

# THE MORPHOGENETIC DESIGN AS AI SYSTEM TO SUPPORT THE MANAGEMENT OF THE DESIGN PROCESSES THROUGH THE TOTAL QUALITY OF THE BUILT-ENVIRONMENT.

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## Abstract

In our research, we have experimented AI procedures in a new strategic approach to the management of design processes in buildings and built environment. The challenge was to evaluate, during the design operations, the total quality of the future built environment. We measured this quality as the difference between virtual scenarios and the collective imaginary. These scenarios were generated by the simulation procedures of building/environment evolution in front of specified design postures. To achieve that we produced, using some original research software, many different scenarios of possible evolutions of the same project. So we could calibrate the different contributions of the single specific design functions and their conflicts (from aesthetics to structural and technological problems, from cost to functional use) to build the more interesting logical approach to design, construction and urban environment evolution.

In this conference, we intend to present some examples of this experimentation defining not a specific solution but a possible logical approach to operating in the management of design. And we also try to walk in a new not-explored land of design processes that maximise the benefits of IT: The possibility to design the evolution and not only a single equilibrium. The first experimentation we present is about the construction of commercial buildings using steel. The second is a dynamic framework project to design and control the evolution and the increasing complexity in the built-environment of a typical Italian medieval town.

Keywords: AI, evolution, (morpho)genetic design, total quality, logical approach, future scenarios.

## Premise

The management of decisional procedures in architectural and building environmental design springs from the identification of the real target of this work in progress.

If the target is the quality, we need to identify this quality, to measure the quality of the system we are structuring.

But we cannot easily measure the quality a priori, before the end (and perhaps the construction) of the work. The approach to the quality is a subjective approach. We can identify the quality as the capacity to reply, in pertinent mode, to the plurality and multiplicity of needs of human life. It means that the quality is the capacity to reply to every individual and subjective need of every user of artificial environment we have designed. And we cannot preview, during our design work, all the multiplicity and complexity of possible needs.

More. This complex and unpredictable multiplicity of possible needs refer not only to the use but also to the realisation and maintenance of the same building. And so, especially, if the realisation is not directly connected to the design process, as in Italy.

We can measure the quality of the design from the capacity of the project to answer to a universe of needs that are not necessary linked, and not necessary identifiable before and during the design work, but that may be unpredictable important in the moment of realisation or use.

We, therefore, design building and environmental systems that will be realised, and use, in a future time. A next future (days or weeks) is, conceptually and operatively, the same that a future of years or centuries. And the built environment has ever long times. The building system we design needs to answer to an approach that is different from our; a possible different approach about use, technical and maintenance tools, and about the hierarchic evaluation between costs and performances. Every user is a different person, and his needs are, at least partially, unpredictable. And this unpredictability grows with the time.

In front of this, there is another problem: we cannot evaluate the quality as the addition of partial factors because we cannot know all the factors, and the complexity of relations between. The only way we can run is to compare a virtual scenario to the reference imaginary of a wonderful environment and measure the difference. But to do that we need to have, every moment of our work, the possibility to generate a scenario of the evolution of our design. Better, to generate a lot of possible scenarios that shows in progress our designing idea.

The IT utilisation allows us to work directly on the complexity and the dynamic transformation of the system without operate reductive and not acceptable simplification. With IT tools, we can structure this quality evaluation as progressive control of the difference between virtual scenarios generated in real time in front of the variation and increasing the complexity of the design procedures and the multiplicity of possible reference imaginary simulated with a hierarchic-random approach to every different possible scenario.

To verify this possibility we have designed an original software that represents, during the design work, the structure of the approach we have used. Every different discipline contribute is put inside and the working team can verify in real time the results of the possible variation of the hierarchic structure in every decision steps in front of the universe of environmental scenarios that the tool generate.

#### Virtual imaginary and quality

To measure is to acquire a paragon term, an evaluation metre. also, if this metre is a subjective one, as in the case of quality.

But it's possible to measure the quality? If it's possible I think we never succeed in doing it if we addition one after the other the capacity of the project to reply to ever single request, using analytic procedures through sequences of cause/effect.

Theoretically, using these procedures we can succeed in measuring quality. But practically this procedure is too complex, long and, dimensionally, too large. It's impossible for us to run this, especially if we need a pertinent answer.

Our analytical operation, also if we close our approach to specified sections that we thought as the pore significant, often we don't succeed in getting acceptable evaluations.

May happen that, if also our single parameters that measure a sector of environmental quality of our project are high, the global quality, measured by the desirability, by the total enjoyability of the built environment may be really much more lowest.

We cannot accept that the total quality of a design decision may be quantified by analytic procedures, adding partial parameters.

It's more interesting, and also more realistic and operable, an approach to quality measurement structured through differences and not through additions.

An approach that is the truth way that the man runs in front of every choice. A peculiarity of men is to have the capacity of imagination. He can draw and live with his mind many absolute unpredictable worlds, virtually possible worlds that are sometimes desirable or detestable.

When a man is in front of a choice, he doesn't operate only with the analysis but use the imagination. He built on his mind some possible virtual worlds. And then he chooses the most enjoyable one. Based on this choice he evaluates the more interesting next step to near with the reality to this possible environment.

The choices, operated inside a design walk, springs from this type of approach to quality. That is the humanistic approach. But also, the final user chooses following this approach.

I don't mind that the designer jumps every systematic analysis. He uses the analysis a posteriori, as a verify of the congruity of the approach. The real decision is operated in front of the research of affinity between the project and the mental image of his virtual world.

But also, the reference imaginary is in evolution. And a good designing team needs to increase this imaginary to go on in following the target.

This approach put on the table two considerations. First, the monopoly of the subjective sphere in the evaluation of quality; second, the strong subjection of the quality measure from the subjective creativity, from the resources of the designing team to configure possible worlds achievable to exceed the reality.

This production of the imaginary need to develop dynamically. In front of the evolution of the project, these reference virtual world grows up, amplify its possibility, takes possession of ever real event to operate projections about the improvement of the possible quality.

The arrow between the designed world and the possible world can measure, in that moment, the quality gained by the project. It draws the difference between the designed environment and one of the possible virtual scenarios that the same reality has built in our mind, and that appear the most desirable when we get a virtual life inside.

Returning to design process, we define it as a sequence of chooses between options in front of a desirable possible scenario.

The management of design needs three different devices: the power and structure to choose, the presence of the options and the presence of some possible desirable scenarios.

In the design process, every choice is, in effect, a moment of formalisation. The options are formal options, and the choice of a formal option is conducted through the preview of some virtual environments. And so these virtual worlds grow up.

When the design gets his choice, the formalised event is put inside the designing paradigm and this global environment is evaluated in front of the reference possible worlds that, in meantime, could has been improved. In other terms, as the project develops gaining ever new shapes and new events, the reference virtual worlds, the thinkable worlds, gain an evolution structuring ever new and desirable possible scenarios.

Managing this evolution, this dynamic accumulation of significance, we can get the tool to measure the correspondence between the subjective posture and the inter-subjective imaginary, that is the imaginary shared by a lot of different individuals. And so to get the dimension to the quality as the value achievable to generate acceptance.

To manage this procedure we need:

1. the possible worlds, the virtual environment we use get a dynamic evolution in affinity with the process of sliding between subjective and inter-subjective sphere.

It means that the dynamic evolution allows an increasing complexity, an increase of the possible use/signification, a complex answer/scenario nearest to an objective excellence defined as the capacity of

pertinent reply to ever possible and random subjective approach. To gain the objective sphere is to gain a universe of possible subjective spheres.

2. Every formalisation choice we operate in a cycle needs/answer must be proposed again in the next cycle as a new need. With this procedure we can, in the time of design, to gain two targets:

A. To close the functional plurality and the accumulation of possible subjective significations, and in the same time to purify our project from the categorical events, from events that cannot succeed in go out from a hard subjective point of view.

B. To build a logic structure to approach to formalisation that allows also the exceptional events. The exception, in fact, is necessary to operate the jump of paradigm to construct the multiplicity of virtually possible scenarios. But every exception, to do that, must be used as a new question in the next step of the design procedure.

3. The sequence of formalisation cycles must draw a dynamic evolution of possible shapes, of possible architectural scenarios. This evolution is directly connected with the information power and complexity. The number of possible alternatives, of possible scenarios, is, in fact, the measure of the resources of the designed environment to reply to the possible needs. It's not the measure of the quality, but it's certainly a good key to evaluating the same quality.

IT tools in the management of design. Our project.

To control these complex procedures we can use IT tools. Using IT is necessary, first, for increasing the operative power of representation as a control tool of design and, second, for increasing, also using random procedures, the representation of virtually possible worlds. That is the progressive sliding from subjective to inter-subjective, defining inter-subjectivity as the simultaneousness of possible infinite subjectivity.

The IT tool that we have designed and realised is born to operate inside the difference reality/virtual environment, the difference designed event/desirable world. The tool can show the multiplicity of possible scenarios that every design choice can light. It's a device to generate ever different possible scenarios in front of every single composition idea, ever single design choice. These results allow us to evaluate the quality of the design process in the act.

Second, the tool gives us a concrete representation of the evolution dynamics of designing idea through the continuous increasing complexity of virtual environments. In other terms, the operative contributes of this tool is in the explicitness of the dynamic evolution of the project from the subjective sphere to the inter-subjective one, allowing us to evaluate the increasing quality during the design process.

Using this tool we have reward some considerations. Following from the possibility, offered by this IT tool, to generate many different 3D scenarios as a projection of single composition idea, we can considerate that the multiplicity of possible shapes is not concurring with the creativity. It's only a possible representation of the idea, as a logic/formal DNA, a post- metaphysical structure of the same idea. This reflection gives a working priority to ever choice operated inside the evolution logic, to the tools that allow these choices and, so, to the evaluation and control of the idea before its infinite possible realisations inside a shape.

In detail for what concern the measure of quality, the experimental research we have done allowed us to identify some elements of the design process that can exercise influence on the quality.

We have experimented the possibility to measure quality trough some quantifiable parameters:

1. The choices operated during the design process, measured in terms of information. (That define the way to slide from subjective to inter-subjective).

2. The consciousness of choices operated, identified as quantity by the grade of the permanence of every choice in the development, end by the possibility to recognise the previous choice as "patina" of time. It's valuable, also, by the increasing difference between different virtual scenarios generated by the simulation.

3. The quantity of base alternatives about every single choice, identifiable, in our IT tool, by the structure of the generation procedures. These algorithms are structured upon the interpolation of different devices representing the various disciplinary components of the decision. These devices are not a database but they are a reference world in evolution, without limits defined before. In other words, this tool uses a lot of simultaneous different linear systems to produce resonance, that is a dynamic non-linear system. As happens in the activity of every genetic code in nature.

4. The availability of the design approach, of the simulation device of this logic approach, to accept, and manage, exceptional events. This point is particularly important because the relation between information capacity and the exception is not linear but, in front of every system, has a different top. I mind that when information power grows in the beginning in front of the presence of exceptional events, this trend changes following different ways in different situations. We can identify, experimentally, the position of this change in the moment that the most of the exceptional events don't succeed in remaining in memory and define new possible points of view about the used paradigm.

Some other parameters have not influenced the quality, and someone has been, for us, a surprise.

1. First of all the single forms/configurations/patterns, we have chosen. For the information structure of our project, the single formal action is not important. Although it's important that have done this formal action using with consciousness a number high of alternatives. To over-evaluate a single formal choice may destroy the increasing complexity, and so the quality.

We can redefine the single formal action as a catalysing event that is important to improve the process of increasing quality, but that also can not be substantially involved. This action can define the cultural reference, the style, but it don't modify the global quality. But the quality is related to the number of alternatives used in this action.

2. The limits we define between norm and exceptions are not important. It's important, for the quality, to have defined these limits, and to operate a logic jump in our design process every time we find, and accept an exceptional event.

These are the first considerations that we have done using our IT experimental tool, and some of these were obvious. But this approach, using IT, is the actual possibility to active some experimentation sectors, and to use the simulation tools in some disciplines, as design processes, that needs to control the increasing complexity.

But this research we have done is, therefore, also a way to approach to the quality of the environmental shape, and offers the opportunity to evaluate this image quality not referring to style, to single choices or events but to logic approach we have used, to the mastery in managing the evolution trend of idea, to the quantity of possible scenarios we have considered and to the consciousness to operate ever a choice even if we can tell "there is not an alternative way to run".