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Digital Development: Visualizing Projects in Synthetic Environments

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Abstract

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Introduction

Over the past twenty-five years, professionals involved in developing and managing building projects have used a range of software applications to assist their efforts. These tools are becoming more diverse and powerful as digital technologies mature. On the leading edge of new developments are simulation applications, which provide realistically rendered 3D computer models of actual or proposed physical environments and allow for user movement, interaction, and information exchange.

Simulated or virtual environments have been regarded as primarily the province of video gamers operating in make-believe worlds, the film industry, or high-end government or research applications, generally very technical or specific in scope. But interactive, visually realistic 3D applications are now being adopted for mainstream uses. Witness the growing popularity of internet-based applications such as Google Earth - a virtual globe, and Second Life - a virtual 3D interactive world. In the building industry, 3D computer applications, notably Building Information Modeling (BIM), are becoming increasingly integral to the project process. Looking ahead, we can foresee the use of realistic 3D virtual environments to manage development of the building projects and the complex issues that affect the built environment.

Tools for the Planning and Managing the Built Environment

Managing and developing the built environment for a long time has been supported by abstractions in the form of maps, project drawings, and scale models. Over the last three decades, Computer Aided Design (CAD) and Geographical Information Systems (GIS) have revolutionized the way building and environmental data are generated, analyzed and managed. Continuing advances in computer technology have given software applications the capability to handle more data in models that are realistically-depicted and increasingly complex. Urban planning and project development will need to leverage these new technologies to illustrate and manage the complex issues affecting development: sustainable design, long-term asset management, traffic and urban impacts, zoning and code requirements, historical preservation, among many.

Moving Towards Integrated Applications

The trend in software development is towards greater integration and interoperability of application areas. AEC professionals are supplanting CAD applications with Building Information Modeling (BIM).

This software not only creates a full 3D model of a building project but has the capacity to associate project data with the model. BIM has the promise of providing a data platform for all participants in the building process, throughout the entire project lifecycle. The enhanced visualization and data management capabilities provided by BIM can improve project performance through increased efficiencies and coordination.

GIS systems became commercialized in the 1980's by vendors such as ESRI and Intergraph. GIS applications are an extension of traditional cartography with the capability to capture, store, analyze, and manage data spatially referenced to the Earth. These applications' strong data management capabilities are being enhanced by new developments in technology which allow for the display and manipulation of data in 3D, useful for many areas of analysis: zoning requirements, census data distribution, infrastructure layout, building information, vacancy rates, among many. GIS applications to date have naturally been geospatial in focus and not directed towards detailed building modeling or data tracking. It's foreseeable that upcoming development in the GIS and BIM area will begin to integrate detailed building models (BIM) into data-rich geospatial layouts. Standards organizations, notably the Open Geospatial Consortium (www.opengeospatial.org) are working to develop standards that will assist in the push for geospatial data interoperability.

Advanced modeling applications used by building industry professionals such as BIM and GIS are invaluable in the building process, but are often too complex for use by those outside the production team. Access to geospatial and building information needs to be simplified for a wider user base. This is becoming increasingly possible through Internet-based technologies. Google Earth is a notable example of a popular and easily accessible application that brings spatial visualization capabilities to a mass audience.

A couple of new terms have come into increasing use in the area of visualizing geographic information with technology applications. *Geovisualization* (short for Geographic Visualization) is an emerging domain that integrates a range of disciplines: computer science, human-computer interaction design, cognitive sciences, graphical statistics, data visualization, information visualization, geographic information science and cartography to discuss, develop and evaluate interactive cartography. This is a notable development area because of its cross-discipline nature as well as its high-degree of user interaction and integral focus of visualization.

Neo-geography is another emerging term meaning "new geography" and refers to Internet-based applications that allow non-GIS users to create their own maps, on their own terms (mash-ups). The

term neo-geography arose from the increased public appeal of mapping and geospatial technologies that occurred with the release of Google Maps and its toolkit for developing add-on applications (the API). An example of one of these applications can be seen at www.housingmaps.com. This site is a mash-up that provides users with access to a list of properties for sale and rent (data retrieved from craigslist.com) displayed for various cities as an overlay on Google Maps.

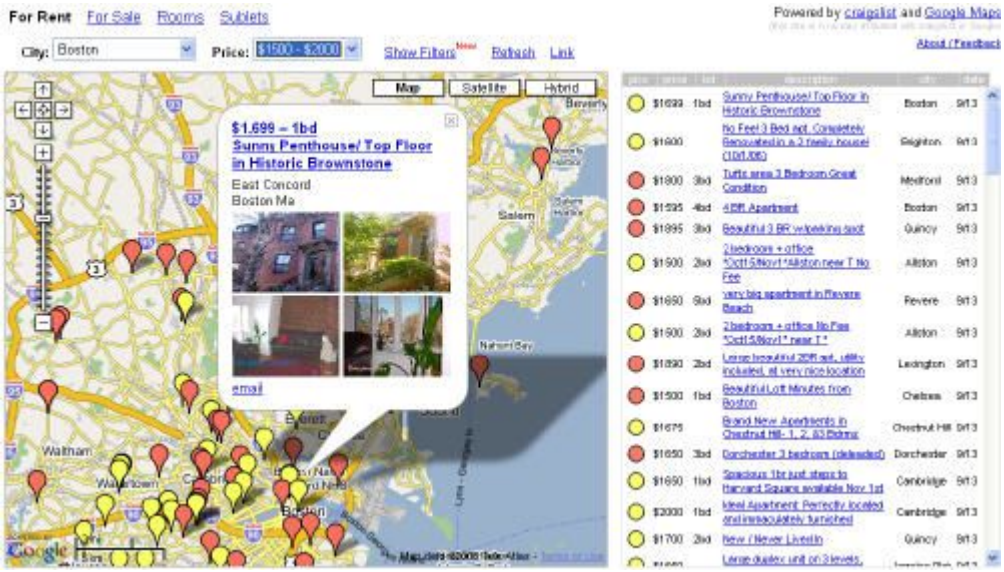

Figure 1: Screenshot from Housing maps.com - Mash up of housing data and Google Maps[1]

Simulation Environments

The logical extension of 3D modeling applications would be to provide the user with the capability to navigate interactively through these environments. Real-time movement through virtual worlds has long been a feature of computer games, where interaction between user and the simulated environment is vital to the application. Computer games have lively visual settings and are increasingly realistic, but do not attempt to provide accurate renderings of actual built environments, nor do they incorporate real-world data retrieval. Such capabilities are at the cutting edge of our current technologies since they demand a robust hardware platform, sophisticated visual processing, complex programming techniques, and accurate real-world modeling.

[1] www.housingmaps.com

Virtual Reality Applications

The term *virtual reality* (VR) refers to those technologies which allow users to interact with a computer-simulated environment -either real or imaged. The most advanced VR applications to date have been developed for well-funded defense projects or aerospace simulations. The depiction of urban environments for these projects have been fairly generic and limited in interior detail -- not to the level required for project development and planning purposes for the building industry and urban planning professionals. With the increasing incidence of military operations in urban environments, this is changing. MOUT simulations (Military Operations on Urbanized Terrain) are increasingly important to military planners, demanding increased building detail to be modeled in these applications.

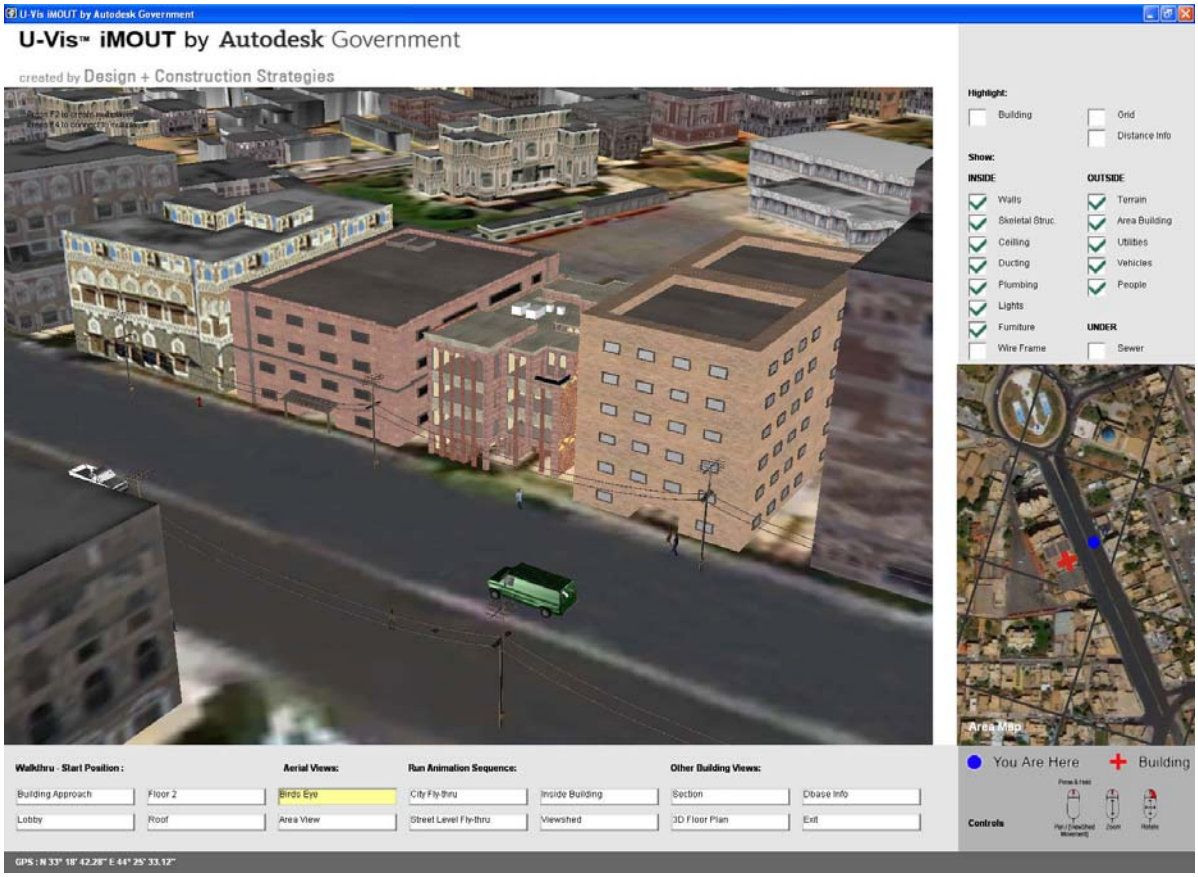

Figure 2: U-Vis® by Autodesk - Simulation Environment for military operation in Baghdad (Courtesy of Design + Construction Strategies)

Commercially available applications for visualizing the built environment are becoming more prevalent. One such product for building industry use is Walkinside (www.walkinside.com). Evolving out of the need to model complex industrial projects in 3D, this visualization program can import very large 3D

CAD files. The program allows non-technical users to navigate through the model and investigate complex designs in a realistic manner than could never be conveyed by traditional drawings.

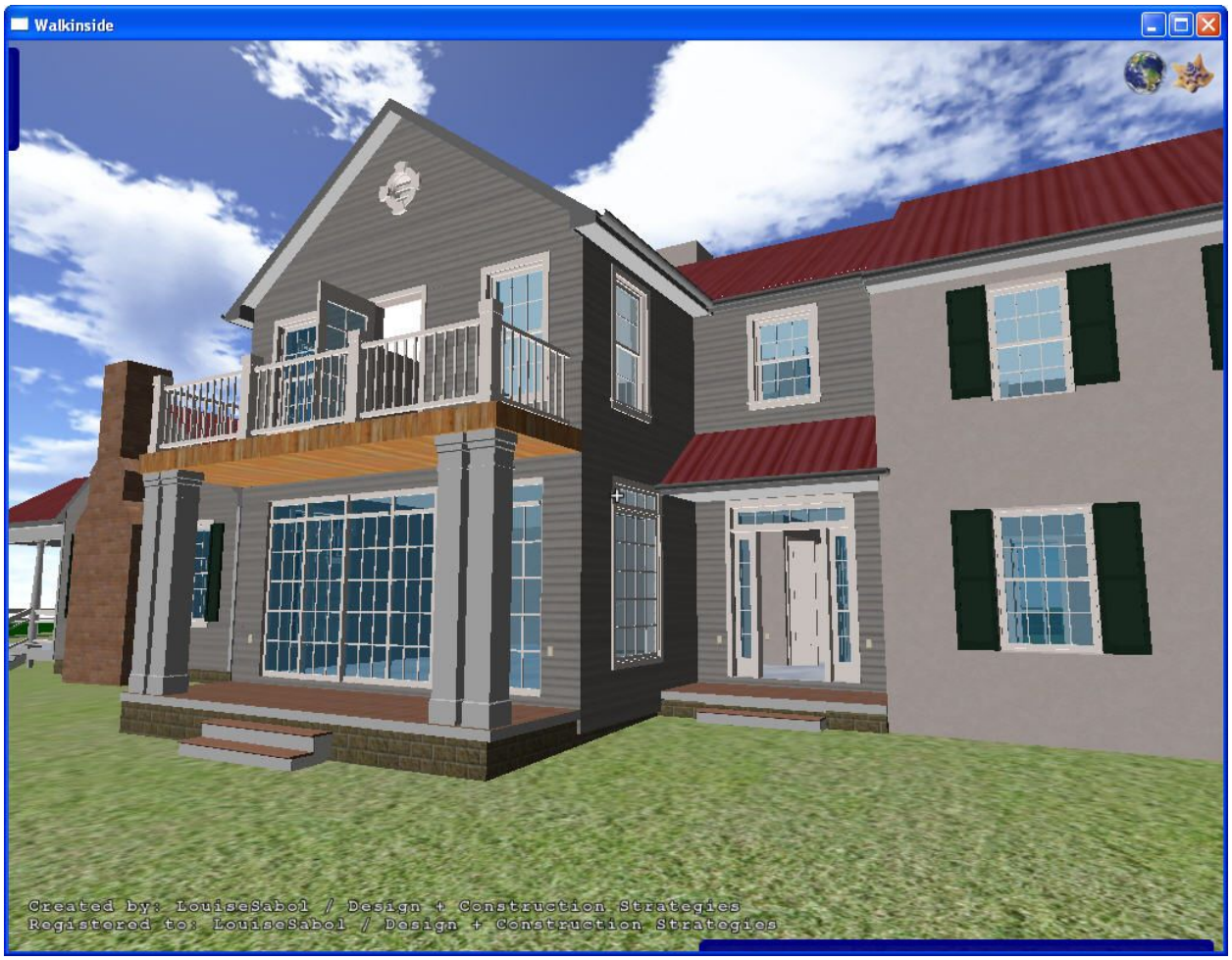

Figure 3: 3D Virtual Model of Heller House Project in Walkinside application (courtesy of Design + Construction Strategies)

Virtual Globes

A *virtual globe* is a 3D software model of the Earth (or another world), of which Google Earth is probably the best known example. This genre of applications can be traced back to the Aspen Movie Map project of the late 1970s which pioneered the concept of using computers to simulate a physical environment - in this project case, Aspen, Colorado. Developed by MIT with funding from ARPA (a research branch of the U.S. Department of Defense), the project was a revolutionary interactive hypermedia system that retrieved video, audio, still images, and metadata from a computer database on the fly in response to user input. ARPA had hoped that this project would lead to future developments, where computers

could instantly create a 3-D simulation of a hostile environment at much lower cost and in less time. The project was way ahead of its time and its innovations weren't directly exploited to any great extent. Commercially, applications that offer functionality first explored in the Aspen project are only recently becoming available to the general public.

Figure 4: Aspen Movie Map image (left) circa 1980 vs. Google Earth view (right) 2007[2]

Google Earth (GE) provides users with the capability to add their own data and make the resulting products available via the Internet. The application has the capability to display buildings and structures in 3D. An increasing inventory of these 3D models, created by individual users in SketchUp - Google's 3D modeling program - is publicly available.

Microsoft has a competing initiative - the Virtual Earth (VE) platform, released in its full 3D version in 2006 along with 15 complete cities containing photorealistic 3D buildings. VE is directed towards being more of a main street browser than a geographic tool. Microsoft views its end user as a consumer, whereas Google sees the end user as a content contributor. Besides these two providers, there are several other virtual globes available - NASA Worldwind, SkylineGlobe, EarthSlot, and Celestia, to name a few.

[2] Wikipedia. http://en.wikipedia.org/wiki/Aspen_Movie_Map

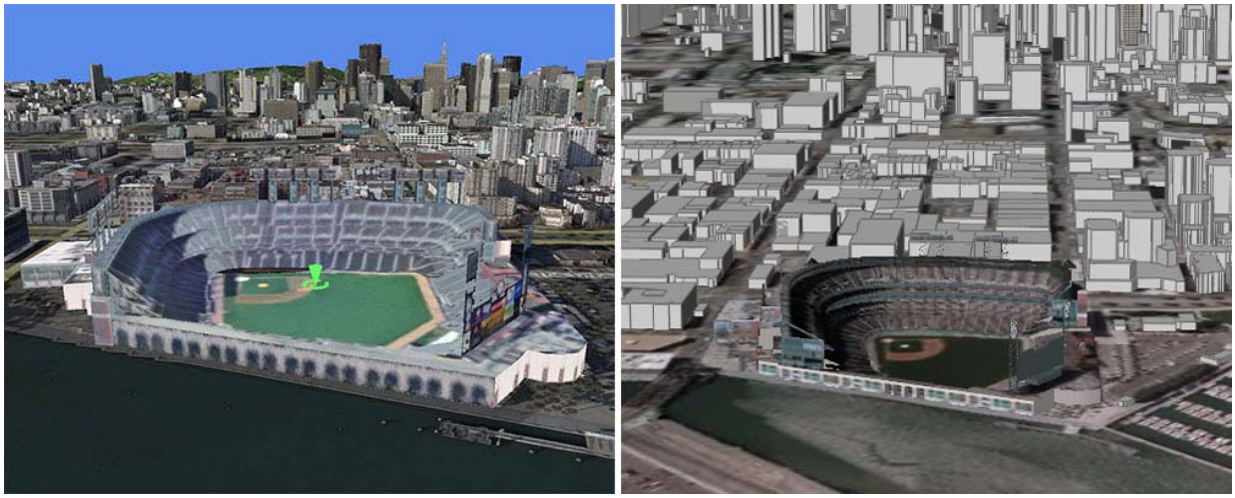

Figure 5: Virtual Earth Examples -

AT&T Park in San Francisco: MS Virtual Earth (left) and Google Earth (right)[3]

Google's platform and toolkit offers the capability for developers to build applications, and is becoming a sort of home page for geospatial data and related files. It integrates with GPS and radio-frequency identification (RFI) systems making it well-suited for asset tracking for many industries. Pole Star, a specialist in asset tracking, is integrating its web interface product with Google Earth. Lloyd's of London has developed an in-house system based on GE to help manage portfolios visually. A company in The Netherlands (geo-games.eu) has developed a product - M3D Glider, to publish 3D building projects on the Internet via either Google or Virtual Earth. The large engineering and construction firm CH2M Hill works with clients to publish asset data ranging from buildings to underground pipelines or electricity lines, along with visual location information, such as maps and pictures, with a Google Earth-based application. Microsoft partner Infusion Development worked with the County of San Diego employing Microsoft Virtual Earth and SharePoint to deploy an emergency management portal directed towards visualizing and collaborating around a crisis event.

Urban Context Models - Where is the Data Coming From?

One of the hurdles in developing workable urban simulation applications is the creation of realistically rendered and modeled data. There is no one source for this information, nor one methodology for developing 3D context models. Many firms and organizations have initiatives for doing so - from

[3] Microsoft Virtual Earth, maps.live.com, and Google Earth

universities and research organizations developing models for funded projects, to commercial entities intent on selling 3D context databases.

Commercial companies are approaching this area in different ways. Google has a presence in this area - providing not only a virtual world framework, but by also allowing users to post building models created with (Google's) SketchUp application to urban locations within Google Earth - for ad-hoc public development of urban content. The German company 3D Geo has commercialized a 3D GIS software application for creating, analyzing, managing, and distributing large-scale geo information, both land, infrastructure, and 3D building masses with realistic imaging. GeoSim, an Israeli company, has adapted sophisticated military imaging technology to develop highly realistic city models for the commercial market. Their Virtual Philadelphia project combines a highly realistic 3D urban model, tagged with data on context objects in an interface the user employs to navigate through (walk, fly), and click to access embedded data. Earthmine is a Berkeley-based startup company that is taking yet another approach. They are employing cutting edge technology, adapted from JPL (NASA) research, to provide a pre-collected base data layer of 3D panoramic images, with applications and tools to utilize it for their clients. Their high-resolution visual database provides a street level photographic quality perspective of urban environments that is fully searchable, spatially accurate, measurable, and taggable with data.

Figure 6: Screenshot of GeoSim Systems Virtual Philadelphia application (Courtesy of GeoSim Systems)

Serious Gaming

There is no single definition of serious games, but they may be a simulation that has the look and feel of a game, but corresponds to non-game events or processes, including business operations and military operations. These applications take virtual reality simulations one step further by adding the capability to play out a script or scenario. Serious games are intended to provide an engaging, self-reinforcing context in which to motivate and educate the players.

Because of the growing sophistication of these applications and power of the platforms needed to run them, the potential for these games to be applied to address some very difficult problems in the real world is rapidly increasing. At present, the largest developers of serious games are for medical and government (defense and security) users. Besides military uses, the government is looking to serious games to simulate events in the built environment for areas such as training for emergency response situations, disaster recovery simulations and security planning. Most serious games that employ urban

simulations have been either government-funded or developed in universities or research institutions. This might remain the case for the near future, since the general intent of these applications is to foster clearer comprehension on broad based issues such as environmental planning or community development as a whole, and not individual developers, owners, or project participants.

Figure 7: Emergency Response Training, Serious Game developed using the Quest3D game engine. (Developed by VSTEP, Rotterdam, The Netherlands)[4]

Serious Games for Planning & Development

Several urban simulation games have been developed to assess urban development issues and planning alternatives. The Swiss scientific association - Metropolitan Space Laboratory, has developed an artificial intelligence (AI) based computer simulation game to address the problems and complexities of urban development in a playful way. Users of their game can run through various development scenarios,

[4] VStep Quest 3D Demo http://www.vstepvideos.com/video/VSTEP_FirstResponderTraining_261005.wmv

visualize the development potential of various functions, choose to check the profitability of a function at a specific location, and potentially uncover unprofitable investments ahead of time.

Many people are familiar with simulation games from playing the popular PC-based game - SimCity. First released in 1989, this popular, mass-market game allows a user to design a city - executing tasks such as zoning land, changing tax rates, building power grids and facing random disaster such as tornadoes and fires. Due to its resemblance to real life city management and urban planning, many educational institutions have used SimCity as an instructional tool.

Developing this idea a bit farther, PlastiCity, developed by the University of Salford (UK) is a serious game directed towards urban planning. In a realistic 3D architectural environment, game players manipulate the size and shape, re-texture or erase existing buildings and site features, and create new ones from a limited catalogue. A key component of the game is a mechanism to harvest data about the decisions people make to create their own, personal version of the simulated city, to develop a data bank of what people rate as important in their urban environment. In the game *Urban Design & Decision Room*, developed at Delft University of Technology, users play the roles of project developers, taxpayers, urban planning experts and property owners to simulate a development project experience. Game players learn about the give and take of the development project and how different decisions and compromises lead to successful or unsuccessful results.

The Leading Edge

Virtual Worlds

On the forefront of visualization applications are *virtual worlds*. These are computer-based simulated environments in which users build and inhabit 3D environments and interact via avatars (a graphical representation that represents a person). Most, but not all, virtual worlds allow for multiple users. A lot of buzz has been prevalent in today's media about the Internet application Second Life - a virtual world rapidly growing in popularity.

Early prototypes were created for virtual worlds in the mid-to-late 1980's. The earliest applications for virtual worlds were not games, but generic virtual reality simulators. Credit for the first online virtual world usually goes to *Habitat*, developed in 1987 by LucasFilm Games and running on the precursor to America Online. A precursor to urban simulation environment was begun in 1996, by the city of Helsinki, Finland, which launched what was called the first online virtual 3D depiction intended to map an entire

city, and became the Helsinki Arena 2000 project. The project's intent was to provide a navigable, visually 3D model of the city, seeded with database information, and supporting rich communication among ordinary citizens.

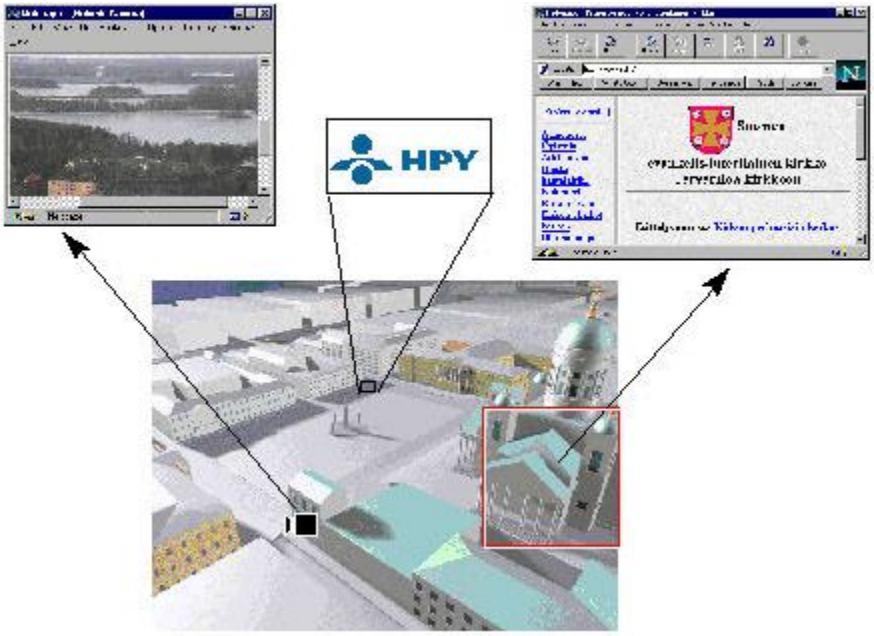

Figure 8: Helsinki 2000 Application Components -
A view to the city with a video, a phone, a web-page link[5]

Second Life and Business

Second Life, an Internet-based application created and owned by Linden Lab, is a three-dimensional virtual social world, in which multiple players interact with each other and the environment through their digital personas (avatars). The environment inside this virtual world is built primarily by the users, called residents, or by virtual world service agencies, hired to build environments for various purposes. Virtual social worlds are open-ended simulations in which the attraction is largely socializing, collaboration and creating. This type of environment can be considered a massively multiplayer online game (MMPOG), a type of environment where thousands of people can play and interact at once.

The application seems like an interesting diversion to those so inclined, but why are businesses giving Second Life attention? IBM and other huge corporations are attracted by the capability to use virtual

[5] Virtual Helsinki http://www.virtualhelsinki.net/english/index.html

worlds, like Second Life, as a platform for a whole new Net - one that is in 3D and is even more interactive than the original Internet. IBM started a $10 million project in November 2006 that will adapt Second Life for an in-house Virtual World to serve as a venue for meetings, training and recruitment. IBM's VP for technical strategy, Irving Wladawsky-Berger is an advocate for virtual worlds, believing that virtual reality offers an enhanced medium for communication. He commented that "there is something very human about visual interfaces. I almost think of text-based interfaces, including browsers, as 'narrowband' into our brains, whereas visual interfaces are 'broadband' into our brains." He also believes that there is a lot of untapped potential this area, noting that "virtual worlds are where video and VCRs were in the early 1980s, or where the web was in 1993."[6] Virtual world applications are important as much for what they represent as for what they actually offer today.

Other corporations with initiatives in this arena include W Hotels. They have built a prototype of their new Aloft hotel brand inside Second Life to gain feedback from the general public about the new venture. Starwood had a splashy exposure on Second Life in 2006 making available a version of their hotels for avatar interaction, but discovered that avatars don't need to sleep, so a virtual hotel presence didn't make much sense in the long run without added functionality (i.e. selling stuff).

[6] David Kirkpatrick. "It's Not a Game", *Fortune Magazine*, February 23 2007. http://money.cnn.com/magazines/fortune/fortune_archive/2007/02/05/8399120/index.htm

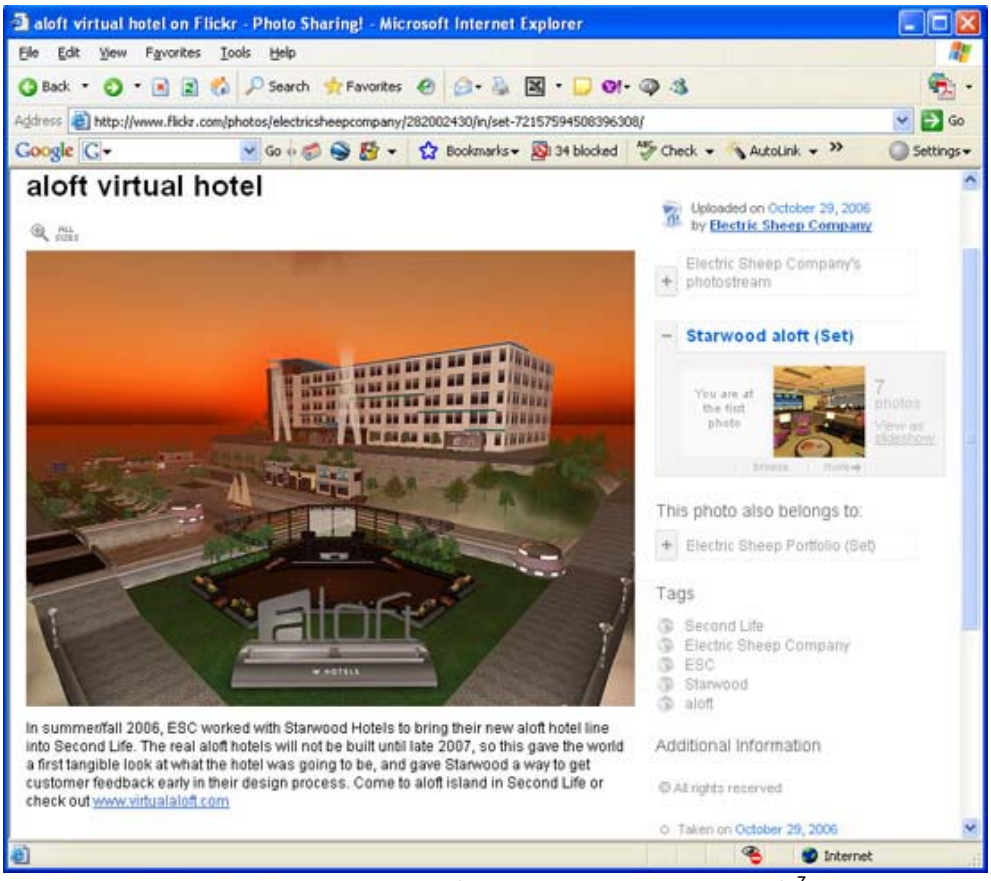

Figure 9: Starwood Aloft Virtual Hotel in Second Life[7]

An architectural firm, Crescendo Design, used Second Life to build virtual models of its designs to provide clients exposure to virtual models and elicit their feedback. The firm also conducts meetings in virtual "real time" - both the architect and client meet in the form of their respective avatars at the virtual site and tour it together. They also use their virtual studio as an educational model to publicize the value of green design features in their projects. Cisco Systems is using Second Life for business-to-business communications - employing a 3D model in the Second Life environment that can be viewed from all angles by multiple people with the capability to discuss the viewed object in real time. This may have implications for building projects teams - providing a medium for collaboration and investigation of a project model visually for all participants.

[7] Lachmi Khemlani, "Exploring Second Life and its Potential in Real Life AEC", *AECbytes*, February 27, 2007 http://www.aecbytes.com/buildingthefuture/2007/SecondLife.html

Conclusion

Computer-based applications are rapidly improving, providing us with advanced capabilities to handle large amounts of data and realistically simulate real or planned development projects. Visualization offers a superior way of illustrating complex problems, melding data from multiple sources, doing what-ifs and illuminating issues for a wide audience of interested parties. Simulation environments have been in use for a couple of decades, but have not been cost effective for wide-spread use in the building and planning professions. Visual based applications like Google Earth show great popularity and a burgeoning potential for these applications to be employed by professionals and the public alike. Serious gaming applications illustrate how complex scenarios can be run-through ahead of time saving both time and money, as well as serving to educate and train individuals in a realistic environment. Virtual worlds such as Second Life may seem to be on the fringe as far as business applications are concerned, but they do demonstrate certain capabilities – such as collaboration, visual project coordination and review, and the ability to test out development models with 3rd parties. Taking these capabilities into account, these computer-based applications may be of value to development professionals sooner rather than later.

About Louise Sabol

Louise A. Sabol is a registered architect with more than 25 years of experience in the building and technology professions. At Design + Construction Strategies, LLC, Ms. Sabol serves as Director of Technology, providing overall technical planning for the firm's technology integration projects for organizations involved in complex capital projects.

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