



**6th International Conference on  
Construction Applications of Virtual Reality  
3-4 August 2006  
Orlando, Florida  
USA**

**Proceedings  
Edited by  
R. Raymond Issa, Ph.D., J.D., P.E.**



**6th International Conference on Construction Applications of Virtual Reality  
3-4 August 2006, Sheraton World Resort, Orlando, Florida, USA**

Dear CONVR 2006 Participants,

Welcome to Orlando, Florida!

On behalf of the Scientific Committee of CONVR2006, I would like to welcome you and hope that you will have an enjoyable and productive conference.

I would also like to extend my sincerest thanks to all the Scientific Committee members who participated in the review process and CONVR 2006 staff who labored tirelessly to make all this possible.

Included in your conference pack you will find the conference program and the e-proceedings.

Once again, I hope that you will have an informative and successful conference.

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Thank You,

Conference Chair

R. Raymond Issa, Ph.D., J.D., P.E.  
Rinker School  
University of Florida



**6th International Conference on Construction Applications of Virtual Reality  
3-4 August 2006, Sheraton World Resort, Orlando, Florida, USA**

**Program**

**3 August 2006**

**CONTINENTAL BREAKFAST/REGISTRATION 8:00-9:00 A.M.**

**Location: FLORIDA BAY 1**

**INTRODUCTIONS**

**9:00-9:30 A.M.**

**R. RAYMOND ISSA, CONFERENCE CHAIR**

<b>TIME</b>	<b>PRESENTER</b>	<b>TITLE</b>
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**Session 1, Chair: R. Raymond Issa**

9:30-9:50 A.M.	Nashwan Dawood University of Teesside UK	VR- Roadmap: A Vision for 2030 in the Built Environment
9:50-10:10 A.M.	Margaret Horne Northumbria University UK	Virtual Reality Urban Modeling - An Overview
10:10-10:30 A.M	Khaled El-Ammari Concordia University Canada	Integration and Visualization Issues in Large-Scale Location-Based Facilities Management Systems
<b>10:30-11:00 A.M</b>		
<b>BREAK</b>		
11:00-11:20	Kurt Maldovan Penn State University USA	Framework for Reviewing Mockups in a Virtual Environment
11:20-11:40	David Heesom University of Wolverhampton UK	Interactive Generation of 'Multi-Level of Detail' 4D CAD Simulations
11:40-NOON	Svetlana Olbina University of Florida USA	Application of 3D Modeling Software for Daylighting Simulation of Shading Devices

<b>NOON-1:00 P.M</b>		
<b>LUNCH</b>		

**Session 2, Chair: Nashwan Dawood**

1:00-1:20 P.M.	Brian Hobbs University of Teesside UK	A VR-based Method for Evaluating Outdoor Environments with People with Dementia
1:20-1:40 P.M.	Wataru Wakita Ehime University Japan	A Proposal of Free Form Modeling System with Force Feedback Based on the Strength of Materials
1:40-2:00 P.M.	Leen Seok Kang Gyeongsang National Univ. Korea	4D System for Visualizing Schedule Progress for Horizontal Construction Project Including Earthwork
3:00-3:30 P.M.	Khalid Naji University of Qatar Qatar	New Trends in Construction Site Management

<b>2:30-3:00 P.M</b>		
<b>BREAK</b>		



**6th International Conference on Construction Applications of Virtual Reality  
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3:00-3:20 P.M.	Mohd Shiratuddin Univ. of Southern Mississippi USA	Southern Miss' Innovation and Commercialization Park: Development of a Large Scale Real-Time Virtual Reality Environment
3:20-3:40 P.M.	Chang Hak Kim Jinju National University Korea	Risk Management Model of Construction Projects Using WBS Generator Linked 4D CAD
3:40-4:00 P.M.	Ivan Mutis University of Florida USA	Virtual Reality Interpreter for Aiding the Reconciliation of Construction Concepts in Interoperability

**6:30-9:00 PM**

**CONFERENCE BANQUET**

**4 August 2006 Program**

7:30-8:30 A.M.

**CONTINENTAL BREAKFAST**

8:30-9:30 A.M.	James C. Oliverio Digital Worlds Institute University of Florida, USA	<b>KEYNOTE SPEECH</b> Distributed Collaboration in Virtual Space: Progress on a Global Scale
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**Session 3, Chair: Svetlana Olbina**

9:30-9:50 A.M.	M. Eduard Tudoreanu Univ. of Arkansas-Little Rock USA	Development of a Virtual Reality Safety-Training System for Construction Workers
9:50-10:10 A.M.	Nashwan Dawood University of Teesside UK	Visual 4D Planning in the UK Construction Industry
10:10-10:30 A.M.	Mohd Shiratuddin Univ. of Southern Mississippi USA	A Proposed Framework of a Virtual Reality Training Tool for Design and Installation of Electrical Systems

10:30-11:00 A.M.

**BREAK**

11:00-11:20 A.M.	Ian Flood University of Florida USA	Increasing Processing Speed for Interactive Real Time Simulation Environments
11:20-11:40 A.M.	Koji Makanae Miyagi University Japan	Development and Evaluation of a Terrain Representation System for Highway Route Planning
11:40-NOON	Cheng Zhang Concordia University Canada	Visualizing Crane Selection and Operation in Virtual Environment

**NOON-1:00P.M.**

**LUNCH**

**CLOSING REMARKS  
R. RAYMOND ISSA, CONFERENCE CHAIR**



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**ADDITIONAL PROCEEDINGS CONTENTS**

<b>AUTHOR</b>	<b>TITLE</b>
Robert Cox Purdue University USA	The Use of Project Specific Websites as a Virtual Office
Nashwan Dawood University of Teesside UK	A Future Vision for a Virtual Reality and Search-Based Outline Design Environment for the AEC Industry
Camille Issa Lebanese American University Lebanon	Integrating Virtual Reality with Structural Aided Design System
Walid Tizani University of Nottingham UK	Virtual Collaborative Building Design Environment Using Software Agents



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**Participants List**

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# ABSTRACTS

# VR- Roadmap: a Vision for 2030 in the Built Environment

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## Abstract

VR is an emerging technology that will greatly benefit the construction industry and its supply chain in terms of capacity to experiment, greatly improved communication, data visualisation and capturing ideas.

This paper presents the outcome of a research project that was aimed at developing a 'VR roadmap: vision for 2030 in built environment'. The methodology used was to thoroughly review previous and current application of VR in the construction and manufacturing based industries and conduct brain storming sessions with Experts in IT/VR regarding future functionalities and R&D needed to develop VR tools and processes capable of supporting future built environment.

Twenty-three Experts from industry and academia from UK, EU and USA working in diverse roles in academia, industry and software development were invited to participate in a brain storming sessions over two-day workshops.

The roadmap is focussed on three main themes: current state-of-the-art of VR in built environment; technology and process specifications towards 2030 and R&D plans to deliver such specifications. Discussions were focussed on identifying enablers, barriers, opportunities and challenges that prevail in the industry and those likely to be encountered towards 2030 with advancement of the technology and process changes.

The paper introduces and discusses the roadmap and its related methodology.

## Virtual Reality Urban Modelling - An Overview

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## Abstract

This paper offers an overview of the increasing use of Virtual Reality (VR) technologies for the simulation of ur-ban environments. It provides a summary of cities worldwide where three-dimensional computer modelling is being utilised to aid urban planning. The study considers the need for a digital representation of cities and raises issues pertaining to advantages, barriers and ownership. A case study of a pilot project on the visualisation of Newcastle upon Tyne is examined to show an approach adopted for the representation of this city in North East England. The process of this visualisation is summarised and future research is outlined in relation to this city model.

# Integration and Visualization Issues in Large-Scale Location-Based Facilities Management Systems

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## Abstract

Large-scale Facilities Management Information Systems (FMIS) require integrating a great amount of information about each building, and the ability to easily locate these buildings and their components, especially when considering the potential of using the FMIS in a mobile Location-Based Computing (LBC) setting. The interoperability of these systems is of paramount importance because of the need to develop and use them by a large number of groups in a distributed fashion. Available interoperability product models, such as Industrial Foundation Classes (IFC), have several limitations with respect to the requirements of these systems. In this paper, we describe innovative methods for integrating and visualizing information of large scale FMIS and discuss the computational issues needed for creating and deploying the 3D models used in these systems. CAD models, maps and images are integrated to create the 3D model of a facility, and then the resulting model is integrated with cost and scheduling information and used to collect inspection data using mobile computers equipped with tracking devices and wireless communications. In order to realize the proposed FMIS, several standards are introduced for the purpose of complementing IFC in fulfilling the additional requirements of integration, visualization, and tracking. The proposed approach is demonstrated through a case study about a FMIS for a university campus.

## FRAMEWORK FOR REVIEWING MOCKUPS IN AN IMMERSIVE ENVIRONMENT

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## Abstract

The use of virtual reality and immersive projection display (IPD) systems in the Architecture, Engineering, and Construction (AEC) industry is becoming a more viable option for traditional design review tasks. A Federal Courtroom mockup begins with the traditional design process and commences with a full review in a physical mockup. These physical mockups are typically made of plywood and housed at an off site warehouse. In some instances full scale mockups including finish materials are constructed. This research investigates the potential use of a virtual mockup to replace or augment the physical mockups. A virtual mockup was developed for a courthouse project and twenty professionals from the owner, end users, and contractor reviewed the mockup in a large display system. Surveys were used to identify criteria that judges, their staffs, and design and construction professionals perceive are the most important aspects of the design review process and which of these aspects can be assisted by using a virtual mockup. We found that virtual mockups can provide a viable avenue for reviewing project sight lines.

# Interactive Generation of ‘Multi-Level of Detail’ 4D CAD Simulations

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## Abstract

Four Dimensional (4D) CAD is becoming a more widely recognised tool to assist in the construction planning process. The ability to link a 3D graphical model with a project schedule provides the ability to visualise the construction process and can further be used to analyse construction operations prior to work commencing on site. Over the last decade, much research has been undertaken in the field of 4D CAD simulations, however a key aspect that still requires attention is the inclusion of the suitable level of detail for the simulation to be realistic. Within existing software tools, the temporal resolution (i.e. the time period between state changes in the 3D model) is fixed. However, construction operations are highly dynamic and as such the temporal resolution very often would require changing for various operations within the same project. A prototype software toolkit is pre-sented that allows the 4D simulation to be generated semi automatically from a real time VR model. ‘Dynamic geometry algorithms’ are implemented to automatically divide the product 3D geometry based on predefined strategies and during this process multiple temporal resolutions can be included in the underlying 4D simulation database. When the simulation is viewed in a real time VR based 4D engine, the user can select the appropriate temporal level of detail to view operations to provide a more realistic construction process simulation.

# Application of 3D Modeling Software for Daylighting Simulation of Shading Devices

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## Abstract

This paper explains research on application of 3D modeling software, Autodesk VIZ, as a daylighting simulation tool. During the design process, building designers need to select the appropriate shading device system to obtain sufficient amount of daylight in the space. This research developed the decision-making framework (DMF) for selection and design of shading devices based on daylighting performance. Daylighting performance of shading devices can be tested experimentally or by simulation. Experimental testing is expensive and time consuming. 3D simulation software is affordable, but can also be time consuming. To evaluate daylighting performance of shading devices, the 3D modeling software Autodesk VIZ was used as a simulation tool in this DMF. Among available daylighting software, Autodesk VIZ was selected because of its ease of use. Also, designers use Autodesk VIZ for the 3D modeling of the building, so the use of Autodesk VIZ for daylighting simulation does not require additional training. This paper describes input for the simulation, daylighting simulation procedure, and output of simulation obtained by the application of Autodesk VIZ as a part of the decision-making process for the selection and design of shading devices. The case study was performed to validate the appropriateness of the Autodesk VIZ application as a 3D daylighting simulation tool and to validate the DMF. The validation showed that the DMF works, and that Autodesk VIZ is a useful daylighting simulation tool in the DMF.

# A VR-based Method for Evaluating Outdoor Environments with People with Dementia

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## Abstract

The importance of designing outdoor environments that are 'dementia-friendly' increases with the ageing of populations world-wide. VR is a promising tool for the evaluation of these environments before they are actually built or redeveloped. We developed a VR-based method for evaluating outdoor environments with people with dementia. An existing town centre was modelled in VR. People with dementia took part in outdoor and (indoor) VR walks. The VR walks were conducted in a cinema-type auditorium, using a personal computer, a new system using two LCD projectors and a curved projection screen. Each participant's walks were rated and, based on the results of the walks, the model was redesigned. The model was then tested again. People's performance on the walks improved. From the findings potentially beneficial adaptations to outdoor environments were identified. We conclude that VR models, together with a rigorous behavioural testing method, can be a useful tool for the evaluation of outdoor environments and for identifying improvements for people with dementia.

# A Proposal of Free Form Modeling System with Force Feed-back Based on the Strength of Materials

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## Abstract

We propose a free form modeling system based on the strength of materials. This paper describes a system which enables users to realize more intuitive and realistic modeling in attaching various material properties to virtual objects by means of haptic device with force feedback. This system presents different features of materials according to the attached material properties to the surfaces of virtual objects and by feeding back reaction force which derives from shape distortion. As a result, in the case that the virtual object is rubber, the system shows soft shape distortion, and in the case that the virtual object is metal, the system shows firm shape distortion. We conclude that our system makes free form modeling intuitive and realistic.

# 4D System for Visualizing Schedule Progress of Horizontal Construction Project Including Earthwork

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## Abstract

One of the main functions of the 4D system includes visualizing numerical schedule data of construction project. The existing 4D tools have an excellent function for simulating building projects that all activities are progressed according to vertical work zone. However, it is not easy to implement all of it in the civil engineering project because the construction activities of highway and railway projects are progressed on the horizontal work zone and the 4D simulation for those projects should include earthwork objects that depend on the natural ground condition. This study suggests a new methodology for improving those limitations of 4D system for the civil engineering project and develops a new system by the suggested methodology. The morphing technique developed in the study can be a new approach to simulate 4D object for the earthwork such as cutting and banking whose activities are progressed on the natural ground condition. The research results can be expected as draft functions for improving the application of 4D system in civil engineering projects.

# New Trends in Construction Site Safety and Management Based on Virtual Environments

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## Abstract

This paper presents new trends in construction site safety management based on virtual environments. A virtual environment, named SIMCON+, which was developed as a test pad to have insight of the construction site, and to support decisions related to the management and safety during construction is presented in this paper. The SIMCON+ environment engages the user into a form of visual interactive simulation where different construction site configurations and scenarios of the surrounding environment (such as building components, materials, machines and workers) could be tested and analyzed during the planning process and earlier to the construction phase of the project. The paper also suggests a framework to conduct what-if analysis related to the safety of construction sites by expecting congested spots on the construction site at which collisions by machine-related resources are likely to occur. A case study for research validation is also presented. Finally, the paper outlines the most recent research effort in this area with highlights on some new trends of the Virtual Reality (VR) as a technology to be engaged in the area of construction planning and management.

# Development of Southern Miss's Innovation and Commercialization Park Virtual Reality Environment

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## Abstract

This paper discusses the development of a real-time Virtual Reality (VR) application for the University of Southern Mississippi's proposed university-related research and technology park. The park is known as the Hattiesburg "Innovation and Commercialization Park" (ICP), located in the City of Hattiesburg. The VR application is developed based on real-world CAD data, then processed using 3D modeling software, and implemented in BuildIT. BuildIT is a modified version of Garagegames' Torque Game Engine (TGE) which has been modified for architecture and construction visualization purposes. BuildIT maintains all the features currently available and adds database functionality in addition to Digital Elevation Map (DEM) terrain generation tools, quick project creation tools and compression tools. The development of the ICP's VR environment involves four main stages: terrain generation, development of road systems, development of parking lots and modeling of buildings. In each stage, techniques employed and the challenges encountered are discussed. The intended main goals of the ICP's VR environment have been accomplished which are: 1) the VR application to be able to run on average desktop computer, and 2) the VR application to maintain an acceptable minimum of 30 frames per second of image generation at any given time.

## Risk Management Model of Construction Projects Using WBS Generator linked 4D CAD

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## Abstract

The results of the study include a computerized system and a systematic process model for risk management and analysis. This study analyzes the present status of risk management in the construction industry, and then suggests reasonable methods for improved risk management plans. This study defines risk management procedures as preparation, identification, analysis, response and management to manage potential risks in the construction project. The modules for computerizing in this system consist of planning, construction, application of WBS (Work Breakdown Structure) and RBS (Risk Breakdown Structure). The methodology for analyzing construction risk uses fuzzy theory, and the scope of developed system is focused to the contractors. The risk management system suggested in this study operates on the internet, for providing contractors with a useful risk management tool by online system, with web-based menus that is helpful for practical application.

# A Virtual Reality Interpreter for Aiding the Reconciliation of Construction Concepts

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## Abstract

Construction project participants such as designers and contractors, rely on drawings and specifications as sources of information to specify building components and to interpret how to build them. The specifications are text-based descriptions of construction concepts, which define building components, parts of components, relationship with other components, and processes among others. Drawings are visual forms to represent construction concepts.

These representations are semantically poor and do not fully explain the intent behind the information, and the conditions are ambiguous and do not represent how the building evolves and progresses through the various construction stages. These information gaps force a construction participant to interpret the specifications based only on their own experiences and perspectives and to make incongruous decisions in the advancement of the activity, which tend to be error prone and inefficient. Accordingly, there is a need in the industry to develop interoperability systematic approach that helps construction participants in identifying the potential inconsistencies.

This approach uses conceptual formalization procedures by developing ontology in order to obtain explicit information. As a result of the ontology development, this research proposes a tool named 'Virtual Reality Interpreter' to help construction participants to perform accurate interpretations with the purpose of aid the reconciliation of two sources of construction concept representations.

# Development of a Virtual Reality Safety-Training System for Construction Workers

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## Abstract

Safety training is an important and time-consuming task for many construction companies. Virtual Reality (VR) simulation can be used in safety training to help users understand and learn safety rules, standards, and regulations. VR can also be used to evaluate the degree to which construction workers acquired skills after taking safety classes. This project focuses on creating a Virtual Reality Safety-Training System and assessing the perceptual and behavior impacts of the VR environments on a trainee. Perceptual and ecological psychology are studied in creating VR worlds in order to make the system effective. The authors' analysis determined that a streamlined, scenario-developing pipeline is needed to support flexible, computer-generated variations of the VR world. This reconfigurable and reusable system creates 3-dimensional virtual images and produces memorable experiences for trainees. Modules of various virtual objects and virtual environmental factors such as temperature, air composition, and visibility are also studied and simulated in the proposed system. The authors also plan to assess the areas of safety training that can benefit most from VR use.

# VISUAL 4D PLANNING IN THE UK CONSTRUCTION INDUSTRY

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## Abstract

Performance measurement has received considerable attention by both academic researchers and industry over a past number of years. Researchers have considered time, cost and quality as the predominant criteria for measuring project performance. In response to the Latham and Egan reports to improve the performance of construction processes, the UK construction industry has identified a set of non-financial Key Performance Indicators (KPIs). Following an increased utilisation of IT based technology in the construction industry and in particular 4D (3D+time) planning. A literature review reveals that a systematic measurement framework to evaluate the value of such systems at both quantitative and qualitative levels does not exist. The aim of this ongoing research is to develop a suitable measurement framework to identify and analyse key performance indicators for 4D applications. Two major issues have been addressed in this research: an absence of a standardised set of 4D based KPIs and lack of existing data for performance evaluation. This paper reports on the first stage of the research study for the identification of 4D performance measures. The ultimate objective of this research is to deliver project based 4D performance measures and to identify how project performance can be improved by the utilisation of 4D planning.

## A Proposed Framework for a Virtual Reality Training Tool for Design and Installation of Electrical Systems

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## Abstract

Electrical systems design and installation represent a minimum of 8-10 percent of the total construction cost. As such they must be properly designed and installed to avoid any cost overruns. The design of the system is the responsibility of the engineer, while its installation is the responsibility of the builder. It is not uncommon that there is a 'disconnect' between designers and builders. The former have limited experience in installing the system and the latter is not familiar with the design of the system, thus potentially leading to errors, rework and ultimately project cost increase. This paper proposes a framework of a Virtual Reality (VR) training tool that can be used in tandem by electrical designers and builders. We envision that this tool will allow designers and builders to better understand each other's concerns for the success of design and installation of the system, thus costly mistakes and rework can be minimized, if not eliminated. Additionally, the VR training tool is expected to enhance the level of interactivity, and provide real-time analysis of possible "what-if" scenarios.

# Increasing Processing Speed for Interactive Real-Time Simulation Environments

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## Abstract

The paper is concerned with simulating physical processes in buildings (such as heat transfer, fire propagation, and dynamic stress response within a structure) at real-time and accelerated-time speeds, so that they may be used in an interactive 4 dimensional visualization environment. Initially, it is demonstrated that conventional computing techniques will not be able to achieve satisfactory processing speeds within our lifetime, since their rate of progress is overwhelmed by the size of these models. Alternative computing techniques are then explored as means of achieving the required processing speed, including the use of parallel computers and direct mapping models. It is shown that the only current technology that has any potential of resolving this problem is the coarse-grain method (CGM). CGM is briefly introduced and a summary of its performance capabilities are presented for the problem of modeling transient heat-flow in buildings. The paper concludes with an identification of where future research needs to be focused.

# Development and Evaluation of a Terrain Representation System for Highway Route Planning

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## Abstract

In recent years, mixed or/and augmented reality, which aims to integrate virtual space with real space have received a significant amount of attention in research and development. In particular, tangible interface is one of the interesting research growth areas. The hypothesis of this research project is that the introduction of a tangible interface should assist designers and planners to recognise the 3-D feature of the terrain and therefore a more efficient highway route planning and construction can be developed. In this context, the objective is to develop and evaluate a tangible terrain representation system (TTRS). The TTRS can represent a terrain surface by controlling the shape of a stretchable screen used to represent the terrain surface by means of a total of 64 actuators (8×8) and projecting an aerial photograph onto the screen. Applying the TTRS to highway planning, a highway alignment is determined by control points which are positioned by a magnetic position device. As a highway planner set the control point of a highway alignment on the TTRS, the image of a highway alignment is projected on the TTRS. The TTRS was evaluated against VR-based visual 3D representation using a group of 9 final year graduate students. A well defined evaluation measures of usability was developed and used in the process. The paper concluded that TTRS is very effective tools for design and construction of highway projects.

# Visualizing Crane Selection and Operation in Virtual Environment

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## Abstract

Selecting suitable cranes in a construction project needs careful planning to meet several requirements from capacity, safety and spatial aspects. To provide construction managers with visual assistance, we present a method to design and implement advanced 3D animation methods to visualize crane selection and construction processes in 3D virtual environment. This paper discusses this approach including spatial conflict detection for equipment workspace using virtual crane animation based on forward and inverse kinematics. In addition, the virtual cranes can dynamically present their kinematics action while respecting the functional constraints for safety and effectiveness of operations. A prototype system developed in Java language is used to demonstrate the feasibility of the proposed method for realizing the proposed method.

## The Use of Project Specific Websites as a Virtual Office

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## Abstract

The use of internet based collaborative project management is presented as a method for improving the overall construction delivery process by effectively providing improved communications, coordination, and collaboration among project team members. The use of internet based technologies to address recently identified owner concerns is proposed as a viable justification for application.

# **A Future Vision for a Virtual Reality and Search-Based Outline Design Environment for the AEC Industry**

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## **Abstract**

It is generally accepted that the early stages of design are vital in that they are where the bulk of the costs are determined and also the form of what is to be built is decided. As yet, the early stages of design are not supported by any commercially available software tools. This is in part because the techniques developed by the research community are not sufficiently comprehensive in terms of their functionality. In this paper, a new approach to design for the construction industry is proposed. The approach suggests using an evolutionary algorithm to produce one or more preliminary 3D models which can then be refined, communicated and reviewed using virtual reality rather than CAD which is too formal for early design. The paper outlines a future vision for a VR-search based design environment for outline design processes. It is postulated that the proposed environment will support a more economical and intuitive way of working than current processes. The resulting environment should also provide a communication tool for the various stakeholders.

# **Integrating Virtual Reality with Structural Aided Design System**

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## **Abstract**

The main issues that significantly contribute to problems and delays on construction sites are changing client's view, incomplete design information, and poor site monitoring and control. Although experienced designers and construction managers control or minimize such problems during the design stage, the complexity and amount of the information in construction project make such a task very difficult to accomplish effectively. This paper presents an actual case study model for an integrated system which aims at presenting construction activities in 3D using virtual reality. Firstly, the technology enables construction managers to walk-through the proposed building perhaps at different construction time intervals-giving a vivid appreciation of the whole situation. Secondly, it enables the users to interrogate the building structural elements to present its details progress thus giving total virtual structural view of the project. Thirdly, the design effect of any changes in the building configuration can be modeled, visualized, and cost effect be calculated. Finally the system enables virtual models to be shared and thus facilitates collaborative global design and construction.

# Virtual Collaborative Building Design Environment Using Software Agents

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## Abstract

This paper describes an architecture for virtual collaborative building design system based on software agents. The environment helps the design team to work collaboratively and concurrently on a centralised shared model and carries out all necessary communication and data exchange electronically. The environment has been implemented in a prototype application as server-client model using .NET technologies. Virtual reality is used for visualisation and to allow for intuitive interaction with the designers. Software agents are used to carry out communication and design activities. The current implementation has shown the potential of the used technologies to support a practical virtual collaboration.