In Search of a Future for the Past:

Use of Digital Technology in Preserving a Twentieth Century Legend

Shamim Javed[1], Robert P Schubert[2], Ki-Hong Ku[3]

[1] PhD Program, School of Architecture + Design
[2]Professor / Associate Dean for Research, College of Arch & Urban Studies
[3]Assistant Professor, Myers-Lawson School of Construction
Virginia Tech, Blacksburg, Virginia, USA

Abstract

The Rice House by the West coast architect Richard Neutra is the only example of Modern Movement's International Style residence in the city of Richmond, Virginia. Built less than fifty years ago, its inclusion in the National Registry of Historic Places testifies to its importance. The present research is an ongoing effort to document and analyze the existing condition of the house and suggest to its current owner, the Science Museum of Virginia, strategies for its renovation that would ensure a viable future for this house without destroying its architectural characteristics.

This paper specifically looks at the tools and techniques used for documenting and analyzing the Rice House. 3D laser scanning is used to document the physical characteristics of the building. The paper compares this technique with solid modeling of the house using other software to show the strengths and weaknesses of 3D laser scanning as a documentation tool for buildings. The use of thermal imaging to identify points of heat-loss from the building, combined with recordings of its temperature and humidity levels using portable data-loggers was used to provide data for energy-modeling software to evaluate solutions to improve the overall energy performance of the Rice House. The paper ends with a summary of 'lessons learned' based on this on-going research activity to ensure a future for this beautiful past – lessons that may well inform preservation efforts of similar icons of twentieth century architecture.
.

***Key words**: 3D Laser Scanning, Thermography, Data Logging, Computer Simulation*

1 Introduction

There has been a growing movement to preserve twentieth century modern architecture in recent years. The web site for the Tenth International Docomomo Conference states, "The legacy of the modern movement has gained legendary status, largely as a result of the appreciation of the masterworks and the visionary architectural concepts…the icons amongst these have even become so precious that they are treated like pieces of art rather than as buildings in everyday use."

Recently Robert Venturi's Libb House was moved from the Barnegat Light, NJ to Glen Cove, NY (see fig. 1) on Long Island to ensure its future when developers wanted to build anew on its original site.

Figure 1. Robert Venturi's Lieb House: Change of Address, Mar 11 2009 - Mar 18 2009, from Barnegat Light, NJ to Glen Cove, NY on Long Island (Source:http://www.storefrontnews.org/exhib_dete.php?exID=150)

The National Trust for Historic Preservation, a private, nonprofit membership organization dedicated to saving historic places, reports in their web site, “Our acquisition of the Philip Johnson Glass House in 1986 and the multimillion-dollar purchase of Mies van der Rohe’s Farnsworth House in 2003 testify to our commitment to preserving, protecting, and promoting works of the Modernist Movement. Pulitzer Prize-winning architecture critic Paul Goldberger noted that these two residences, in Connecticut and Illinois, respectively, “are arguably the most important modern houses in America.”

The Rice House by the West coast architect Richard Neutra (see fig. 2) is the only example of the Modern Movement’s International Style residence in the city of Richmond, Virginia. Recently gifted by its former owner to the Science Museum of Virginia and is intended to be used as a scholars’ residence for their visitors. Virginia Tech has joined this effort to preserve this icon of Modern Architecture by helping the current owner strategize renovation efforts that would make it more energy efficient.

Figure 2. The Rice House exterior.

2 The Rice House:

While less than a twenty minutes drive from downtown Richmond, the Rice House has a setting completely off the beaten path. It is set on Lock Hill above the banks of James River, cusped in the sound of the Williams Dam to its south, and railway tracks on the north (see fig. 3). Richard Neutra, using a limited palate of materials: aluminum, glass, white marble, and stucco, created on this pristine site a house where the man-made and nature embrace each other. The tall floor to ceiling glass walls on the south, hovered by sweeping cantilever roofs, almost floating, brings the panorama of the James River deep into all public spaces inside. A mirror wall spanning two floors next to the minimalist stair and reflecting the river view, adds to this continuity of interior and the exterior space.

Figure 3. Rice House setting between the Williams Dam and the railway tracks on a bend on the James River.

In recognition to the significance of the Rice House, it was placed in the National Register of Historic Places in 1969. The nomination document for the purpose says:
“The Rice House vividly incorporates the architectural features and elements Neutra had employed and refined throughout his distinguished architectural career. Though less than a half century old, this property warrants listing because of its exceptional architectural significance in a city whose residential character is dominated by late-Victorian town houses and Colonial Revival neighborhoods. To ensure preservation of the house and its natural setting, Ambassador and Mrs. Rice donated the property in 1969 to the Science Museum of Virginia Foundation [retaining life tenancy].”

When Mrs. Rice permanently moved out of the Rice House in January 2008, giving complete custody of the property to the Science Museum of

Virginia, the Museum Foundation promptly appointed a Rice House Project Team and an Advisory Team. Virginia Tech was represented on the Advisory Team and brought a team of faculty and students to assess the property for the necessary renovation to ensure its continued preservation in the spirit of the donation the original owners had made.

3 Preservation Strategy:

The team from Virginia Tech working on this project has selected five tools that would help them develop a plan to ensure the physical and economic future of the Rice House. These include:

A. 3D Laser Scanner: to document the context of the house
B. Thermography: for heat-loss and moisture penetration studies
C. Data Logger: for indoor thermal comfort study
D. Computer Simulation: for optimization of renovation strategies
E. Proposed Cave Collaborative Console: as a virtual collaboration tool in the preservation effort.

3D Laser Scanner:

Methodology:
The Rice House was scanned with a Faro LS480 laser scanner inside and out over two days on 14-15 November 2008 (see fig. 4). Spherical registration marks were used to match different scans to create a 3D continuous image of the exterior and interior spaces. This post-processing work was done using '**Faro Scene**' and '**Pointool**' software.

Results:
There were some issues with the setting up and calibration of the equipment that resulted in less-than perfect recording of the scenes. In the interior scans in particular some 'tearing' of data were observed.

Comments:
In this first attempt at scanning the house the color capture features of the laser scanner was left out. We hope to overcome this and other shortcomings in the use of this tool in future applications at the Rice House.

Figure 4. High resolution scan of the 'object of interest' after low resolution over all scan (top). An example of post-processing (bottom).

Thermography:

Methodology:
About 6:00pm on Thursday, 26 March 2009, some thermographic images were taken of the Rice House (see fig. 5). It was a fairly warm afternoon, as can be guessed from the temperature of the shrubs registering around 62 deg. F.

Results:
It was found that the windows from the Kitchen / Pantry space were showing a greater heat flow in comparison to other surfaces. There was heat leakage from the Guest Room sliding doors on the north wall as well.

Comments:
Monitoring of concurrent indoor air temperature would give greater meaning to the data collected with thermography.

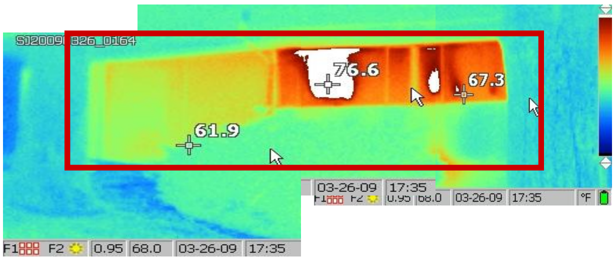


Figure 5. Thermography of a portion of the north wall showing high heat-loss from the kitchen window.

Data Logger:

Methodology:
For a 24 hour period, beginning 4:00pm of Friday, 14 November 2008 seven temperature reading data-loggers were placed at various interior locations in the Rice House (see fig. 6). An eighth data-logger was placed outside to record ambient conditions over this same period.

Results:
Preliminary analysis of the recorded data shows over-heating in the kitchen / pantry area supporting results from thermography.

Comments:
We lacked sufficient number of humidity and daylight sensing data-loggers to provide comprehensive coverage in all thermal zones. Use of these in future assessments can yield valuable date to optimize energy use.

Figure 6. Data logger deployment indoor.

Computer Simulation:

Methodology:
The Home Energy Efficient Design (HEED) program developed by the U.S. Department of Energy's Energy Efficiency and Renewable Energy (EERE) program was used to simulate various 'what if' scenarios for renovation strategies.

The steps followed were:

a. With only four inputs from the user (building type, square footage, location and number of stories) the program generates 'scheme-1' which is just a square box with equal amount of windows on all sides but which still meets progressive California energy codes.

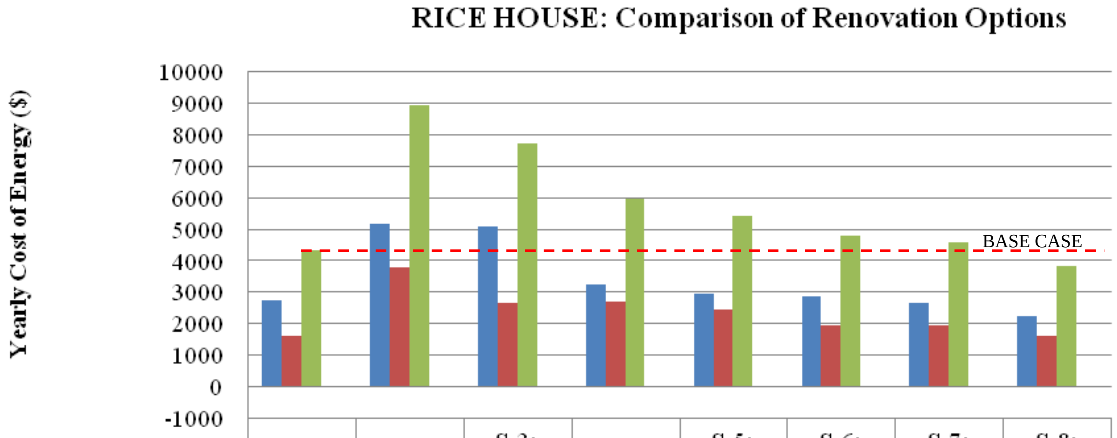
b. This base building is next modified to represent the Rice House 'as is' today calling it 'scheme-2'.

c. Next, progressive upgrading of scheme-2 was done, resulting in improved energy efficiency, until a scheme was reached which was better than the base-case scheme-1.

d. The renovation strategies, in the order of their application, are:
   - High-efficiency windows
   - Interior Shading
   - Roof Insulation
   - Weather Stripping
   - Natural Ventilation
   - High-performance HVAC Equipment

Results:
As can be seen in the graph (see fig. 7) on the next page compared to the 'base-case' scheme-1 (S-1):

- The present Rice House (S-2) is coming out to be 106% less efficient.
- Adding high-performance windows decreases the inefficiency to 78% (S-3).
- Adding interior shading to S-2 (cumulative) brings inefficiency to down to 37% (S-4).



	S-1: Meets Energy Code	S-2: Best Guess Existing	S-3: Add High Perf. Window	S-4: Add Interior Shading	S-5: Add Roof Insulation	S-6: Add Weather Stripping	S-7: Add Nat. Ventilation	S-8: Add Better Furnace & AC
Yr. Cost: Electric ($)	2739	5187	5075	3261	2967	2870	2665	2227
Yr. Cost: Gas ($)	1612	3778	2667	2693	2454	1928	1939	1601
Yr. Cost: Energy ($)	4351	8965	7742	5954	5421	4798	4604	3828
Savings Comapre to Scheme-1:		-106%	-78%	-37%	-25%	-10%	-6%	12%

Figure 1: Graph showing progressive improvement in energy performance of the building with application of various efficiency measures.

- By adding roof insulation (S-5), weather stripping (S-6), natural ventilation (S-7) and high-performance heating and cooling equipment (S-8) we can finally make the building 12% better than the base-case, code-compliant, model of S-1.

Preliminary Findings:

As owner/custodian of the Rice House, the Science Museum of Virginia, Richmond has in their possession a precious piece of history that continues to appreciate in value with the growing interest in preservation of the recent past. As well-put in a recent video from the National Trust for Historic Preservation[4] "Unless history lives in the present ...it has no future", the survival of the Rice House depends on its continued use.

Towards this goal the following observations are listed, regarding our efforts to date:

1. A variety of state-of-the art tools have been tried in documenting and analyzing the present state of the Rice House.

2. We are at the beginning stage of the learning curve in proficient application of these sophisticated tools for diagnostics and treatment of historic buildings. Continued application of these tools on the Rice House should yield more accurate results in the future.

3. The confidence-level with the results obtained so far would improve significantly if: (a) accurate knowledge of existing condition of the Rice house can be ascertained more accurately, specially, regarding the thermal performance of the various components of the building's envelop, (b) historical data of the energy use of the building is available and (c) additional details on its HVAC systems and appliances is gathered.

4. Repetition of the analysis performed and cross-checking of their results with new analysis tools shall improve the reliability of suggestions.

5. Incorporation of the 'life-cycle cost' component to the analysis results shall assist in making hard choices amongst renovation strategies with limited resources easier.

Suggested future course of action:

1. Conduct a workshop / field study to document and evaluate the existing condition of the Rice House. This would be comprised out of a group of graduate students from Virginia Tech with armed with necessary drawings and instruments, assisted by industry experts from the manufacturers/suppliers of building analysis tools and preservation specialists.
2. Based on this analysis and in consultation with local builders, the group would then formulate strategies for the preservation of the Rice House, incorporating the 'live-cycle cost' component in their recommendation.
3. A Blower-Door Testing would be carried out on the Rice House to assess the 'air infiltration rate' through its skin.

Actionable Items:

1. Roofing membrane be replaced with a light colored variety (higher reflectance) to stop rain-water penetration and decrease cooling load. Adding insulation to the roof cavity during this renovation would be a smart choice and decrease heat loss in the winter.
2. All window areas be replaced with clear-glass, double-pane, argon filled glazing in thermally broken aluminum frames to increase insulation value of the glazed area and decrease infiltration (informed by life-cycle analysis).
3. Visually discrete, movable interior shading on glass areas be added to lessen heat-gain in the summer.
4. Once the current heating and cooling equipment reaches their useful life, it is suggested they be replaced with high-efficiency models incorporating 'heat-recovery' feature from exhaust air.

Acknowledgements

This study could not have been possible without the support and encouragement of the Members from The Science Museum of Virginia Foundation.

Bibliography

FARO Scene: high performance 3-D point cloud software
http://www.faro.com/content.aspx?ct=ENG&content=pro&item=5&subitem=48 (accessed May 21, 2009).

HEED (Home Energy Efficient Design).
www.aud.ucla.edu/heed (accessed May 21, 2009).

International Committee for Documentation and Conservation of Buildings, Sites and Neighbourhoods of the Modern Moverment: Tenth International Docomomo Conference.
http://www.docomomo.com/conferences.htm (accessed May 21, 2009).

National Trust for Historic Preservation.
http://www.preservationnation.org/issues/modernism-recent-past/ (accessed May 21, 2009).

National Trust for Historic Preservation.
http://www.preservationnation.org/issues/11-most-endangered/ (accessed May 21, 2009).

POINTOOLS: High performance point cloud software
http://www.pointools.com/

United States Department of Natioinal Park Services: National Register of Historic Places Registration:
http://74.125.45.132/search?q=cache:WlFylOoXdL4J:www.dhr.virginia.gov/registers/Cities/Richmond/127-5810_Rice_House_1999_Final_Nomination.pdf+rice+house+richard+neutra&cd=6&hl=en&ct=clnk&gl=us
(accessed May 21, 2009).