COMPUTER MODELS OF HISTORICAL SITES: SAZAEDŌ
- From the Aizu History Project -

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Recently declared a National Important Cultural Property (*jū yō bunkazai)*, the temple building Sazaedō in Aizu-Wakamatsu, Japan, has long been noted for its unique architectural feature, a double-helical interior walkway that takes visitors to the top of the structure and back down again to the entrance. The monks and architects who planned and designed Sazaedō at the end of the eighteenth century utilized unusual construction techniques to house Buddhist imagery and accommodate modes of popular worship. Both the construction and the historical context and background of the building are discussed in this paper.

The Aizu History Project

The Sazaedō model is part of the Aizu History Project, a Worldwide Web site exploring Japanese history by examining the Aizu region of northern Japan. Currently under construction, the project can be viewed at:

http://csua1.cs.ucla.edu/~jan/ah/menu.html

Our project's primary goal is to provide educational resources in Japanese history and culture, especially for university students. In particular, we employ multimedia techniques to create interactive environments in which users themselves may direct and control the learning process. In addition, we provide examples of multimedia interactive techniques for the creation of interactive learning modules and for classroom and research presentations.

We use three-dimensional modeling techniques to recreate historical sites that have been destroyed, as well as to preserve sites and objects that might face destruction in the future, and to understand their features more thoroughly. For example, our model of the Enichiji Golden Hall made use of archaeological remains to recreate a building originally constructed in the ninth century and destroyed in medieval times.

http://csua1.cs.ucla.edu/~jan/ah/tour.html

The Sazaedō model, on the other hand, preserves the construction data of an existing building and can be used in reconstruction of the building if it is ever dismantled or destroyed. Work currently in progress on user-driven spatial exploration methods such as VRML, will enable students to "visit" historical sites and examine them at their own pace.

The History of Sazaedō

According to a document of 1889 soliciting contributions for the repair of Sazaedō , the building was originally constructed in accord with the vow of the abbot of the Zen temple Jissō ji in the castle town of Wakamatsu, capital of Aizu domain.[1] Sazaedō , formally called Entsū Sansō dō , was built within the precincts of the Jissō ji branch temple Shō sō ji on the slope of Iimori mountain. The work was completed in 1796, with the help of donations from the populace. Its architect, Yamagishi Kiuemon, is the forerunner of a distinguished Aizu family of shrine and temple builders, including the creator of the dragon-shaped frieze at the entrance to the building, and his grandson Yamagishi Seiji, adviser to the Aizu History Project.

Sazaedō 's main image was the buddha Amida, but the building also contained thirty-three images of the bodhisattva Kannon, replications of the images of the temples along the famous Kannon pilgrimage route in the Saikoku (western) region of Japan. All the images have unfortunately been lost, but originally they were placed in alcoves along the interior walkway. As worshippers ascended and descended the walkway--just as they might ascend and descend a sacred mountain--they could stop to pray to each image of Kannon and leave donations there.

The architecture and iconography of Sazaedō places the temple building within important popular Buddhist traditions. Japanese Buddhism relies heavily on specific images and holy sites. Temples are often located on mountains, and the term ″"mountain" is often used to denote a temple. Perhaps because certain mountains were regarded as sacred space in pre-Buddhist Japan, mountain imagery links Buddhist and indigenous traditions.

As temples were constructed throughout the Japanese islands in the Heian period (794-1185), first aristocrats and later commoners embarked on pilgrimages to visit sacred sites. Eventually, set routes were created that led from temple to temple that enshrined a particular Buddhist deity or saint, such as Kannon or the founder of Japanese Shingon, Kō b ō Daishi. By completing a pilgrimage, a devout Buddhist could hope to earn merit for rebirth in paradise, as well as a host of worldly benefits such as good health and prosperity.[2] Unfortunately such rewards were often denied the poor, who lacked the time and resources to embark on lengthy journeys.

It was perhaps with the poor of Aizu domain in mind that the abbot of Jissō ji had Sazaedō built to replicate the famous Saikoku pilgrimage. Such abbreviated sites were common throughout Japan, allowing the ordinary believer to accomplish the journey of a lifetime in one afternoon.

The Aizu region fell on hard times during the Boshin War of 1867, the brief civil war that led to the Meiji restoration. A firm supporter of the old government, the Tokugawa bakufu, Aizu domain held out against restorationist forces even when the Tokugawa themselves had given up. The drama of the Byakkotai--a troupe of samurai boys who committed suicide when they thought Aizu castle was burning--took place on Iimori mountain, not far from Sazaedō . In the wake of Aizu domain's defeat, samurai leaders were exiled to inhospitable places where many died, and many old temple buildings were destroyed. Buddhist institutions in Aizu suffered another blow in the anti-Buddhist riots of the early Meiji period, when Shintō fanatics smashed many sacred images in vengeance against a religion popularly identified with Tokugawa rule.

Sazaedō was not destroyed in the early Meiji period, although the images were removed from the temple and eventually lost. But the building gradually fell into disrepair, inspiring a fundraising campaign to rebuild it in 1889. The document circulated among the people to solicit donations links the temple with the heroic images of the Byakkotai, and describes the building's serpentine interior walkways.[3] The campaign was apparently successful, and over the years Sazaedō has emerged as a monument to Buddhist faith and practice in the Aizu region.

Although the restored building lacks its images, it is possible to recreate or simulate them with computer modeling. By the use of virtual reality walkthroughs with user control over position and lighting, something akin to the original experience can be recreated.

Sazaedō Architecture: Creating a Computer Model

Sazaedō 's architecture is best depicted graphically rather than in words. Drawings, models, and animation can provide a clear view of the building's unique features, and a virtual reality walkthrough can allow viewers to pursue their own "pilgrimage" through the old building. Figure 1 shows the present building as well as a drawing and computer model.

Figure 1a
Photographic image (early 20th century)[4]

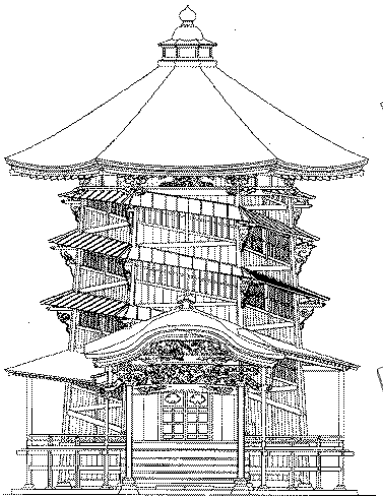


Figure 1b
Engineering drawing showing the structure[5]

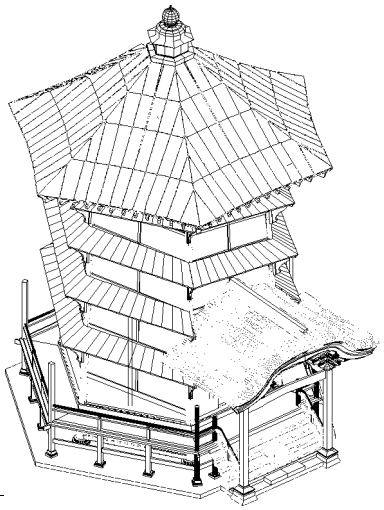


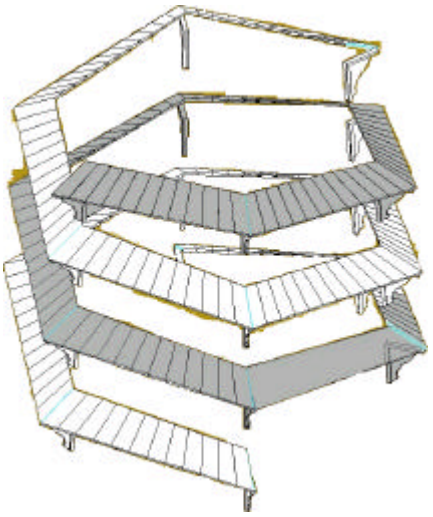
Figure 1c
Wire frame 3D model of the structure

The double helical interior walkway of Sazaedō has no precedent in Japanese architecture.

An early eighteenth-century temple building in Edo, the Sansō dō of Rakanji, was characterized by a single spiral walkway, but required visitors to descend stairs to the exit.[6]

Kobayashi Bunji suggests that the Sazaedō architect may have derived his inspiration from the European models of double-helical stairways.[7] Although such models were known in eighteenth-century Japan--Satake Shozan, the lord of Akita domain, had apparently copied one into his sketch book--there is no known connection between Satake and Sazaedō.[8]

Perhaps a more plausible model is the twisted sacred paper found at Shintō shrines.



(2) Building's helical structure

(3) Photograph of the tower showing helical structure

Creating the Sazaedō Model

The three-dimensional graphics technology used for creating and displaying the Sazaedō model is common and readily available, and scholars in the humanities field are just beginning to use it. One of the authors (Carl Vilbrandt) created the model on a PC, not a specialized high-end computer, using off the shelf software such as AutoCad to create wire-frame structures and 3D Studio for rendering (adding surfaces and textures). We used Adobe Photoshop and Graphics Converter for the manipulation of images (e.g., the adjustment of color) and JPEG View to display the images. When we presented this paper at the PNC Conference, we did so via PowerPoint, and had an HTML version also available, along with the Netscape browser software. The images and text can be presented using a capable word processor. The user can explore the model (when suitably prepared) through VRML and/or Java.

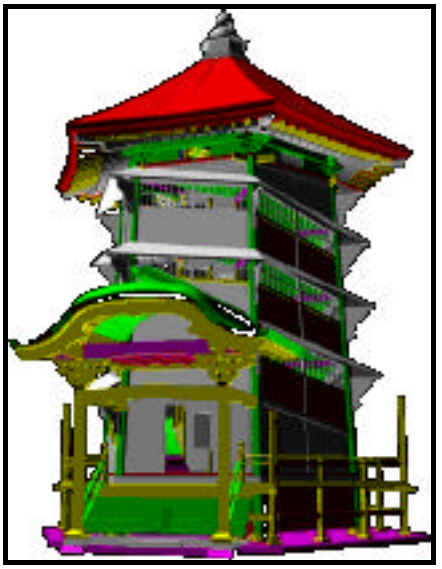
Components of the model

Wire frame and rendered models of the following components are shown below. In some views, false color has been added so that features can be more readily identified.

- **The completed structure**
- **Tower and interior walkway**
- **Roof (view from below)**
- **Entrance**
- **Base**

Overview of the Structure

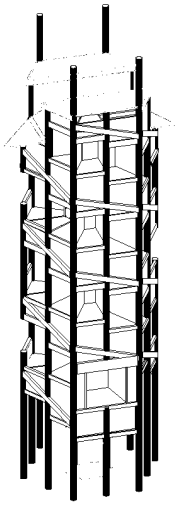
(4a) The completed CAD model in wire frame



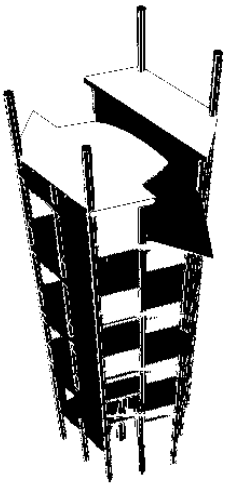
(4b) A false-colorized view of the structure

The Tower and Interior Walkway

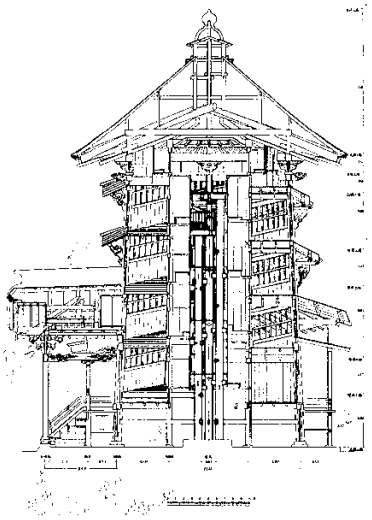
The double helical walkway is part of an interior tower shown in figure 5.



(5a) Interior tower with image alcoves - wire frame

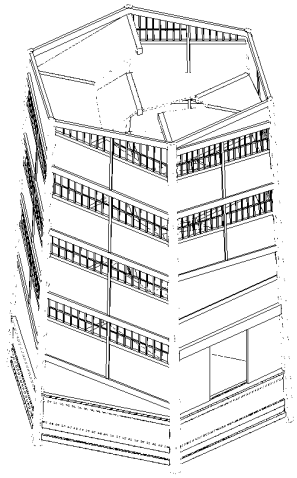


(5b) Interior tower - colorized

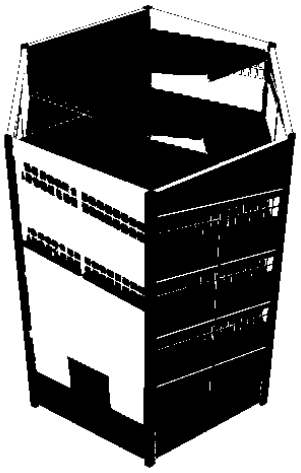


(5c) Full drawing showing the location of the interior tower

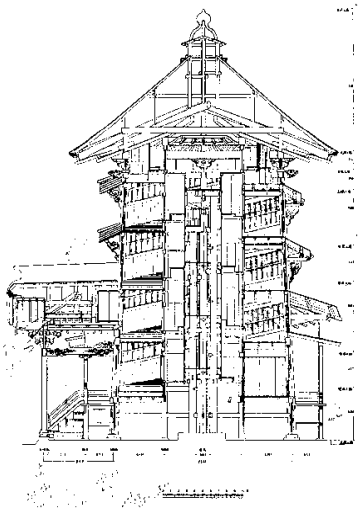
The 3D CAD model can be used to display such components separately, so that the construction may be seen and understood. Even an actual visit to the site does not enable such views.



(6a) Exterior tower with walls added - wire frame

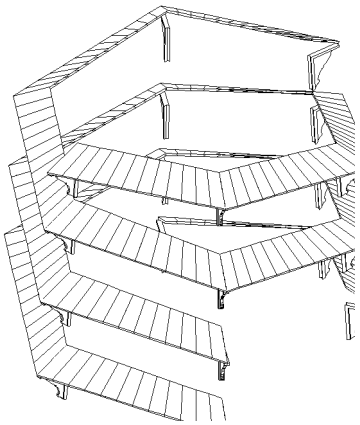


(6b) Model of exterior tower with walls - colorized



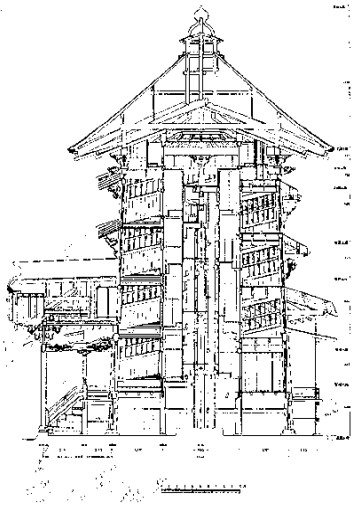
(6c) Full drawing showing the location of the exterior tower

The interior tower is housed in an exterior tower, with a separate support structure, shown in figure 6.



(7a) The exterior tower overhang - wire frame

(7b) The exterior tower overhang - colorized rendered view



(7c) Full drawing showing the location of the exterior overhang

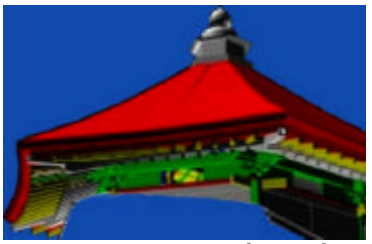
The tower exterior is completed by helical overhangs which protect the windows from direct sunlight, as shown in figure 7.

The Roof

The model of the roof, seen from various angles, further demonstrates the value of the three-dimensional model. Actual photographs of building components can be difficult to interpret, especially when lighting is poor or pictures must be taken from restricted angles.

An accurate 3D computer model can clarify details of the structure, and one can choose illumination and viewpoints, as well as remove obstructing objects as desired.

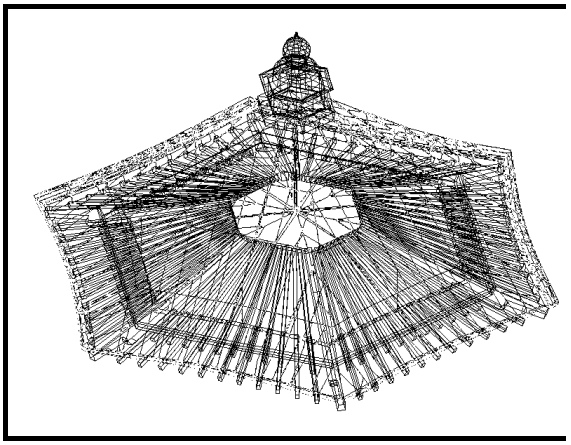
(8a) Photographic view from below (inside)



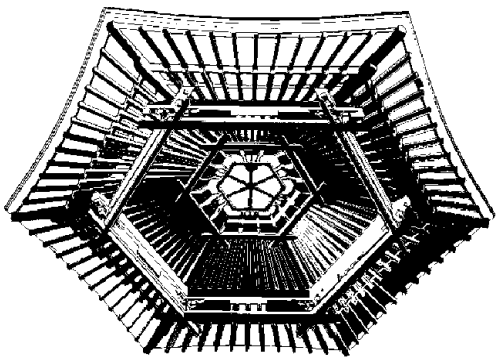
(8b) A colorized view of the final model showing just the roof

Figure (9a) is an engineering drawing of the roof shown from below. By using measurements from this drawing, and supplementing them by measurements taken on site, a 3D CAD model was constructed, and is displayed in the wire frame view in figure (9b).

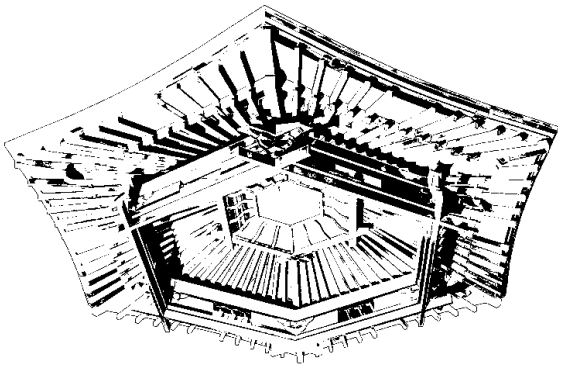
(9a) Roof - engineering drawing



(9b) Roof - wire frame 3D CAD model



(9c) Roof - false color CAD Model



(9d) Roof - Rendered 3D CAD model, seen from below

The wire frame model can be rendered to provide pleasing or photo-realistic views of the roof, or can be displayed using "false color" to emphasize structural elements with similar functions. In addition, the single 3D model can be displayed from various angles and points

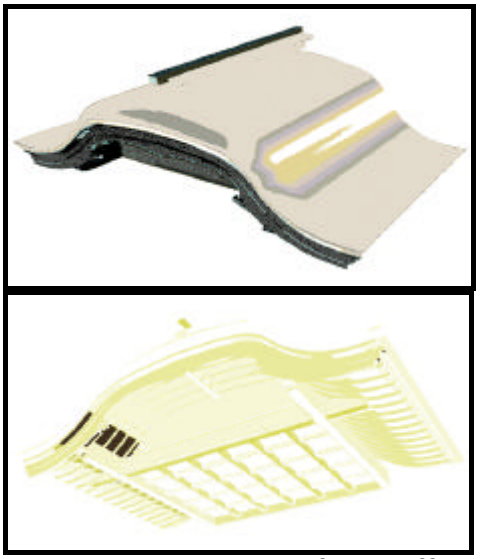
of view in either the wire frame or rendered versions, enabling a better understanding of the structure.

Modeling the Entrance Canopy

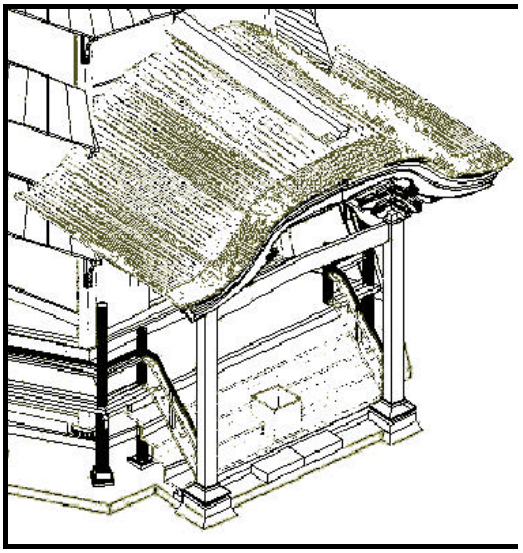
The entrance and its canopy are structures which again can be better understood from the model than from a photograph (figure 10a) or even from a visit to the actual site, since they are complex objects and access and sightlines are restricted.

(10a) Entrance canopy - photograph

(10b) Entrance canopy - wire frame CAD model



(10c) Entrance canopy from different angles

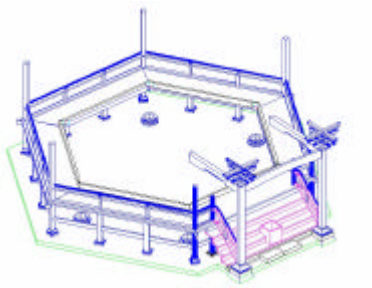


(10d) the canopy attached to the building

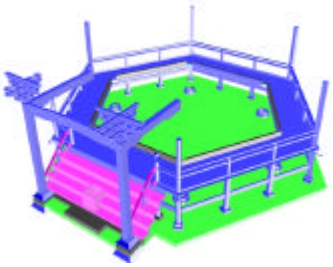
It is possible to select only one section from the single CAD model of the entire structure, and display it from multiple viewpoints and with various levels of detail.

The Base

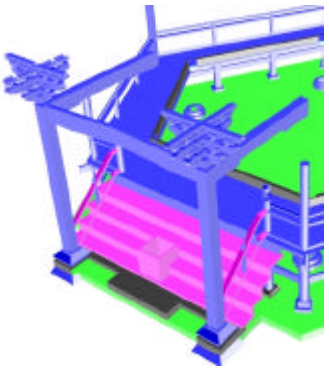
The following models of the base show how one can "zoom" in to explore selected features in detail. Even features which are inaccessible in the actual building because they are obscured by other components can be viewed and studied.



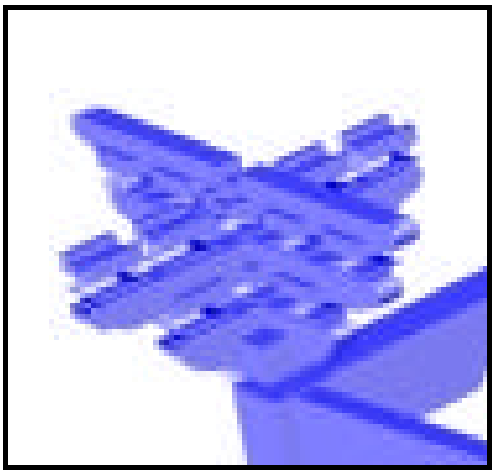
(11a) Wire frame of the base



(11b) Colorized CAD model of the base



(11c) Base - detail of the supports



(11d) Support detail.

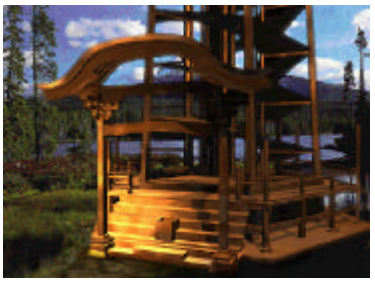
(11e) Photographic closeup of support

Figure 11 shows the model of the base in various degrees of detail. Comparison of a photograph of part of the support structure (figure 11e) with the 3D model (figure 11d) shows how much information can be gained from images of the 3D model. It should be noted that figure 11d is just a blowup of 11b, causing "zooming blur". If we had, instead, re-rendered that portion of the model, no blur would occur.

Settings

A 3D model can also be placed in a variety of real or imagined settings. For example, one might wonder what a Japanese building would look like in Yosemite or Death Valley!

(12a) Wood look 3D CAD model rendered without walls



(12b) An artist's view of the same rendered CAD model in an artificial setting

(12c) The rendered model showing helical structure

The Full Model

When rendered, the full model presents a detailed view of the actual structure.

(13) The full model: Rendered with wood texture and frontal lighting

Changes in lighting while rendering (see figures below) can suggest how the building might look at at various times of day. When the images in figures are shown on the computer, the effects of lighting changes can be seen in animation.



3D Modeling and Computer Presentation: Important Issues

The benefits of using three-dimensional graphics techniques are obvious. First of all, such models can be manipulated to provide viewpoints from a number of possible angles. Rotating the models can provide a better understanding of the physical relationships of the components of the actual structure, as well as the construction techniques involved. Secondly, three-dimensional models can replicate the actual construction of the building itself, including features normally hidden to the eye, such as interior bracketing. The model can be deconstructed to reveal such hidden features.

Finally, by exploring a model through VRML or Java, the user can investigate features at many levels of detail, manipulate small objects, "walk through" interior space, and examine the effect of lighting on the structure's appearance. Although completely photorealistic models are extremely difficult to obtain, 3D techniques can provide a fuller view than even a series of photographs taken from different angles.

On the other hand, creating an accurate computer model is labor-intensive, requiring extreme care in the collection and manipulation of data. Nothing is more disconcerting than to construct a model that seems to fit together from one angle, only to discover when rotating it that the walls don't quite reach the floor. In the case of Sazaedō , the only way to guarantee that the data was accurate was to take measurements at the actual site. This was difficult and time-consuming, especially in the case of the interior walkway, made from boards which are all shaped somewhat differently from one another and thus had to be measured individually.

The creation of 3D computer models requires individuals with a variety of talents. In recreating historical sites, it is helpful to form a team of experts in fields such as art, architectural design, computer science, and history. In addition to the authors, our team includes Yamagishi Seiji (shrine and temple construction expertise), Jody Vilbrandt (photography, text preparation, and HTML editing), Turlif Vilbrandt (modeling and rendering), Yamadera Jun (computer expertise and assistance with local contacts) and Michael Cohen and Jens Herder (computer expertise).

Work was begun at the University of Aizu in Aizu-Wakamatsu, and was funded initially by Fukushima Prefecture. It has continued at Applied 3D in Eugene, Oregon, and in Los Angeles, as well as at the University of Aizu. The present work is being funded by the authors. Equipment and computer systems used include PCs for modeling and rendering, Macintoshes for presentations and Internet access, and Unix and Linux-based operating systems and work stations, also for Internet access. Continued Internet service has been provided by UCLA and California State University, Stanislaus.

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Carl Vilbrandt <carl@applied3d.com>

NOTES

[1]This document has been reproduced in Yamagishi Seiji, *Mukashi no hanashi*, Aizu-Wakamatsu City, 1996, p. 37.

[2]For a discussion of the benefits expected by pilgrims, see Ian Reader, "Pilgrimage as cult: the Shikoku pilgrimage as a window on Japanese religion," in P.F. Kornicki and I.J. McMullen, ed., *Religion in Japan: Arrows to heaven and earth*, Cambridge University Press, 1996, pp. 267-286.

[3]Yamagishi, *Mukashi no hanashi*, pp. 36-37.

[4]Photograph courtesy of Yamagishi Seiji.

[5]This drawing and the other engineering drawings in the paper were done by Prof. Kobayashi Bunji of Nihon University in 1965.

[6]Kobayashi Bunji, "Rakanji Sansō dō kō," *Nihon Kenchiku Gakkai Ronbun Hō dō kokushū* 130 (12/1966); Timon Screech, "The Strangest Place in Edo: The Temple of the Five Hundred Arhats," *Monumenta Nipponica* 48:4 (Winter 1983).

[7]Kobayashi Bunji, "Aizu Sazaedō no genryū --barokku to Edo kenchiku," *Asahi Shinbun*, 1972/20/11.

[8]*Mukashi no hanashi*, p. 34.