

Museum Exhibit Ideas for Virtual Antarctic Historic Hut Experience

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GCAS 2004/2005

Personal Project

Introduction

The aim of this report was to investigate museum exhibit ideas for a Virtual Antarctic historic hut experience. The author's one-line response to probably the most important question on the GCAS course application form is reproduced below:

2. Indicate how, on completion of the course, you intend to use the experience in future postgraduate research, education, community work or in your career.

Since I work at HIT Lab NZ, perhaps we could see if we could put together some type of interactive exhibit to help educate people on Antarctica.

With this background information in mind, the author was contacted by Nigel Watson from the Antarctic Heritage Trust (AHT) at the beginning of the GCAS course. He suggested a topic idea for the personal project dealing with virtually visualizing the historic huts. Nigel is interested in providing "virtual access to showcase the Antarctic historic huts and the Antarctic 'heroic-era' legacy" (Personal Communication, Watson, 2004). A GCAS 2001/2002 student conducted a literature review on the subject that did a nice job of reviewing what was currently available on Antarctica at the time, various technologies that are available, and suggestions on what could be done in the future to create a much better virtual hut experience (Hyde, 2002). The author of this report assumes familiarity with the terminology that was nicely explained in Peter Hyde's literature review and would suggest reading it prior to this report if unfamiliar with any terms mentioned. This report focused on what could be done in a museum setting and an attempt was made to provide some actual Antarctic related samples that could be used to pursue project funding. There is information about HIT Lab NZ (www.hitlabnz.org) towards the end of the report but mention is made throughout the report on ways this University of Canterbury lab could contribute towards a project such as this.

There are 34 historic interest sites in the Ross Sea Region that the AHT recognizes (www.heritage-antarctica.org/index.cfm/default) under 3 different category classifications. The AHT's main focus is currently on four of the huts and they are:

- 1) Cape Adare Huts, Northern Victoria Land
(British Southern Cross Expedition 1898 – 1900, led by Carsten Borchgrevink)
- 2) Discovery Hut, Ross Island, Hut Point
(National Antarctic Expedition 1901 – 04, led by Commander RF Scott)
- 3) Nimrod Hut, Ross Island, Cape Royds
(British Antarctic (Nimrod) Expedition 1907 – 09, led by Ernest Shackleton)
- 4) Terra Nova Hut, Ross Island, Cape Evans
(British Antarctic Expedition 1910 – 1913, led by Captain R F Scott)

For some more insight into the huts, refer to the GCAS 2003/2004 Syndicate report that investigated the question whether the huts should be removed, repaired, or restored (Evans et al, 2004). The authors of this report passed on a personal communication from J. Heap about comments that were made in a case where an attempt was made to get grant money. Questions were asked about who would actually get to see the huts

located in Antarctica and a discussion followed dealing with creating a Virtual Reality experience so the general public would be included (Evans et al, 2004, p. 43).

This author's GCAS 2004/2005 Syndicate project report investigated the question "Raising the bar for an International Polar Year 2007-2008, how much will this IPY raise the bar compared to IGY?" (available from Gateway Antarctica). The official website for the International Polar Year (IPY) 2007-2008 can be found at: www.ipy.org. An Education, Outreach, and Communication (EOC) Committee has been established for the IPY. They have set up five target areas for education and outreach initiatives that include school children, potential new polar researches, Arctic communities, the general public, and decision-makers (ICSU IPY 2007-2008 Planning Group, 2004). Creating a Virtual Antarctic experience for a museum to showcase during IPY would represent a perfect time to get the message out about the historic huts. The huts could be part of a bigger virtual world that included 3D-models of certain key buildings from Scott Base, McMurdo, and the South Pole as well as key land formations such as Mount Erebus. The IPY offers a perfect catalyst to pursue project funding as there are currently 29 nations planning to be involved (as of January 2005). There exists the potential to put together a traveling museum exhibition that would be experienced by several thousand people during the timeframe that IPY is taking place. Not only would the message get out about the Antarctic huts to the public but it also provides an opportunity to generate revenue.

A great deal of the project time went into working with software and trying to make small demos. So in addition to the screen capture pictures in the report, there are also seven places that refer to a movie clip (provided on a CD, places highlighted by a "*" at the beginning of a line) since a variety of software was used which would have to be installed to view otherwise. Note that the software used to record the video only captured at 15 frames per second (fps) and so the motion appears jerky at times but the demos run smoothly on the source computer.

Museum Exhibit Ideas

This section begins by briefly explaining another project that HIT Lab NZ is about to begin that would make a perfect platform to showcase any Virtual Antarctic experience. Then an outline is given on how a museum exhibit could happen. Then a more in-depth look into some of the software that was used is discussed.

Vision Space

The goal of the Vision Space project that HIT Lab NZ has been funded to work on for two-years is to develop a low-cost stereoscopic visualization platform to intuitively visualize and interact with complex datasets. The Vision Space project involves developing a high-end three screen projection visualization theatre for viewing a wide range of data. The application domains include science, education and entertainment. This platform will be able to show both 2D and 3D (stereoscopic) images in a wide field of view (120 degree) environment. The theatre will be large enough to support simultaneous use by a group of up to 12 participants at a time. And unlike other visualization centers, the Vision Space facility will be designed for mobility. Each of the screens and display modules will be able to be separated for transportation to other locations. This will enable the Vision Space hardware to be used throughout New Zealand to enhance local science and industry capacity.

For over a decade virtual reality (VR) interfaces with headset displays have allowed researchers to become immersed in their datasets, while projection-screen based visualization centers are becoming more commonplace. In both cases complex datasets are rendered as three-dimensional virtual imagery that is easy to understand, interact with and manipulate.

Researchers have found that presenting complex datasets in this form increases comprehension, improves collaboration, and reduces the interaction time needed with the data. Carolina Cruz-Neira (www.vrac.iastate.edu/~carolina), the inventor of original CAVE projection display, identifies the following advantages of projection based high-end visualization environments:

- A high resolution display, limited only by the projection resolution;
- A large field of view (often more than 120 degrees);
- A non invasive display so that users do not need bulky VR head sets;
- It is easy to share — multiple people can share the same display;
- There is no need to recreate real objects;
- There is no isolation from the real world;
- Real and virtual images can be mixed together; and
- People can tolerate slower rendering speeds.

Note that the above section regarding Vision Space was completely extracted from two HIT Lab NZ project proposals. Interest in the project was expressed from several NZ companies including the following few that are mentioned: Science Alive, Story Inc, NIWA, The Canterbury Museum, and The Auckland Museum. The project is due to begin in March and it has been split into milestones. The first milestone is to have the software and hardware platform for low-cost stereo graphic visualization completed within a year. In order to get an idea of what is planned, visit the website of an expensive system at: www.sgi.com/industries/sciences/museums/index.html.

Antarctica Sense of Scale

Since not everyone that would visit a museum would necessarily be familiar with the size of Antarctica, it would be good to show a world map and the comparison from the current museum location to the Ross Sea Region. A good example to follow is the animation done by NASA when it appeared the B-15A iceberg was going to collide with the Drygalski Ice Tongue (refer to Figure 1).

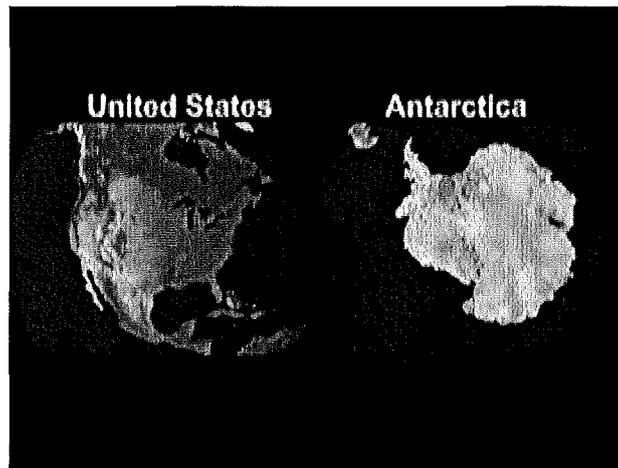


Figure 1: “B-15A iceberg moving steadily towards Drygalski Ice Tongue” (source: www.nasa.gov/vision/earth/lookingatearth/ice_berg_ram.html 6-1-05)

* The **video** is included on the CD and is titled: *web_104952main_B15A_dates.mpeg*

NASA makes available a detailed true-color image of the entire Earth which was stitched together from a collection of satellite-based observations. Months of observations over land, oceans, sea ice, and clouds were put together to create a seamless, true-color mosaic of every square kilometer of Earth. The image is referred to as the NASA Blue Marble and pictures of it appear in Figure 2.

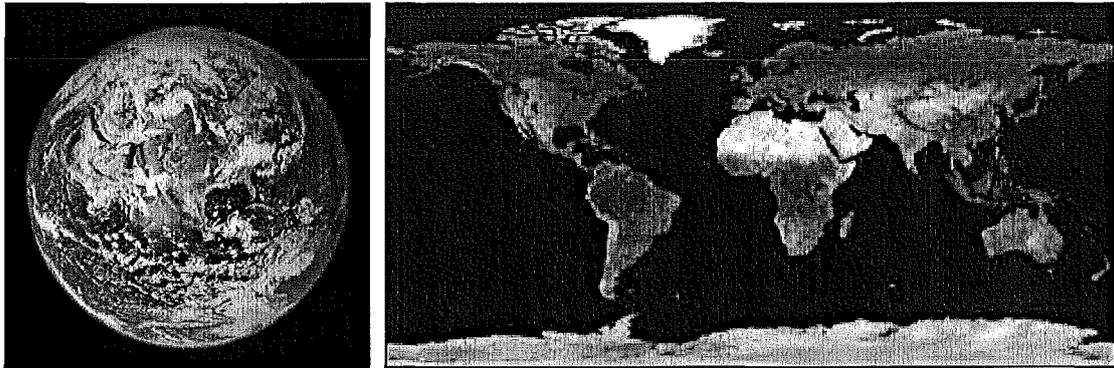


Figure 2: NASA Blue Marble (source: <http://earthobservatory.nasa.gov/Newsroom/BlueMarble/BlueMarble.html>)

The author's original intention was to use the OpenSceneGraph Graphics Toolkit to virtually visualize the 3D-models of the huts but later decided to use a game engine (more on that later). OpenSceneGraph (www.openscenegraph.org) is open source code and has been used in the development of flight simulators, virtual reality, and scientific visualization applications. The toolkit's website shows screenshots of NASA's Blue Marble as a model in one of its application examples. At the beginning of this project it seemed like a lot would be needed to get to the point to display this detailed model of the earth. However, after installation of OpenSceneGraph and consultation with a member of HIT Lab NZ, it turns out that a viewer included with the toolkit can process the high-resolution images and display the 3D model results. NASA provides different resolutions of the source images that can be used to construct a 3D-model. There are basically 12 different levels-of-detail. In order to generate a 3D model to level 7 (with 12 providing the highest detail), two images had to be downloaded whose combined size was 640 MB. It took 4 hours and 15 minutes to process these images to provide seven levels of details. The output folder with all the sub-models contained 1.9 GB's worth of data. But the Open Scene Graph viewer was able to display this data in real-time. The mouse controls for moving around the earth's surface were a bit sensitive, so the animation path that was recorded jumped in a few places. But video was recorded to give an idea what could be done, in this case flying from the Canterbury area to the Ross Sea Region. The second pass of the animation shows the earth rendered in a wire frame mode and it becomes easy to see the different levels-of-detail. When the view zooms out there is no need to render the earth's surface with the same size triangles. In order to prevent a performance hit for having to render a larger size area of the earth (and thus more triangles), the size of the triangles changes.

* The **video** is included on the CD and is titled: *gcas_NASA_BlueMarble.avi*

Fly-Over Landscape

As part of the user getting a sense of scale for Antarctica and getting them excited about engaging with this virtual world, it would be great to include a fly-over of the landscape in the Ross Sea Region. It would be spectacular to fly over Mount Erebus. An example video of the idea in mind shows Mount Cook. It was put together by two New Zealand companies working in partnership: K2Vi Software (www.k2vi.com/index.htm) and GeographX (www.geographx.co.nz/downloads.htm).

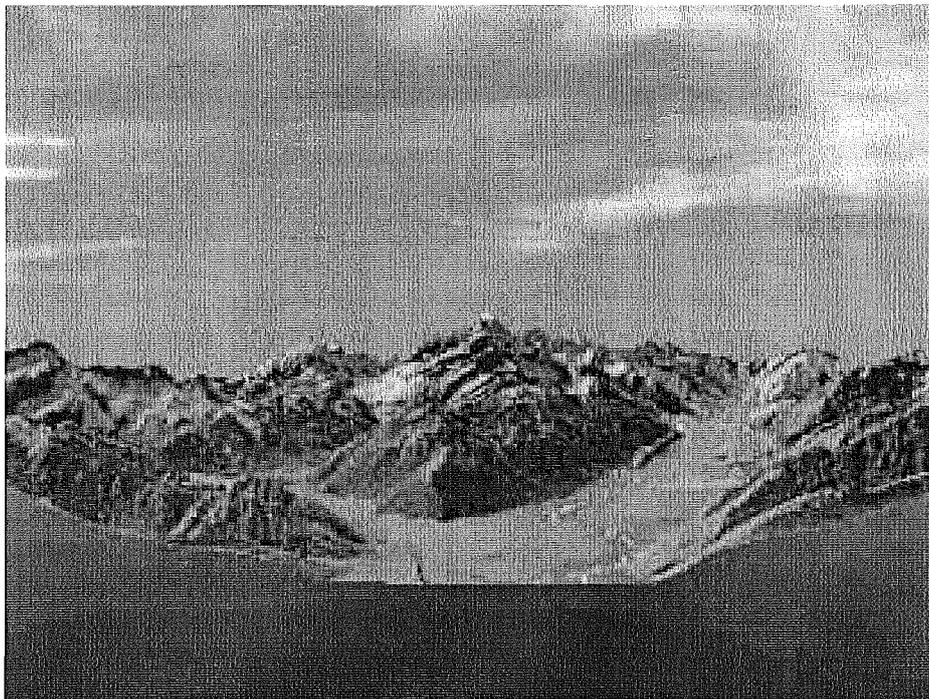


Figure 3: Mount Cook Fly-Over (source: www.geographx.co.nz/downloads.htm)

* The **video** is included on the CD and is titled: *web_aorangi.avi*

Note: The video included on the CD was converted to an .avi file which caused the quality to be dimensioned, see GeographX for higher quality .mp4 version).

Paul Barr from Gateway Antarctica made a first generation attempt of flying over Scott Base and McMurdo using a GIS software package (believe it was with ESRI ArcGIS Geographic Information System).

* The **video** is included on the CD and is titled: *gcas_Paul_1stGenerationTest.avi*

The author originally envisioned allowing the museum user to fly around the landscape much like what a bird might do. But after investigating the game engine idea and increasing the museum vision to include key base buildings and terrain in-between, the vision changed to flying into Antarctica in a C-130 cargo plane and then taking a

helicopter flight past Mount Erebus to experience the terrain that way (much like what our GCAS group got to do when taking a helicopter to Cape Evans).

At the high-end of the spectrum is a 3D model of Mount Everest that was put together by a team from the Institute of Geodesy and Photogrammetry at the Swiss Federal Institute of Technology (www.photogrammetry.ethz.ch/research/mounteverest). A visiting professor at HIT Lab NZ who specializes in 3D GIS modeling recommended checking out what this group had done. In a report paper they wrote, they mentioned making the model was more than an academic exercise and pointed out how it could be used for many different purposes including: natural heritage protection (UNESCO World Heritage List includes mountains) and use in media coverage (mentioned 50th anniversary of Mount Everest summit by Sir Edmund Hillary and Tensing Norgay). The model was created from data taken during a photogrammetric mapping project sponsored by the National Geographic Society and the Boston Museum of Science way back in 1988 for originally creating a topographical map (Gruen and Roditakis 2003).

But more research is needed to see what mapping data might already be available for use in the Ross Sea Region.

Game Engines

In order to visualize 3D models in a virtual world, a convincing medium is needed. With today's current computer games, children and adults are looking for high quality graphics and now have high expectations. The current game engines can provide so much more than just graphics rendering and include modules like: physics, collision detection, sound, artificial intelligence, and database. The author of this report chose to work with the Unreal Tournament 2004 (UT2004) game editor that makes use of the Unreal Engine 2 (latest is Unreal Engine 3 – see www.unrealtechnology.com/html/technology/ue30.shtml) since a student at HIT Lab NZ has written a script that generates stereoscopic images. All that is needed then to view the virtual world in 3D is a pair of projectors with polarizing filters attached properly and a pair of glasses (one of the demos that HIT Lab NZ shows from time-to-time). Plenty of time was spent searching the Unreal Developer Network to find answers to questions (<http://udn.epicgames.com/Two/IntroToUnrealEd>).

The latest and greatest game engine seems to be the Source engine by Valve which was used to create the game Half-Life 2. The SDK was recently released that allows gamers to create and modify their own levels. It is also possible to create and integrate code modifications now in C++. The same HIT Lab NZ student who created the stereoscopic script for UT2004 has started working with the Source engine. The author also purchased Half-Life 2 and wanted to try to get a demo running in this environment but there just wasn't enough time. Valve's website mentions that the Source game engine is offered at extremely competitive prices but only discussed under Non-Disclosure Agreements (www.valvesoftware.com/sourcelicense/default.htm). Probably still very expensive except for big game companies but it might still be worth asking. One commercial game engine mentioned that special agreements can be made for applications

not involving the selling of commercial games. The other commercial game engine that would be worth investigating more before any decision would be made is RenderWare (www.renderware.com).

But if all the commercial versions are too expensive to license, fortunately there are low cost options available of good quality. Three names that were mentioned by several students in the lab to take a look at are:

- 1) Torque Game Engine SDK including source (www.garagegames.com/products/1)
- 2) OGRE (Object-Oriented Graphics Rendering Engine), although there was some debate if this was a game engine or not but it is open-source (www.ogre3d.org)
- 3) Crystal Space 3D (http://crystal.sourceforge.net/tikiwiki/tiki-view_articles.php)

Before any final decision would be made on a game engine, it would be wise to evaluate the benefits of each and make sure the workflow between other software that is planned is carefully evaluated (ie what type of file formats supported for model imports and does that match capabilities of software planned for creating models without 3rd party conversion tools).

Bendik Stang's paper presents how game engines make a great tool to present virtual reality experience. It used to be that special custom software was needed for virtual reality that made it very expensive but the high-end game engines of today can actually outperform many of the custom virtual software packages (Stang 2003).

The videos that follow all depict the use of the UT2004 game editor.

Creating 3D Models

It is possible to download free or purchase common 3D models. In regards to virtually visualizing the huts, the question of historic accuracy versus any cost savings that might be seen is raised. But an attempt was made to use various models from the free download section of 3DCafe (www.3dcafe.com/asp/freestuff.asp). But out of the 13 free models that were tried, only four were of any potential use. Some of them lacked completeness and were missing supporting files needed to render properly. Deep Exploration from Right Hemisphere (www.righthemisphere.com/products/dexp) was needed in almost all cases to convert the models to 3dsMax format (www4.discreet.com/3dsmax) which is the 3D modeling tool used commonly in HIT Lab NZ. The sub pictured in the video was provided in 3dsMax native format (no conversion needed) but it originally took around 5 minutes to import into the level editor of UT04 the first time. However, the sub appeared to be rendered smoothly in the game even though it consists of 35,660 triangles. The other model of the plane was a low polygon count mesh that lacked any great detail.

* The **video** is included on the CD and is titled: **gcas_3dCafeExamples.avi**

There seemed to be a wider selection of models available from www.turbosquid.com although almost none available for free. But they had a beautifully modeled C130 3dsMax model available for purchase (refer to Figure 4).

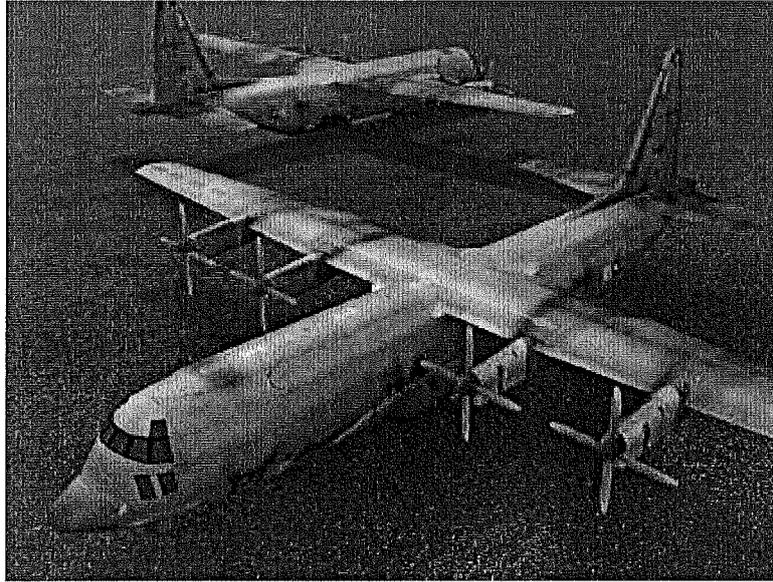


Figure 4: Airplane Cargo Transport C130 Hercules for \$99 from www.turbosquid.com/FullPreview/Index.cfm/ID/218642/Action/FullPreview

The author took the photo in Figure 5 of three C130 cargo planes lined up in a row on the ice runway that are part of the re-supply flights for the South Pole station.

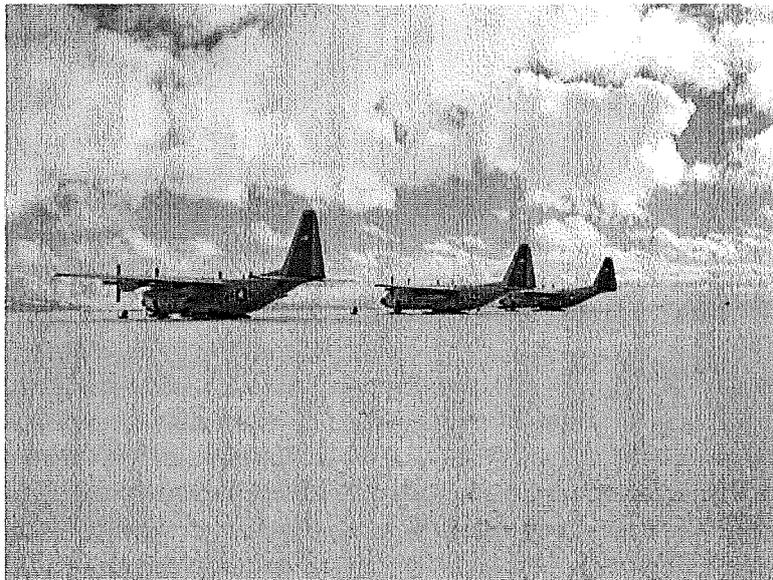


Figure 5: Personal photo from GCAS trip to Antarctica

Photogrammetry Modeling

Photogrammetry is the science of extracting measurements from photographs and this technique allows the creation of 3D models from 2 or more photographs. It also allows the extraction of the proper textures for the 3D model. Two of the high end software versions are by: PhotoModeler (www.photomodeler.com/index.html) and REALVIZ ImageModeler (www.realviz.com/products/im/index.php).

The very rough steps involved in the process are:

- 1) Calibration: estimate camera orientation using photo clues (mark common points between the photos)
- 2) Once camera positions are estimated, extract geometry by clicking points
- 3) After model extraction, select texture regions to use for models

Photogrammetric modeling has its drawbacks though. There are occlusion problems, if an object is blocked from view in a picture, than it can not be recreated. But this can be solved by taking several photos. Lighting and balance are important because the software interpolates the objects surface texture between multiple photos. The interior of the huts have many objects.

Since the author's photos of the huts at Cape Evans and Hut Point did not turn out that well, AHT provided copyrighted photos of these two along with Cape Royds to use in creating 3D models. However, the author made the mistake of struggling to make models with a low-end version of photometric software for too long called Photo3d from www.photo3d.com/eindex.html. A student version of ImageModeler was ordered and downloaded but delivery of the software key was delayed for a precious 3 days due to a quoted "technical glitch". So the author did not get as far as hoped in this area (please see Personal Comment at the end). The first video was created using sample models downloaded from the ImageModeler's website. The models had to be exported to VRML models, converted to 3dsMax format using Deep Exploration, processed in 3dsMax to prepare the models for UT2004, imported into UT2004, models had to have the textures manually matched in the UT2004 level editor, and then finally they could be used in the virtual world (mention was made in the Game Engine section about evaluating entire workflow before jumping into creating virtual world and this is one of the reasons as this turned out to be labor intensive).

* The **video** is included on the CD and is titled: **gcas_ImageModelerExamples.avi**

The pictures that were used (by whoever prepared the chateau example) to create the sample model are included in Figure 6.

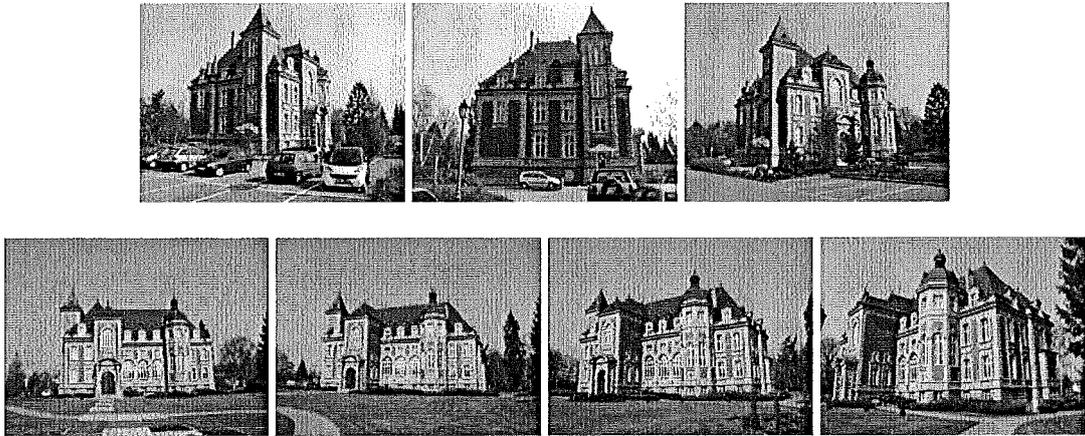


Figure 6: Images used in REALVIZ ImageModeler Example (source: www.realviz.com/products/examples.php?product=im)

The pictures used to create the lion-faced stone wall (by whoever prepared the example) are shown in Figure 7 and also in Figure 8. Figure 8 includes a larger view to show that lego markers were used which helped in the calibration process. It also shows that the picture properties include vital camera information which helps in the accuracy of the 3D models created.

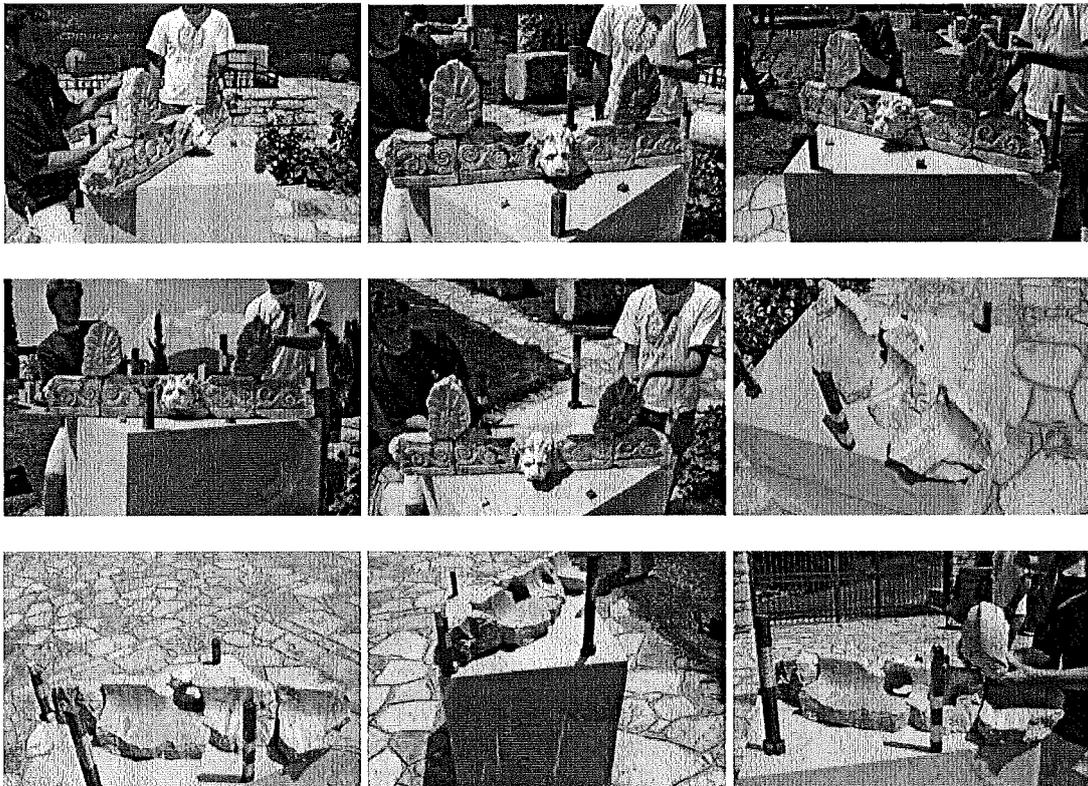


Figure 7: Images used in REALVIZ ImageModeler Example (source: www.realviz.com/products/examples.php?product=im)

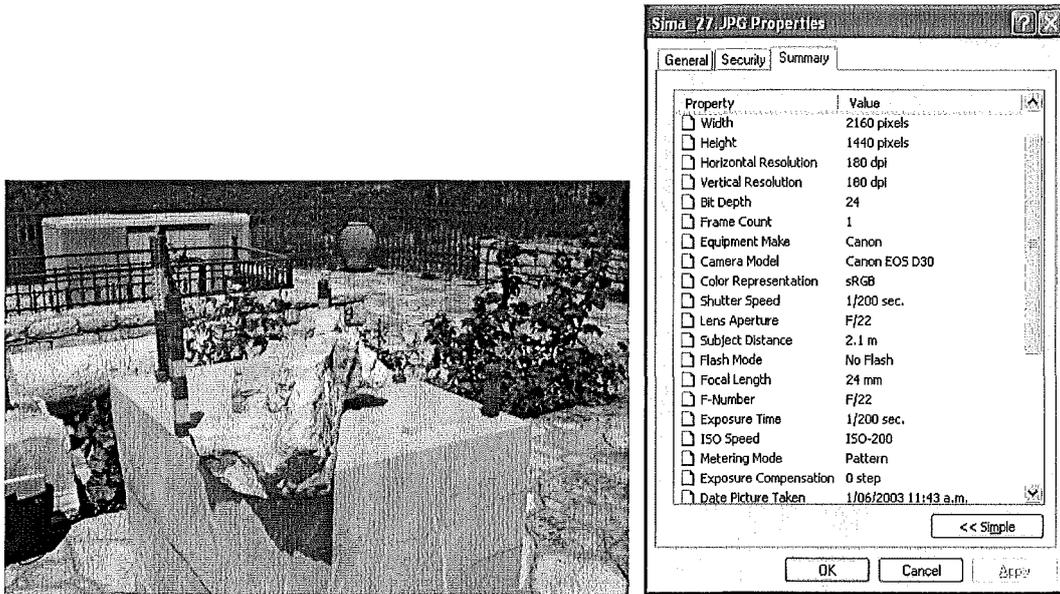


Figure 8: Close-up image used in REALVIZ ImageModeler Example (source: www.realviz.com/products/examples.php?product=im)

A 1st generation hut attempt using ImageModeler was generated from the two photos shown in Figure 9 (taken from AHT CD provided to the author).

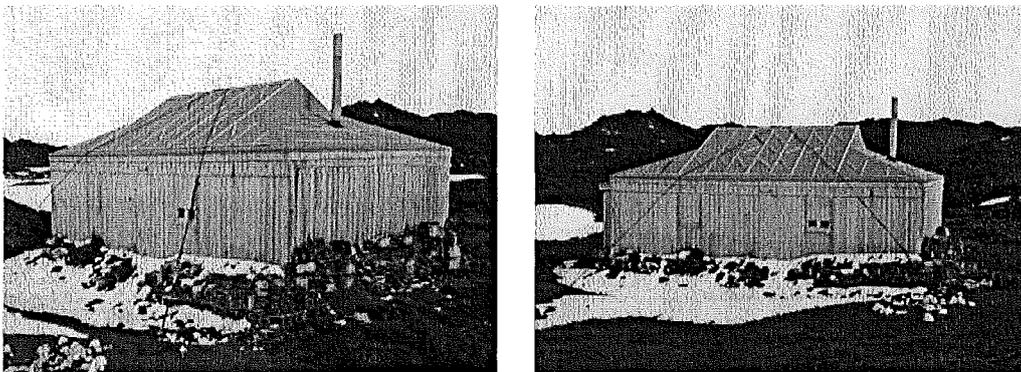


Figure 9: Cape Royds photos from AHT (used with permission)

Due to time, only two sides of the building were extracted and the textures are off a bit. And the author probably should have started with simpler examples to gain a better understanding of the software package (please see Personal Comment at the end).

* The video is included on the CD and is titled: **gcas_1stGenerationCapeRoyds.avi**

HIT Lab NZ

HIT Lab NZ (www.hitlabnz.org) currently has 35 people working at the lab in some form or another and is based on the University of Canterbury campus. The lab is comprised of 15 students, 12 staff, 7 interns, and a visiting researcher. The interns are usually on a 6-month contract and the lab works with partner European universities to keep bringing in new student interns. Several of the interns are highly skilled in 3dsMax and would be perfect candidates in creating a 3D virtual Antarctic world. The lab is supported by 28 industry consortium members and has 14 academic members in what it refers to as the Virtual Worlds Consortium.

HIT Lab NZ has worked on museum style exhibits before, including a Lord of the Rings Motion Capture exhibit for the Boston Museum of Science. The lab has just completed work on its part of a New Zealand pavilion for Expo 2005. The NZ government has spent several million dollars to be represented at the Expo 2005 Aichi in Japan (www.expo2005.co.nz/english/pavilionactivities/new_zealand_pavilion.html). HIT Lab NZ worked with StoryInc on this project.

Suggestions

Look into game engine licensing using Half-Life 2, Unreal, and RenderWare. Since it will likely be too expensive, also begin comparing Torque Engine capabilities to Ogre3D and Crystal Space 3D. The software workflow needs to be considered carefully as well. If lots of models are going to be generated, then this process should be as automated as possible and manual labor reduced as much as possible. Other software that was used during this project seems to fit into the workflow naturally, which includes: Adobe Photoshop, Adobe AfterEffects, and 3dsMax (since the lab has students always arriving who know this high-end 3D software package). Then a decision between ImageModeler and PhotoModeler needs to be made (author could only get a student copy of the ImageModeler software, but both offer trial versions but can't export models or use you own photos during the trial).

If seed money was found for this initial stage, focus should be on modeling artifacts here in Christchurch to develop a better understanding of the software. Then try using with existing hut photographs (but it may be better to have clear markers for the huts, author found it hard to get the cameras calibrated in ImageModeler).

But once the software workflow is understood, then the models could be generated at a reasonable rate. The author had a simple note mentioning the steps for converting 3dsMax models to UT2004 which was as follows:

- 1) Turn to the poly modifier and set limit to 3
- 2) Convert to editable mesh
- 3) Attach list to one mesh
- 4) Optimize step command
- 5) Collapse mesh
- 6) Save as .ase file

Getting to this simplified command stage took quite some time working with the new software involved, but then it was quite simple from that point on.

Personal Comment

A lot of time was spent working with new software that I haven't touched before (but have been wanting to) and there is always a learning curve involved. With the heavy GCAS workload and dealing with this new software, I didn't accomplish as much as I would have liked (especially in regards to the virtual hut models). But I really enjoyed the project and hope that it develops into a funded project that HIT Lab NZ and myself are a part of. I would (within reason since it would be on my own time) be willing to continue work towards generating a better Antarctic demo to pursue project funding if HIT Lab NZ would benefit when funding was secured. I would be in a position to act as a project manager on the HIT Lab NZ side of things and show new incoming interns the software flow and help keep the project on track (and volunteer to return to the Ice to get the required datasets for the models).

I think with some seed money that an investigation could begin to narrow down the final software packages to be used and test out the software workflow. Think it would be best to concentrate on objects of relevance located here in Christchurch first so that technique could be better refined (ie using markers to aide with photometric models, considering impact of low light inside huts, etc). This experience would also aide in estimating the amount of work involved and just how much can be tackled before the start of IPY (whether Virtual Hut Visualization part of bigger project showcasing a variety of International bases or best to stick to just visualizing the huts).

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Special thanks go out to:

Paul Barr, Gateway Antarctica GIS Technician
(www.anta.canterbury.ac.nz/people/pb.shtml)
Provided copy of 1st generation fly-over attempt.

Raphael Grasset, HIT Lab NZ Post-Doctoral Fellows. Advice on using OpenSceneGraph.

Julian Looser, HIT Lab NZ PhD Student. Advice with game engines and mentioning the stereo UT2004 script. Julian has begun work with Half Life 2 to create the same effect.

Billy Chang, HIT Lab NZ Master Student. Advice with game engines.

Nigel Watson, AHT Executive Director and Fiona Wills, AHT Executive Assistant
Providing copies of copyrighted AHT hut photos and other videos. In hindsight, I should have taken their offer on photographing smaller artifacts for creating models.

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