creation" to the visual uprising of a not previously seen object. If

[6] F. Varela, H. Maturana , "El Árbol del Conocimiento", (Madrid: Ed. Debate, 1984)

we assume that we cannot see what we don't understand, creation is first understanding and then bringing into sight.

In the design process, we balance our interpretation of reality with reality itself, creating a new structured relationship between them. But a question that emerges is asking where the need for a design action does come from? Why is needed to design something, and how this need transforms itself in action? The design act can be seen as a constitutive part of reality, a moment in which reality itself, increases his structural level, and develops an improvement. So a creative design act is self-awareness of reality, and improvement carried out by a designer.

4. Modeling RID

A comprehensive and dynamic Reality Informed Design Models (**RID**)[7], would be a new trend in the design world. RID, should not be understood as an enhanced CAD tool, since his main aim is not to aid in the design of an object, but to inform a design process in his integration with the reality. This means to establish a relation between the act of design and the structure in which it interacts. RID design tools should be orientated towards a broad incorporation of a new kind of "data-patterns" and interfaces, most principally those "link-patterns" and "connections-fluxes" of data.

The RID framework corresponds to a dynamical process that moves through the space proposed in the model following the design process developed by the designer. This movement corresponds to an a-periodic cycle composed of the three identified phases of the design process. To achieve all of the proposed, the structure of the framework should have at least two components, a main structure leading the process direction and constructing the memory of it; and a smaller group of proceedings (scripts) coherent to the phase in which the design is involved, constructing the "design acts".

- Like a machine-learning network the main structure is composed of a net of logical connectors corresponding to validation patterns, the initial matrix weight of connections is defined by the hypothesis presented by the designer[8], establishing a heterogeneous matrix of relations between the different validation patterns. During the process of design, the "weights" of connections evolve, the number of validation patterns reduces or increases and the changes are stored. The storage of changes in the main structure would be the dynamic sequence of "time-events". We should call this the time-event implications model in the design process.

- The second structure of the RID framework corresponds to an evolving group of proceedings that establish a direct and an ongoing link between "inputs" and "outputs" during all the "time-events" of a design process. This proceedings (or scripts) correspond to the relation established between designer and software (i.e. assessment of size and scale, 3d / 2d translation, explorative iterations, etc). The type or family of scripts will be defined by the position-time in which the process is in the model. We should call these "time-event" singularities.

To support and enhance the "designing act", understood as a sequence of value orientated design decisions are far more strategic then aims which brings us beyond the representation

[7] Rodrigo Martin & Danilo Lagos, "Between Analogue Design and Digital Tools", A+C (vol.2), (Santiago, Universidad de Santiago USACH, 2007), 26-35.

[8] Similar to a Neural Network training phase, in which the net is presented to training data and the internal weight is adjusted to obtain the wanted result, previous to present new (and unknown) data to the net. In this case, training and operation are mixed together.

of the designing products. If we can throughout asses or validate the qualities, purpose and the design consistency during the design process we are beginning to understand the complexity and the implications of the “designing act” as a validated and relevant “time-event” design sequence. This will provide the designer an ongoing “validation assessment process” over his own design decisions.

Designers in the very near future will have the opportunity to share new continuous “time-events” design models and “validation-patterns” strategies, which will deepen our understanding on “how we make relevant design decisions during the design process”. This will bond the design community together in a networking community by sharing a constantly growing flow of design “time-event” singularities.

We want to reach the point in which, much more than the design product, we are putting our attention to the multiple ways of validating the birth of self-awareness inside the design process, which means a new decision dynamic within an increasing independence from the design commands: “The design is the process in itself”. This awareness of the design process gives us the possibility to link all our “design singularities”, creating a global network of design decision on-line.

6. Figures

1. Rodrigo Martin, “Local and global optimal”, 2008
2. James Gleick, “CAOS la creación de una ciencia”, (Barcelona: Seix Barral,1998), 151.
3. K. Alligood, T. Sauer, J, Yorke, “Chaos, an introduction to dynamical systems”, (New York: Springer-Verlag ,1996), 547.

7. Endnotes

1. Stuart J Russell & Peter Norvig , “Artificial Intelligence: A Modern Approach” (2nd ed.), (Upper Saddle River, NJ: Prentice Hall, 2003) pp. 111-114.
2. Vose, Michael D.,“The Simple Genetic Algorithm: Foundations and Theory”, (Cambridge, MA.: MIT Press, 1999).
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5. Robert M. Harnish, “Minds, Brains, Computers”, (Massachusetts: Blackwell Publishers, 2002)
6. F. Varela, H. Maturana , “El Árbol del Conocimiento”, (Madrid: Ed. Debate, 1984)
7. Steven Pinker, “How the Mind Works”,(New York – London: W.W, Norton, 1999)
8. K. Alligood, T. Sauer, J, Yorke, “Chaos, an introduction to dynamical systems”, (New York: Springer-Verlag ,1996)
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10. James Gleick, “CAOS la creación de una ciencia”, (Barcelona: Seix Barral,1998)