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Innovative Design Process for Intelligent Buildings

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Abstract

An intelligent building needs to be designed to meet the needs of initial occupants and be flexible to meet the needs of future occupants. Creating an intelligent building does require an investment in advanced technology, processes, and solutions. An ingenuous investment is required to realize a significant return later on. It is unrealistic to expect to make a project intelligent unless there is early acquisition in on investment. Over, these decisions need to happen prior to the start of design work. One of the 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 solutions significant for success.

Keywords: Innovative design process; Future housing; Open-building

Introduction

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. An intelligent building is realized as follows: "Use of technology and process to create a building that is safer and more productive for its occupants and more operationally efficient for its owners". Intelligent Buildings are the results from implementing the new manufacturing technologies, are buildings that cost less to operate and are attraction more to their occupants. For projects that are proprietor engaged, the benefits of an intelligent building provide immediate benefits in terms of higher employee productivity. For commercial developments, these projects are expected to result in above market fees, improved maintenance, higher occupancy rates, and lower operating expenses. All around, this is a win-win situation. The technologies and processes that are required to create such projects 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.

Intelligent Buildings Design

In the intelligent construction the design process use modelling and simulation of the building. Intelligent construction is a new building construction mode, with construction process computerized. The attribute intelligent makes the building more marketable with a lower impact on the environment. Creating a project that is environmentally friendly and energy efficient connect in closely, with many of the intelligent attributes [1]. 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. 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. 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. The starting point for the development of the building system is based on informatics tools. Thus the quality and efficiency could be enhanced considerably. The current intelligent construction includes BIM (building information model) technology which provides auxiliary design for the construction industry, including all the information from the beginning of architectural design, medium-term construction, and later maintenance and operation. It is integrated into a three-dimensional model, which provides an information exchange and sharing platform for engineers of different majors. Engineers can work collaboratively according to BIM technology, which not only improves work efficiency, but also saves resources and reduces construction costs [2].

For an owner-occupied building, surveys and focus groups can be held with the building occupants, analysing 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.

Building Modelling

In architectural design, modelling is a process, either mental or externalized, of translating conceptual ideas into visual forms. Although at its root the idea of modelling 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 modelling 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 modelling information to make decisions about optimization and continuous recommissioning 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.

An intelligent design needs to start with a complete model. Currently, the technical development of a product begins with the numerical analysis and simulation of the product, carried out in a virtual scenario.

Three dimensional modelling and visualization in motion introduce a new dimension to architectural representation. Building information modelling tools 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. First of all, the building modelling is a process of representing of the building geometry, that helps the architects to predict the effect of changes on construction site. Modelling of an intelligent building will be used not just in design, but will continue into construction and operation. The actors – the designers and the clients – cooperate in three key areas of interest: strategy development, solution architecture and program management.

Virtual Prototyping

A virtual prototype is a computer simulation of a physical product that can be presented, analysed, and tested from concerned product life-cycle aspects. On the bases of the virtual prototype the designers manage to lower costs, reduce risks and enhance experience. 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 [3]. The use of virtual prototyping optimizes the design performance, increases collaboration, reduces costs and shortens time to production. Even if buildings have static structures, everything else related to architecture is dynamic. Functions and environmental conditions of buildings dynamically change during building life cycles. 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.

The Open Building concept aims to address changeability with individualized characteristics. Open Building aims to involve users in the building process and to create buildings that have increased flexibility. Flexibility of the building is designed with the facility to

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make changes at the various levels of technical composition of a building. For an open building design process an essential phase is the simulation as a means of imitating a real system and predicting its behaviour [4]. Computers have had the ability of simulating most of the aspects of design for a long time, but such applications are not widely used in practice. This is mostly due to the lack of integration between analysis and design tools. 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. 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 we 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. Once we've learned the principles, however, no matter which language we learn them with, we'll find that knowledge transfers easily to other languages. 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 analyse the results of change.

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. The prototype building structures - starting from the most basic problems and leading up to more complicated cases - includes numerous scenario of building frames [5]. In our example, a scene shown in Figure 1, presents a virtual intelligent building. 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 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.

Figure 1: The use of virtual prototyping for design evaluation in a new building – virtual model with controls.

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Conclusion

Visualization techniques and virtual representations should well respond to the needs of the building design process. 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. The prototype building structures - starting from the most basic problems and leading up to more complicated cases - includes numerous scenario of building frames.

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