INTELLIGENT DESIGN SOLUTIONS FOR INTELLIGENT BUILDINGS

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Abstract. This paper is focused on the various virtual architectures of the intelligent buildings. One of the actual challenges is to educate owners on the benefits of an intelligent building design. This makes the education of both owners and architects about the benefits of intelligent design solutions as virtual prototyping. In current quest for modernization designers need that the building owner receives the best product possible. Building designers face exciting new challenges in incorporating new and innovative technologies in designing an efficient integrated intelligent building in areas of the building structure and its mechanical and electrical systems. The innovative design technologies would need to ensure that the end users achieve the utilization of its abilities in optimization of the projects.

Keywords: innovative design process, intelligent building, virtual building

1. Introduction

The technologies and processes that are required to create intelligent buildings 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.

The decision to make a project "intelligent" needs to come early in the design process for intelligent buildings. Making the decision to create a new project or modify an existing one to make it intelligent is similar to invest in a project with superior performance and value. Once this occurs, the design process can continue as usual.

Intelligent buildings are designed for long-term sustainability and minimal environmental impact through the selection of recycled and recyclable materials, construction, maintenance and operations procedures.

Providing the ability to integrate building controls, optimize operations, and enterprise level management results in a significant enhancement in energy efficiency, lowering both cost and energy usage compared to non-intelligent projects.

Researchers are investigating how the home and its related technologies, products, and services should evolve to better meet the opportunities and challenges of the future.

Now, new tools are required to study technology in the context of home life that will support qualitative and quantitative studies investigating the relationships between spaces, the behaviors of people, and pervasive computing technologies.

The definitions of an intelligent building can be systemically classified by the information and control services that serve the needs and expectations of the occupants.

The specially designed controlling software and actual electronic hardware and devices installed within the structure that manipulate the telecommunications and building automation functions are necessary to create such a facility. Thus, the study of Intelligent Building is now a common topic worldwide.

In this particular scope, there are two areas which deserve added attention, both from the research and professional communities.

Designers need to ensure that the building owner receives the best product possible. Hence, everyday, building designers face exciting new challenges in incorporating new and innovative technologies in designing an efficient integrated intelligent building in areas of the building structure and its mechanical and electrical systems.

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

2. Related works

In [1] paper is evaluated the intelligence of the home according to the level of systems integration. In this paper, a home (building) is considered an intelligent one only when it is able to provide an environment and the means to optimal utilization of the building according to its designation.

In order to achieve an intelligent building, various building systems, example lighting system, automation systems, communication systems and others domestic systems are required to equip in the building.

These systems must able to integrate among the systems and between the systems and building structures in order to function well in the building. Therefore all these systems' integration has to be properly planned from the initial design stage as virtual building prototype.

One approach views the problem of smart home control in terms of end-user programming. These end-user programming systems explore various interfaces to provide end-users control of home devices, including natural language, visual programming [2], and programming by demonstration etc.

The end-user programming approach has several benefits. It provides users control over an unpredictable amalgamation of interoperating devices, and allows users to customize services as they might see fit, even inventing new services.

3. Intelligent buildings design

One of the first attributes in an intelligent design is to carefully evaluate the current and future use of the project. This starts by clearly identifying the purpose and needs of the targeted building occupants. This process will vary depending on whether it will be an owner occupied or a commercial development.

For an owner-occupied building, surveys and focus groups can be held with the building occupants, analyzing and prioritizing their needs to select proper project features.

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 good intelligent 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.

An intelligent building needs to be designed to meet the needs of initial occupants and be flexible to meet the needs of future occupants.

An intelligent building design begins by looking at the site as it integrates with existing buildings; space planning as it is a new "green field" location, getting it in the right position for maximum solar efficiency.

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

An intelligent building starts with an environmentally friendly design. Creating a project that is environmentally friendly and energy efficient connect in closely, with many of the intelligent attributes [3].

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Providing the ability to integrate building controls, optimize operations, and enterprise level management results in a significant enhancement in energy efficiency, lowering both cost and energy usage compared to non-intelligent projects.

Intelligent buildings are intended to be the preferred environment for occupants.

This requires focused attention to environmental factors that affect occupants' perception.

An intelligent design finds the balance, providing a superior indoor environment and minimizing energy usage and operating labour. This is where the technology becomes valuable. The starting point for the development of the building system is based on informatics tools. Thus the quality and efficiency could be enhanced considerably.

4. Building modeling

In architectural design, modeling is a process, either mental or externalized, of translating conceptual ideas into visual forms. Although at its root the idea of modeling has been the same throughout the history, it has taken on many forms of expression. These expressions are mainly the result of technological advances in producing imagery.

Design thinking is a collaborative process by which the designer's sensibilities and methods are employed to counterpart people's needs, not only with what is technically feasible and a viable business strategy. In short, design thinking converts need into demand. It's an approach to problem solving, which helps people become more innovative and more creative.

In the past, building modeling has been widely used as a design tool and often for construction as well. In an intelligent building we would expect that this model will be used by new sophisticated tools that will actually be able to use the original modeling information to make decisions about optimization and continuous re-commissioning of critical building systems. Ideally, the model will

follow through the lifetime of the building, be updated as necessary and serve as a digital document of the building [4].

An intelligent design needs to start with a complete model. This modelling begins early on with CAD designs that evolve into project renderings. Using new standards such as AEC-XML and GB-XML, this information can readily be shared with HVAC and other system models. Three-dimensional modelling and visualization in motion introduce a new dimension to architectural representation.

Building information modelling tools (such as Autodesk Revit®, VectorWorks Architect®) were developed to integrate design information with the geometry, however, studies indicated that such tools were primarily used by architects as visualization tools ignoring their other functionalities.

In architectural design, modeling is a process, either mental or externalized, of translating conceptual ideas into visual forms. Modeling of an intelligent building will be used not just in design, but will continue into construction and operation.

5. Virtual prototyping

A compact definition of the virtual prototype is the following: A virtual prototype is a computer simulation of a physical product that can be presented, analyzed, and tested from concerned product life-cycle aspects such as design / engineering, manufacturing, service, and recycling as if on a real physical model.

On the bases of the virtual prototype the designers manage to lower costs, reduce risks and enhance experience. The actors – the designers and the clients – cooperate in three key areas of interest: strategy development, solution architecture and program management. Once built, a virtual prototype can be used in the whole product life cycle from preliminary design to cost estimation, manufacturing, and marketing.

The construction and testing of a virtual prototype is called virtual prototyping. Virtual prototyping software not only simulates the way things appear but also the way things work. They enable designers to check for potential design problems, such as difficulty in accessing components and completing assembly sequences. Designers can perform several “what-if” tests prior to the development of the first real prototype.

The use of virtual prototyping optimizes the design performance, increases collaboration, reduces costs and shortens time to production.

As example, a scene shown in Figure 1, presents a virtual intelligent building. The types of such changes as recognized by open building literature include spatial changes, increasing or decreasing floor areas, changing functions and changing needs of different groups of inhabitants.

Conventional simulation tools encompass building designers with a large amount of data, often in a format difficult to understand, so the practitioners are not very willing to use conventional simulation tools because of the non-graphical output and uncomfortable interface of such tools.

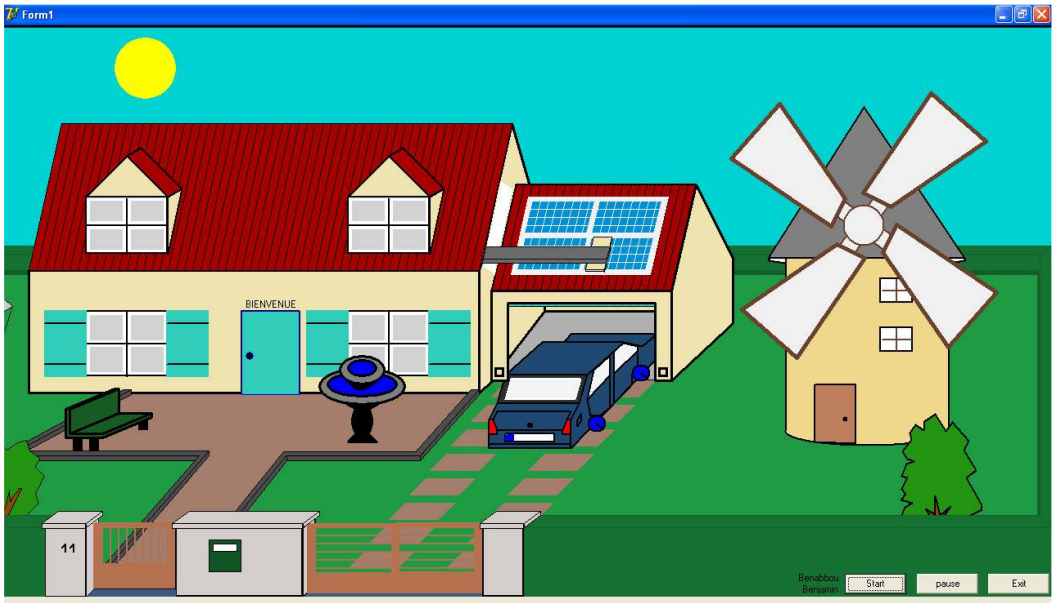

Figure 1. Using of virtual prototyping for design evaluation in a new building: virtual model with controls to investigate the effects of change in design parameters

In conventional building design practices, form generation is followed by performance evaluation. In this "generate and test" model, form generation takes priority over performance evaluation.

The current international effort in building and engineering design is attempting to achieve a higher level of integration between form generation and performance evaluation [5].

Despite the gradual transformation of design techniques, experiencing design in an integrated way is yet only possible with the virtual prototyping approach.

In this paper the authors propose a non-conventional building design technique using Delphi programming platform. Delphi Object Oriented Programming language allows the programmers to create and manipulate objects.

Delphi, along with C++ and Java, is a fully object oriented language. The principles of object oriented programming are the same in all these languages, though of course the syntax is different.

Basic concepts and data abstraction are the same in C++, Java, and Delphi; it's just the language syntax that differs.

Virtual prototyping on Delphi platform allows us to look at a system as a whole. A building is a perfect example for such system. Virtual prototypes enable several "what-if" scenarios to analyze the results of change.

The virtual building system makes it possible to implement a range of different housing plans and to adapt these plans to correspond at changing housing needs. However, the users (occupants and buyers) did not become involved just after completion; therefore, any design modifications – to meet the needs and demands of future occupants – could not be made in the construction stage.

Inevitably, traditional ways of thinking and working had to make way for more innovative approaches. One innovative approach is the virtual prototyping.

6. Conclusions

Visualization techniques and virtual representations should well respond to the needs of the building design process.

Validation of the virtual model is required for any type of simulation to ensure that the virtual model effectively represents the reality.

Virtual prototyping offers new characteristics that make it a distinctive and unique world-class experimental R&D infrastructure designed for the evaluation and optimization of new construction components and solutions, systems and services. The main distinctive feature of the Virtual prototyping is its capacity to create realistic scenarios, its "openness", to perform experimental research regarding the intelligent buildings.

It is important to note the contribution of Virtual prototyping for the activities related to the new product development for buildings.

Currently, the technical development of a product begins with the numerical analysis and simulation of the product, carried out in a virtual scenario. The prototype building structures – starting from the most basic problems and leading up to more complicated cases – includes numerous scenario of building frames.

The product is then tested in a laboratory in accordance with standardized procedures, and is finally launched on the market.

The authors aim to create design strategies for more flexible environments that better meet occupants' physical and cognitive needs than current environments.

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