SIMULATION TOOLS FOR THE LEARNING APPROACH TO DYNAMIC EVOLUTION OF TOWN SHAPE, ARCHITECTURE AND INDUSTRIAL DESIGN.

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Introduction

The software I present springs from teaching problems about architecture and industrial design.

These topics need a learning approach about "how" the environment change, and not only "why" the events or the development born.

As all disciplines, it's naturally important to organise systems that offer information. But in the schools of architecture, where learning is not to memorise something but to improve the own approach to design, it's necessary to structure an intelligent tutoring system that allows the student to enter in the dimension of "how" to approach the dynamic evolution of shapes. Because the development of designing logical process needs to operate within transformation and not within sequences of moments of equilibrium.

The first basic concept is that the student of architecture needs to get the mental control of the three-dimensional space.

But it,s not enough. Second, the student needs to get the control of the fourth dimension, the time. For doing that, he needs to approach the morphogenetical sequences of design and to know how to consider the evolution and transformation of possible architectural forms, town shapes or industrial objects.

In front of these problems, I have built same learning software for my students of the courses in Architectural Composition and Environmental Design in the Polytechnic of Milano.

First. A software that operates in a visual dimension and allow the student to analyse a picture, a two-dimensional image, as a three-dimensional object. With this tool, it's possible to increase the mental control of 3D space. The student is forced to operate a subjective interpretation of picture in front of the problem of building, in his mind, a three-dimensional model.

Second. A system of software that simulates the dynamic evolution of shapes in natural and town environments, architecture and industrial design. This software in not, originally, a learning software. It is the result of my experimental recherche in the last five years. But this approach is very interesting in learning composition, because any step of the design process is,really, a morphogenetical transformation between a form to another.

1st SOFTWARE. TO READ 2D PICTURES AS A 3D OBJECTS.

This software looks like a graphical colour editor. But we can operate with a vectorial structure that allows the production of dynamic visual scenes, since the walking through the virtual scene.

We can draw directly sketches in perspective mode and verify, in real time, the true 3D volumes with axonometric views or with a simulation of walking through inside the same sketch.

We can also begin our session importing drawings or bitmap photographs from other editors, (like, for example, a picture of Picasso, as shown in the screen dumps), redraw the picture and enter in real time inside the scene.

The student, using this tool, increases his mental control of three-dimensional space, and , at the same time, learns the use of different representations.

From a technical point, the programme and its supplementary files are made up of four parts:

-the main programme with the main menu which provides access to the other parts.

-the graphical colour editor which builds the three-dimensional model operates with the files, etc..

-the perspective part to operate the model-in-progress in perspective mode.

-the axonometric part to control the stereometric and dimensional problems.

2nd SOFTWARE. TO CONTROL THE DYNAMIC EVOLUTION OF SHAPES.

The experimental research I have recently been doing springs from a question. It is possible, with custom designed software, to simulate the dynamic morphological variations of the urban image? And to simulates the development through time of formal town evolution, time that is taken by irreversible architectural events and that renders the urban landscape increasingly complex?

To answer these questions, I worked directly, doing my experimental software, with the instability of dynamic town system, and I have declined to base the analysis on the moments of equilibrium that represent only, when they occur, an accidental configuration in town time development.

Being related to this recherche, this second learning tool is more complex than the first. It offers a morphological approach that identifies the "modus operandi" of formal transformations during the time. The town, architecture or object image development is considered as a dynamic/chaotic system, and its rules are written by algorithms.

The simulation of any possible development of a system produces an infinite number of unexpected and dissimilar images.

Each image springs from an iterative process of formalisation which, at each stage, increases the complexity and randomness of the result.

And the student, or the same teacher when to explain these problems, can modify, with an interactive interface, same parameters and get a lot of different 3d model that show the possible scenarios shaped by this variation of evolution structure.

This software has three different parts, that identifies three different approaches to design: the Environmental design, the architecture, the industrial design.

TYPE A

THE SIMULATION AND CONTROL OF DYNAMIC URBAN DEVELOPMENT WITH RESEARCH/LEARNING SOFTWARE THAT GENERATES 3D TOWN MODELS WHICH ARE ALWAYS DIFFERENT BUT ALWAYS IDENTIFIABLE AS THE SAME TYPE OF ENVIRONMENTAL TOWN SHAPE DEFINED BY THE CHOICES OF OPERATOR.

This software get the variation of urban shape starting with the disequilibrium state of the system (the presence of different architectural forms together with different stages of urban growth, often contradictory) to simulate time and produce a series of computerised three-dimensional models of urban shapes, identifiable as a whole as "species" and differentiated as "individuals". These models represent the multiplicity of possible scenarios of town after a simulated evolution.

The student can verify every modification of parameters (that reflects possible design choices) not directly with the variation of one model, but with the variation of all the different models (but the same kind of models, because the logic used is the same) that the software produces.

Towns are, in fact, accumulations of events with different and often contradictory objectives; their structures are unstable, their evolution unpredictable.

Tool, capable of examining and testing the dynamics of transformation renders possible a positive approach towards the comprehension of urban structures. The target is to operate into the morphogenetic dynamics and not only the occasional modifications.

If the purpose of a learning tool in environmental design is to urban patterns and their progressive disintegration and/or requalification, the instrument used should trace back and analyse the formation process of urban shape through simulation of the entire cycle. Every architectural event does, in fact, modify urban shape as every urban shape modifies successive architectural events.

The awareness of the impossibility of evaluating all the causes that brought about the evolution of town should bring us to design algorithms within a specific field based on form and its transformation in order to obtain more exact and pertinent results. This implies the capacity of identifying a logical process to explain how, and not why, a form is evolving; how and not why an aggregation of forms gives a recognisable urban shape.

This approach, that is exclusively morphological, allow to reproduce the complexity of urban shape in its morphogenic dynamism. But how can this be used in learning?

Like all mathematical and formal models, those that represent the logic of urban evolution are an effective tool to simulate interaction, verify and learn the approach to planning. Any variations in the model generate transformations that can be analysed and evaluated. Each result is identifiable and characteristic and always reflects the design choices that has been operated.

Operating Steps.

1. In the opening interface of this simulation tool, we can choose a "species" of the environment, or we can build one.

2. We can choose the type of morphological site (hills, lake, riverside, isle, etc.) to be built for our environment. And so the programme defines one of the random parameters in increasing complexity.

3. We use the operating interface. The environment is growing. We can operate changing parameters during the process, and modify the system evolution. We can also change the length of time simulation, the "species" of urban shape, the percent of exceptions that the system can accept, and so on.

4. The simulation terminates. We have a 3D model, represented in perspective mode, but we can, also, read this model with external software packages, ad CAD, or transfer this model to every graphic workstation.

If we do another time the same simulation, the model results different, but we can find the shape of the "species".

TYPE B

THE SIMULATION AND CONTROL OF VARIATION IN ARCHITECTURAL COMPOSITION, WITH A TOOL THAT GENERATES 3d MODELS OF ARCHITECTURE ALWAYS DIFFERENT BUT IDENTIFIABLE WITH THE SAME DESIGN APPROACH TO COMPOSITION, TECHNOLOGY AND MATERIALS.

This software gets the variation of architectural frames in front of different sequences of events, but with the same design approach. The student can choice same characteristics of an architecture, define to use some materials and some specified technologies, and the programme can start.

The software produces, one after the other, perspective views of always different 3D models of architectures, and the operator can get variation, with an interactive interface, and evaluate, in front of the new parameters, the transformation not of a single model, but of the entire sequence of successive different models.

These models, of course, may be transferred to other packages to increase, evaluate, or modify, the result.

TYPE C

THE SIMULATION AND CONTROL OF THE DYNAMIC EVOLUTION OF SHAPE IN INDUSTRIAL DESIGN WITH RESEARCH SOFTWARE THAT GENERATES 3D MODELS OF VIRTUAL OBJECTS WHICH ARE ALWAYS DIFFERENT BUT IDENTIFIABLE WITH THE SAME LOGICAL APPROACH TO DESIGN.

This software identifies and simulates the specific morphological approach that is needed in the design.

The ability in design is not to generate a lot of different shapes, but to organise one's own approach to the problems. This approach characterises every object that is designed.

The software simulates and explains this topic, and it can be used in design procedures learning.

As the previous one, this software simulates the possible variations of shapes in a design sequence. And offers the possibility to evaluate the increase of complexity or the composition "quality" in front of interactive variation of choices.

In fact, this software is a project of a formal DNA, a software-design of a kind of objects. In the example, the object designed with this morphogenetic approach is a "species" of the chair. It generates an endless set of chairs, everyone different, but everyone identifiable in a kind of chair. A species that reflects the same design approach drawn in the software.

And this type of software is not only a learning tool. It reflects also the new approach to industrial design that operates in front of the advanced production technologies, as robots. Today the numeric control machines can produce (with the same work) a varied series of the object, and not only ever the same object. This software can be used as a non-stop reprogramming software for robots.