

# 3D WEB DESIGN IN REAL TIME INTERACTIVE ENVIRONMENT

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## ABSTRACT:

The paper presents findings collated from the creation of an interactive 3D learning resource, a showcase gallery which exhibits product designs, modelled by university students, in an online 3D environment. The design and implementation are described with alternative methodologies, comprising suggested findings. The insights, gained from the 3D web project, are detailed and include solutions for future developments. The paper considers whether interactive web-based environments offer an effective alternative to 2D web displays. The conducted research considers the first 3 stages of the project; namely, the first stage is the research of the most suited 3D Web software; the second stage includes the analysis of the interactivity required to showcase the models; and the third stage is devoted to the website design and its development. The interactive environment provides users with sources for individual investigations and sharing best practice.

## 1. INTRODUCTION

The learning resource employed for Griffith University staff and students to enable collaboration on projects between university disciplines, and industry is an interactive 3D Gallery Showcase, namely an interactive website. However, the site can be seen as an effective tool to be applied for external areas outside the university, for example, in primary and secondary schools; at conferences, workshops and exhibitions. The interactive 3D learning resource project devised by Design Lecturer Larry Vint had been undertaken with the framework created by Griffith University's Flexible Learning & Access Services (FLAS).

### 1.1. EDUCATIONAL PURPOSE OF THE LEARNING RESOURCE

The resource, 3D Gallery Showcase (Fig. 1), has an educational, industry orientated and perceptive focus. The tools presented in the resource enable viewers to interact with 3D designs, including architectural and environmental projects in real time. With a click of a mouse, users can interact with product models and technical constructive environments. Consumers can view the product from any perspective, zoom in and out, push buttons to activate moving parts, change colours, view animations and listen to music or voice tours. This learning resource provides a richer multi-sensory experience than a traditional 2D website. Students from various disciplines can observe the complete design journey from conception, research and design implementation by viewing storyboards, research and conceptual documents together with critiques and practical applications. Design projects of both the universities students and staff are demonstrated on this online environment, namely product and interior designs.



Figure 1: 3D Gallery Showcase project

## 1.2. POTENTIAL FOR SHARING THIS EDUCATIONAL RESOURCE

Targeted towards design communication, engineering, gaming, education and distance learning applications; this resource makes use of strategic technologies that give the competitive advantage to the processes of 3 dimensional design, modelling, and presentation employed in industry today. 3D publishing enables viewers, clients and consumers to interact with advanced 3D designs and concepts on-line. This educational resource prepares students to apply interactive 3D solutions for e-communication, e-business and e-learning, to model and display high quality interactive 3D objects and 3D animations on websites. Medical, engineering, architectural, 3D, product and interior designs can be analysed and examined on-line.

## 2. VIRTUAL EXPERIENCE

The Gallery Showcase tools, which allow one to conceptualise and create purposeful and functional models, can be seen as essential in product design and interior architecture. However, despite the virtual exhibition does not replace the practical touch and feel of manufactured products; it is designed to facilitate the learning and understanding, via interactive analyses (Bernardo, Preul, Zabramski and Spetzler 2003).

Interactive environments are increasingly being applied by industry, academic and medical fields:

- Commercial and retail displays;
- Scientific simulations, clinical visualisation, medical education, surgical training (by researchers, medical practitioners, patients, medical students, distributors, etc);
- Art galleries, museums, planetariums and exhibitions;
- 3D worlds, avatar environments (i.e. Second Life, Zango, Habbo);
- Multi world games (i.e. Ultima Online, EverQuest, Final Fantasy, Playdo);
- Architecture (i.e. My Virtual Home);
- 3D learning environment, e-learning, training simulation, interactive learning (by students, parents, trainees, apprentices, demonstrators, instructors, universities, colleges, resellers, etc).

Virtual environments can be characterised according to their function:

- Modelling of product: generate product changes and features in real-time after the selection is made. The customisation through visual interface imitates real design functions and design options;
- Multi-sensory information: interactive 3D models, simulation, animation, visualisation, text, images, sound and kinaesthetic virtual feedback;
- Field of use: research, medical (practitioners), industry, education, entertainment, sales, demonstration and promotion;
- Learning resource: powerful spatial navigatable interface; enables virtual experiences rather than observations; exploring interactive 3D content in on-line environment; electronic documentation;
- Simulation: replication of the functional ability of the product illustrating restrictive and limited movements; interaction and assembly of parts; enhancements and design options;
- Entertainment: provides relaxation, stimulation, amusement and diversion;
- Demonstration: teaching through illustrative modelling, creating a proposition of benefits and services to the consumer;

### 3. RESEARCH

The website as a showcase of university students' designs is intended to be employed by the following focus groups: designers, students, educators and potential consumers as members of the public.

The conducted research considers the first 3 stages of the project:

- Stage 1: Review 3D Web software and technologies for modelling 3D products for promoting student designs to the public and used as a teaching resource;
- Stage 2: Investigate the interactivity required for the 3D models, the interface and functionality;
- Stage 3: Website design development; establishing system structures, interface, functionality, look and feel, database development, search capability, browser compatibility and ensuring compliance with accessibility standards and university corporate web standards;

The design of the primary interface and information layout was intended to meet desired outcomes, including:

- To gain an appreciation of creative and innovative 3D design products and architecture;
- To allow visitors to obtain a better understanding of processes undertaken in creating 3D models and concept visualisations;
- Enable consumers to be fully engaged in the models and receive a better insight into the benefits of modelling and interactive online presentation;
- Create opportunities between disciplines and professionals to engage students and communities, research and industry professionals;
- Create a pool to gather projects and ideas.

Creating an interactive website provides not only an enjoyable tool for visitors to interact with 3D models, but offers other benefits, including:

- Open discussion forums to share ideas and designs;
- Teaching and learning disciplines required interaction with 3D designs;
- Products and design processes to be explored;
- Store and display designs in one accessible place.
- Opportunities for students in other disciplines to collaborate on various design and visualisation projects.

## 4. RESEARCH METHODOLOGY

Research was conducted on experimental learning research. The method used in the study, experimental learning, identified key characteristics of the website design in the aspect of suitability towards projects needs. Experimental learning research can be defined as “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (Kolb 1984, p. 41). The process of experimental learning involved prior knowledge and familiarity, insightful scrutiny, theoretical concepts and vigorous trialing of website design, 3D visualisation and user interface (Kolb and Kolb 2005).

### 4.1. EXPERIMENTAL DESIGN

From direct experience, this stage determined the student requirements, software used and website purposes from identified criteria. The experimental design established which

software performed the best suitability to interactive functionality for the exhibited designs and the requirements of prospective employers, students and academic staff. Variables were settled on influence of the outcomes by cause and effect, namely practical engagement with concepts and skills applied in a practical setting. Specifically, the experimental learning cycle involved observations and reflections to formalise software purchase, website design and layout, content inclusion and expected outcomes. The reflection process presented data to link theory to practice. Not only the technical aspects of knowledge, skills and experience were considered but also the human aspects and physical involvement (Carver 1996).

## 5. QUANTITATIVE ANALYSIS OF THE KEY CHARACTERISTICS OF THE WEBSITE DESIGN IN THE ASPECT OF SUITABILITY TOWARDS PROJECTS NEEDS

The key characteristics of the website design, student learning achievements and software features were analysed for their requirements and expected outcomes.

Ten Web 3D software programs were reviewed, these being Anark Studio, Autodesk Plasma, MindAvenue AXELedge, Cycore Cult3D, Demicron Wirefusion, Worldweaver DX Studio, Enliven Viewpoint, EON Professional, VRLogic Quest3D and Electric Rain Swift 3D. During the testing phase it was announced two of the software listed was being discontinued; Autodesk Plasma and MindAvenue AXELedge.

The final analysis of the top four candidates was conducted by viewing existing sites, downloading software trial versions and comparing their capabilities with the desirable characteristics for the website. The top four being Cycore Cult3D, Demicron



Wirefusion, MindAvenue AXELedge and Enliven Viewpoint. The selection criteria were based on pre-set criteria, namely:

- **Web plugin**  
Download size for plugin to play 3D Web in browsers. Does the web plug-in come as a default within the internet browser? If not, what is the download speed and size of web plug-in which allows the user to view and interact with the online models (viewer plug-in). Is the plug-in compatible/compliant with the variety of browsers and operating systems;
- **Features**  
The authoring tools (Fig. 2) available for application of interactivity, sound and special effects to the model. What can the software do and what it cannot do? Features list included zoom, rotate, translate, scale, modifiers, triggers, animated sequences, hot spots, play sound, switch textures, change colours, play animation, turn on and off lights, add rollovers, scripting capabilities, change avatars, change views, restrict rotation, set keyboard navigation, set friction. Professional features include: having a loading manager, interaction editor, collision detection, progressive antialiasing, virtual walkthrough capabilities, extended Java API, dynamic lighting, layers layout, full screen application, full transparency, transparency masks, cartoon shading, reflectivity, particle systems, bump mapping, edge effects, phong shading, advanced movement, multiple sounds and script libraries.
- **File size of export models**  
Mesh optimisation. Does the software support polygon reduction tools when exporting the model for website upload? If not or inadequate, is the software supported by a 3<sup>rd</sup> party mesh optimisation tool?

- Pricing  
Professional, standard and educational per use and per site licence. What is included in the bundled version, and what still is required to purchase;
- Online support, tutorials and examples
- Import and export options
- Operating system  
Windows, Macintosh, Linux.
- Support for specific 3D modelling programs  
Including 3DS Max, ArchiCAD, Rhino, etc.;
- Other information
  - Longevity of the software company;
  - Does the website files have to be operating from the software company's server site, or can it be functional from the designer's website?
  - Operationally stable;
  - Html, flash and/or VRML editable;
  - Programming skills required providing additional interactivity to the model.
- Personal review
  - Interface;
  - Friendliness of interaction;
  - Functionality.

According to the above-stated selection criteria of the top four 3D Web software the Demicron Wirefusion was decided on to be employed in the project.

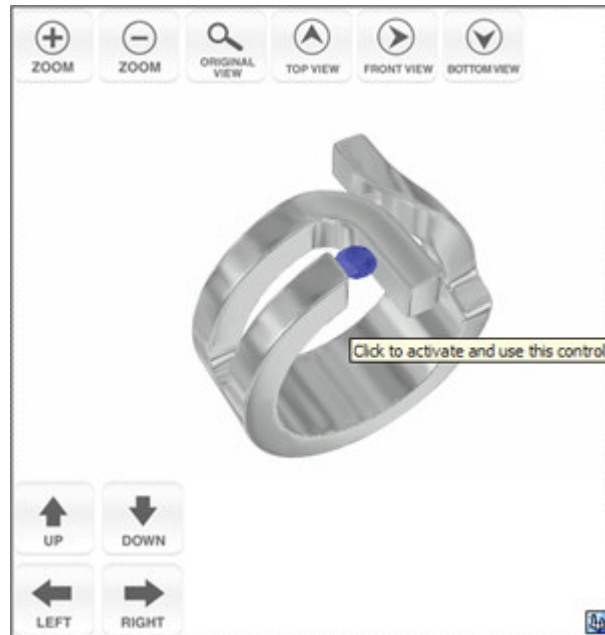


Figure 2: Authoring Tools

## 6. COMMUNICATION AND INTERACTION

The technical framework of the website required specific attributes to enable communication and interaction between the user and website interface to be seamless and effortless. Thereby, the web 3D software must comply with interactive functions specific to the project needs. These observations and outcomes included:

- Interactive functionality for models with high numbers of triangles (polygons). These include interior architecture, landscapes and detailed models;
- Fast website loading and operation speed;
- Website stability;

- Maintained constant frame rate and flicker free for smooth real time interactivity;
- Compact file size and data structure;
- Fast preprocessing of physical data allowing quick interactive responses;
- Detail control of model and environment;
- Accurate texture and bump map alignment for realistic visualization (Rusinkiewicz and Levoy 2001).

The integrity of the interactive models and website working environment should not detrimentally affect the projects design, including detail, speed and functionality.

## 7. IMPLEMENTATION ISSUES

The decision was made for MindAvenue Axeledge 2.0, which technical characteristics were the most acceptable. Axeledge was a powerful and cost effective solution for creating high impact interactive multimedia for the web, CD and DVD. This option allowed to incorporate 2D, 3D, video, Flash, text and sound, add animation and interactivity without requiring any other 3D tools or any programming or scripting skills. However, this program was only partially used as its production was terminated. MindAvenue was sold, and Axeledge was discontinued.

The project was implemented by means of the second option – Demicron Wirefusion. The users were provided with advanced functionality of this software like visual interface and interactive presentations. This software allows to design without sophisticated designing scripting or programming skills.

## 7.1. BUILDING

Demicron Wirefusion published as a Java Applet, which is very heavy on the processor if the 3D model is complex or has lots of animation. Thereby, limiting the number of works uploaded to the site.

## 7.2. 3D MESH OPTIMISATION

For projects to interact freely and in real time on the web, the files must have two attributes. First, be small in file size for fast upload and interactive times, thereby visitors can browse, investigate and explore without frustration of waiting because of slow refresh times. Secondly the model must have a low polygon count. The greater the polygon count, the slower the model will refresh on screen; too many polygons and the model will not upload.

Students therefore were required to create the model in 3D and generate minimum polygon numbers when constructing their model. In game design mesh detailing is substituted with texture and bumpmap detailing, thereby objects are generated with the barest number of polygons. Industrial and product designers often find this modelling technique not practical, as mesh detailing is crucial for prototype reproduction and generating working drawings. This is also the case with the 3D models used in this research. To accommodate this, 3D optimising tools were tested and evaluated for compatibility and effectiveness to reduce file sizes and polygons.

The ideal 3D model file size for the website was under 500kb and 5,000 polygons. Many source models used in the project were over 2 MB file size and 28,000,000 triangles (polygons). For optimal functionality, they were required to be optimised to

be less than 0.4 MB file size and 4,000 triangles (polygons). The optimisation was completed either manually (slowly and meticulously) within the 3D modelling program using built-in modifiers or by a specialist 3D mesh optimising software program with polygon reduction features.

Polygon optimising software was used to analysis, reduce, optimise and repair students polygon based 3D objects. It was important that the software selected preserve the visual qualities and coordinates within the model. 3D optimisation speeds up the run time and repairs objects that are damaged in transformation between different 3D formats and changes in level of detail.

### 7.3. PROTECTED INTERACTIVE 3D GRAPHICS

Techniques for protecting the 3D content were investigated in case of online theft or misuse. Research indicated that remote rendering systems offered the best protection. The system shared archived 3D models and protected the 3D geometry from unauthorized copying. The server stops any unlawful downloading (Koller, Turitzin, Levoy, Tarini, Croccia, Cignoni, Scopigno 2004).

## 8. CONCLUSION

The findings provided direction to improving the interactive 3D Gallery Showcase which implies future work will include making changes based on further research.

Interactive 3D websites delivers an attractive gateway for showcasing products for marketing and promotional, training and educational purposes, design and visual arts. However, the process of creating a 3D website challenges needs to be

addressed; namely, the software has to be selected carefully. It should have specific features, which comprise creative interactions and functionality; an easy interface, which appeals to the user; moreover, it should be an effective demonstrator. Over the last decade there has been a shift towards international commercialisation of sustainable products and merchandise. The internet devices have become ideal vehicles for increasing public awareness of products. Choosing design options on the website, the visitor can receive additional knowledge on the product and investigate its functions; construct design choices and cosmetic changes; make intuitive decisions and place orders to purchase items in real-time. The visitor is entertained, given freedom to select changes and has privacy in shopping. The shift in using interactive website design is gaining momentum with product designers, architects and inventors; museums and galleries; e-trainings, including the medical and scientific community; 3D worlds and on-line game designs.

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