VISUAL PROGRAMMING TECHNIQUE AND VIRTUAL PROTOTYPING TECHNOLOGY USED IN CIVIL ENGINEERING

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Abstract. Building designers face exciting new challenges in incorporating new and innovative technologies in areas of the building structures. In this paper the techniques of 3D modelling and virtual prototyping were applied to create and to develop of virtual models related to the construction process. The 3D models created to support rehabilitation design emerge as an important tool for the monitoring of anomalies in structures and to assist decisions based on the visual analyses of alternative solutions.

In this paper was also developed virtual interactive models, showing construction works. These applications allow the visual simulation of the physical progression of each type of work and also assist in the study of the necessary equipment needed and how it functions on site. The introduction of CAD and virtual prototyping technique in civil engineering is helpful to engineers in order to advice them to consider these techniques as important supports, in their professional practice.

Keywords: 3D models, innovative design, visual programming technique, virtual prototypes buildings

1. Introduction

The engineers must expect to constantly update computational resources in normal use in their professions. There are many possibilities for the creation of computational models mainly where the subject matter is suitable for description along its sequential stages of development. The applications with these characteristics make the advantage of using visual programming techniques, especially when compared to the simple manipulation of complete models.

Visual programming technique could be applied as a complement to 3D modelling, leading to better communication between the various stakeholders in the process of construction, whether in training or in professional practice. This role is particularly relevant to the presentation of processes of construction which are defined through sequential stages as generally is the case in the construction of new structures.

Besides this constant updating of training in the new graphic resources available to and in widespread and frequent use in professions in the fields of engineering or architecture, the universities should also adapt its teaching activities to the new tools of visual communication.

Today, in practical activity a variety of engineering software is used, but this requires skills and knowledge to develop economical and feasible solutions.

Educational institutions can use and virtual prototyping technology as a tool to create new buildings, as a form of collaboration and communication with future engineers and architects, or as a means of online designing.

A communication platform allows participants to exchange information about specific domains and interact and work cooperatively. Today, 3D models and virtual prototyping technology are used in engineering universities to aid both the lecturers and students to improve the preparation of didactic materials to support teaching [1]. They offer students the opportunity to visualize the civil structure in order to achieve a better understanding of the engineering concepts. The computer simulation and virtual prototyping technology are viewed as virtual laboratories [5].

The development of Computer Aided Design (CAD) programs has been changing design methodology, at least in part. The use of CAD and virtual prototyping technology is helpful in areas such as Architecture, Engineering and Construction (AEC). However, the introduction of these new technologies into designers' actual practice has been generalized [6].

At present, when carrying out a project, the use of graphic systems and, in particular, those relating to 3D modelling, makes a very positive contribution towards improving the transmission of rigorously correct technical information and, in general, to the understanding of spatial configurations in their environment. This means of expression surpasses a drawing, a picture or a diagram [7].

The innovative technologies in civil engineering start with design and go through long-term operations, modify the building by adding newly developed parts that were not available when the building was made and eventual decommissioning.

Designers need to ensure that the building owner receives the best product possible. Hence, everyday, building designers are in face of the exciting new innovative technologies.

The innovative technologies would need to ensure that the end users achieve the utilization of its abilities in the building space optimization.

2. Visual programming

One of the most important techniques for interactive creation of virtual buildings, with the informatics tool is the visual programming technique**.**

Visual programming is programming in which more than one dimension is used to convey semantics. Examples of such additional dimensions are the use of multi-dimensional objects, the use of spatial relationships, or the use of the time dimension to specify “before-after” semantic relationships. Each potentially-significant multi-dimensional object or relationship is a token (just as in traditional textual programming languages each word is a token) and the collection of one or more such tokens is a visual expression. Examples of visual expressions used in visual programming include diagrams, free-hand sketches, icons, or demonstrations of actions performed by graphical objects. When a programming language’s (semantically-significant) syntax includes visual expressions, the programming language is a visual programming language (VPL).

Although traditional textual programming languages often incorporate two-dimensional syntax devices in a limited way--an x-dimension to convey a legal linear string in the language, and a y dimension allowing optional line spacing as a documentation device or for limited semantics (such as “continued from previous line”)--only one of these dimensions conveys semantics, and the second dimension has been limited to a teletype notion of spatial relationships so as to be expressible in a one-dimensional string grammar. Thus, multidimensionality is the essential difference between VPLs and strictly textual languages.

When visual expressions are used in a programming environment as an editing shortcut to generate code that may or may not have a different syntax from that used to edit in the code, the environment is called a visual programming environment (VPE). Visual programming environments for traditional textual languages provide a middle ground between VPLs and the widely-known textual languages. In contrast to just a few years ago, when strictly textual, command-line programming environments were the norm, today VPEs for traditional textual languages are the predominant kind of commercial programming environment.

Commercial VPEs for traditional languages are aimed at professional programmers; these programmers use the textual languages they already know, but are supported by the graphical user interface techniques and accessibility to information that visual approaches can add. VPEs for traditional languages serve as a conduit for transferring VPL research advances into practice by applying these new ideas to traditional languages already familiar to programmers, thus affording a gradual migration from textual programming techniques to more visual ones. VPLs are usually integrated in their own custom environments, so for the remainder of this article, the term VPEs is used for traditional languages.

The most common specific goals sought with VPL research have been:

- (1) to make programming more accessible to some particular audience;
- (2) to improve the correctness with which people perform programming tasks, and/or
- (3) to improve the speed with which people perform programming tasks.

To achieve these goals, there are four common strategies used in VPLs:

Concreteness: Concreteness is the opposite of abstractness, and means expressing some aspect of a program using particular instances. One example is allowing a programmer to specify some aspect of semantics on a specific object or value, and another example is having the system automatically display the effects of some portion of a program on a specific object or value.

Directness: Directness in the context of direct manipulation is usually described as “the feeling that one is directly manipulating the object” [2]. From a cognitive perspective, directness in computing means a small distance between a goal and the actions required of the user to achieve the goal [3]. Given concreteness in a VPL, an example of directness would be allowing the programmer to manipulate a specific object or value directly to specify semantics rather than describing these semantics textually.

Explicitness: Some aspect of semantics is explicit in the environment if it is directly stated (textually or visually), without the requirement that the programmer infer it. An example of explicitness in a VPL would be for the system to explicitly depict dataflow relationships (program slice information) by drawing directed edges among related variables.

Immediate Visual Feedback: In the context of visual programming, immediate visual feedback refers to automatic display of effects of program edits. The system responds to program edits, and to other events as well such as system clock ticks and mouse clicks over time, ensuring that all data on display accurately reflects the current state of the system as computations continue to evolve.

3. Applications of the visual programming in architecture and construction

The use of the visual programming technique is helpful in areas such as Architecture and Construction. Below is an example in witch the visual programming techniques were applied as conception design support to the development of virtual models related to the construction process.

At present, when carrying out a project, the use of visual programming and, in particular, those relating to 3D modeling, makes a very positive contribution towards improving the rigorously and correct comportment and, in general to the understanding of spatial configurations in their environment.

Architecture. The results of the architectural design of a building are usually several drawings, which, recently, are often complemented by 3D models. Architects create 3D models of buildings so that their clients can more clearly understand what the building will look like when will build.

The development of Computer Aided Design (CAD) programs has been changing design methodology, at least in part. In general, designers approve of the use of CAD since because it improves designing, but mostly CAD is still used only as drawing aid. However, the process involved in design projects could easily derive clear benefits from the use of CAD because it can make drafting and the creation of alternatives quicker and more effective throughout several stages of designing, including the conception phase. For that, however, it is not enough for designers to learn to use CAD properly, they also have to learn how to create and to support their activity with it, which requires, also, a new way of thinking and reacting to CAD [4].The visual programming and the virtual prototyping technology comes in this senses.

*Construction***.** Models concerning construction need to be able to generate changes in the project geometry. The integration of geometric representations of a building together with scheduling data related to construction planning information is the basis of 4D (3D + time) models. Thus, in this field, 4D models combine 3D models with the project timeline, and virtual technology has been used to render 4D models more realistic allowing interaction with the environment representing the construction site. The 4D models are being used to improve the production, analysis, design management and construction information in many phases and areas of construction projects.

The Virtual Building Technique (VBT) has been developing and implementing applications based on this technique providing better communication between the partners in a construction project].

Note the contribution of VBT in the example illustrated in Figure 1 to support conception design, to introduce the plan and to follow the evolution of the intelligent parts of the commercial construction.

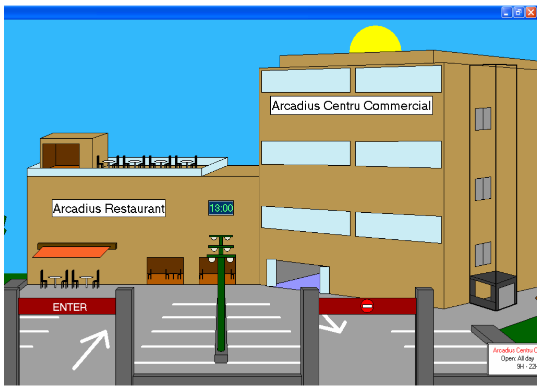

Figure 1. Virtual building prototype

The virtual prototype model, created to help the management of intelligent systems in buildings, allows the visual and interactive transmission of information related to the behavior of the elements, defined as a function of the time variable. These applications allow the visual simulation of the physical progression of each type of work and also assist in the study of the necessary equipment needed and how it functions on site.

The didactic project model presented shows a sequence of the evolution of the diary activity that implies the evolution of the intelligent parts, allowing step-by-step visualization. The models concern a commercial center and a restaurant, as a significant component of a multi-functionally building, each with different degrees of detail and technical information.

This application clearly demonstrated that the 3D geometric model allowed a quicker understanding of the structural organization of the building and a useful tool for the surveying and mapping of its intelligent parts. The 3D models helped work out many kinds of data and also to identify incompatibilities in the introduction of new elements within old structures.

The virtual prototypes models appear as an important tool for compartmental surveillance of the intelligent structures and for supporting decisions based on the visual analyses of alternative solutions. In this case, many alterative solutions were modeled and finally were worked out the optimal solution.

One of the first attributes in a commercial building is to carefully evaluate the current and future use. This starts by clearly identifying the purpose and needs of the targeted building costumers. This process will vary depending on whether it will be a commercial area development.

The reality is that most innovations come from a process of rigorous examination through which great ideas are identified and developed before being realized as new offerings and capabilities. It is important to realize, however, that few projects are used as originally envisioned. A multi-functionally commercial centre design should incorporate flexibility to allow for easy change.

Examples of this type of design characteristic include communications, life safety, automation, structured cabling design, and open space with movable or demountable partitions.

Site integration is critical for environmental impact, and strongly affects how the costumers interact with the commercial building.

At a macro scale, community integration is determined by community space planning and zoning regulations. The attribute intelligent makes the building more marketable with a lower impact on the environment.

A new building starts with an environmentally friendly design. Creating a project that is environmentally friendly and energy efficient connect in closely with many of former attributes. This requires focused attention to environmental factors that affect costumers' perception.

The starting point for the development of the building system is based on informatics tools. Thus the quality and efficiency could be enhanced considerably.

7. Conclusion

There are many possibilities for the creation of computational models mainly where the subject matter is suitable for description along its sequential stages of development.

The innovative design technologies would need to ensure that the end users achieve the utilization of its abilities in optimization of the projects.

The applications with these characteristics make the advantage of using visual programming and virtual prototypes technique, especially when compared to the simple manipulation of complete models. The visual aspects and technical concepts must be integral elements in the design and creation of these models.

Visual programming technique allows users to explore and manipulate 3D interactive environments in real time. This technique is seen today as an integrating technique, with great potential for communication between project participants, and most recently, as a tool for the support of decision-making.

The main aim of a research project, which is now in progress at the Department of Installation of the Transylvania University of Brasov, is to develop virtual models as tools to support decision-making in the planning of construction management and maintenance.

The paper contains an example drawn for a future construction and is joined by a large library which covers background analyses and computer subroutines. The authors consider this analysis a planning technique necessary to ensure the edification of the future buildings. They provide a large range of computer subroutines with reference to the scenario of prototype structures and their components.

Virtual prototypes structures will provide very useful guidance for practicing engineers, researchers, designers, technologists, mathematicians, and specialists in computer aided techniques of construction. The design firm will use CAD software to create complex renderings and 3D views. Each stage of the creative process gives insight into the architect's imagination. Here's a sampling of architectural drawings for a variety of projects, from famous structures to visionary structures that were never built.

This paper purposes and suggests the innovative tools for design in civil engineering for avoid the limitations of conventional design methods.

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