CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER

SPRING 2022

CONSERVATION OF EARTHEN ARCHITECTURE

Getty Conservation Institute

A Note from the Director

Photo: Anna Flavin, GCI.

In June this year, Terra 2022, the 13th World Congress on Earthen Architectural Heritage, takes place in Santa Fe, New Mexico. Organized by the GCI, the National Park Service's Vanishing Treasures Program, and the University of Pennsylvania's Stuart Weitzman School of Design—and under the aegis of the ICOMOS International Scientific Committee on the Conservation of the Earthen Architectural Heritage—Terra 2022 will focus on the latest research and best practice in the study and conservation of earthen built heritage.

The extent of that heritage is vast. Consider just those earthen heritage sites internationally recognized—about 10 percent of the cultural sites on the World Heritage List are made of earth. And the world's earthen architectural heritage extends well beyond places on the List, running the gamut from churches and forts to homes and human settlements in Africa, the Middle East, Asia, Europe, and the Americas.

For decades now, the GCI has engaged in research and field projects related to the conservation of earthen architecture. My GCI colleague currently leading that work is Claudia Cancino, a senior project specialist in the Buildings and Sites department and the author of the feature for this edition of *Conservation Perspectives*. In her article, Claudia charts the development of earthen architectural conservation, highlighting some of the people and organizations that have endeavored to bring attention and research to the preservation of this segment of the world's built heritage. She also suggests further work that can and should be undertaken to build on that half century of effort.

In his article on education in the conservation of earthen architecture, GCI project specialist Benjamin Marcus reviews education efforts that began in the 1970s and explores the challenges and opportunities that lie ahead in providing professionals the specific skills needed to preserve our earthen built heritage. In another article, Soumyen Bandyopadhyay, the Sir James Stirling Chair in Architecture at the University of Liverpool, traces the development of the conservation of historic earthen architecture in Oman and then explores in more depth conservation and adaptive reuse in Omani historic settlements constructed with earth.

Offering us examples of how up-to-date engineering techniques are helping to characterize the condition of earthen structures is Rafael Aguilar, a professor in the Department of Engineering at the Pontificia Universidad Católica del Perú, who has been part of a team applying these techniques to adobe buildings in his country. And in our roundtable, conservator Angelyn Bass, archaeologist Annick Daneels, and architectural engineer Aqeel Aqeel discuss the challenges in conserving and preserving that particularly vulnerable earthen heritage—earthen archaeological sites.

Working with *Conservation Perspectives* editor Jeffrey Levin as guest coeditors on this edition were his GCI colleagues, Claudia Cancino, Benjamin Marcus, and Leslie Rainer.

The use of earth for construction is both practical and apt. It's practical because it's an abundant and inexpensive building material. And it's apt because an earthen structure is composed of the very material upon which it stands. That our built earthen heritage continues to stand—now and in the future—is a responsibility we all should share.

Timothy P. Whalen

John E. and Louise Bryson Director

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Contents

CONSERVATION OF EARTHEN ARCHITECTURE

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ON THE COVER

Kasbah Ait Hammou Ou Said in Morocco's Draa Valley. The valley is home to a large number of earthen architectural heritage sites. Photo: Scott S. Warren, for the GCI.

Read this issue and more online at **getty.edu/conservation**.

FROM VISIONARY LEADERSHIP

Over Fifty Years of Earthen Architecture Conservation

More than five decades have passed since the first discussions between colleagues working on the conservation of earthen heritage sites took place internationally. This milestone is an opportunity to celebrate the field's achievements but also to reflect on its history.

BY CLAUDIA CANCINO

Earthen site conservation has grown into a complex field of study. Early efforts to design technical solutions to preserve the material for its cultural significance evolved into the development of more holistic conservation approaches, including the management of archaeological sites, historic environments, and cultural landscapes. Because earth is a universal and ubiquitous construction material, earthen site repair for and *by* communities has always been an important part of its preservation.

All of this was not addressed initially. It took—and still takes—visionary professionals who carry out exemplary implementation projects and groundbreaking research, and lead international, regional, and local organizations to broaden the field of earthen heritage conservation. It is impossible to mention all the organizations and individuals who have enriched this field and all the implementation projects and research conducted worldwide in the last fifty years. Those I have selected have had a major impact in moving the field forward by addressing its challenges.

ORIGINS

The establishment of UNESCO at the creation of the United Nations resulted from the need to repair sites damaged during and after the First and Second World Wars. In 1956 the UNESCO General Conference in New Delhi embraced a proposal to create an intergovernmental center to study and improve restoration methods; thus the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) was born.[1] This was followed in 1964 by the Second International Congress of Architects and Technicians of Historic Monuments, held in Venice, which adopted the International Charter for the Conservation and Restoration of Monuments and Sites, better known as the Venice Charter. A second resolution, proposed by UNESCO, to create the International Council on Monuments and Sites (ICOMOS) to implement its charter worldwide, was also adopted.

The first ICOMOS General Assembly was held in Cracow, Poland, in 1965, where Piero Gazzola was elected its first president. According to Raymond Lemaire, Gazzola was one of the main promoters of international collaboration and scientific training for conservation specialists;[2] according to Giorgio Torraca, vice-director of ICCROM at the time of the General Assembly, the first activities in the field of the conservation of mud-brick monuments should be credited to him.[3]

Another visionary of the significance of earthen architecture was Belgian architect Jean Dethier, author, curator, and stage designer of architectural exhibitions at the Centre Pompidou in Paris from 1975 to 2005. In 1965 Dethier began a one-year study trip in North Africa and ended up staying for four more years, in Morocco, working for the Ministry of Housing and Urbanism and UNESCO on different projects, including the rehabilitation of the earthen village of Tissergate in the Draa Valley.[4] In 1981 Dethier curated the exhibition *Down to Earth*, dedicated to earthen architecture, which included three segments: a world survey of "ancient and vernacular" heritage; a summary of effective but disregarded examples of best practice in the conservation of earthen sites; and finally an appeal to focus on contemporary ecological architecture by using earth as a building material. Dethier continued this plea with his 2020 publication, *The Art of Earthen Architecture*.

1. ICOMOS, *International Council on Monuments and Sites 1964–1984* (Naples, Italy: ICOMOS, 1984).
2. Raymond Lemaire, "Report of the President of ICOMOS, Piero Gazzola, 1965–1975: A Tribute to Piero Gazzola," in *Scientific Journal: Thirty Years of ICOMOS* (Paris: ICOMOS, 1995), 88.
3. Giorgio Torraca, "Introduction," in *Third International Symposium on Mud-Brick (Adobe) Preservation, 29 September–4 October, 1980* (Ankara, Turkey: ICOM, ICOMOS, and Turkish National Committees, 1980), vi.
4. Ulf Grønvold, "Architecture at the Pompidou: Jean Dethier Interview," *Om Arkitektur* (May 2012).

TO A FIELD OF STUDY

The annual community maintenance of the earthen Great Mosque of Djenné in Mali, in 2006. Photo: Jeanne Marie Teutonico, GCI.

CONFERENCES, COURSES, AND ORGANIZATIONS THAT SHAPED THE FIELD

Believing that the exchange of ideas at the international level would benefit the field, Piero Gazzola became a big supporter of the First International Symposium on the Conservation of Mud-Brick Monuments, held in 1972 in Yazd, Iran. At the conference, ten papers on the conservation of mud-brick sites in different countries and a section on Iranian mud-brick monuments were presented.

The same year, Hugo Houben—later founder of CRAterre—participated in the construction of several hundred houses for a village in Algeria. Through that experience he recognized earth as a significant and sustainable construction material and began his research on the topic, seeking to publicize what appeared to him an appropriate response to ecological problems.[5]

In 1975 Sylvio Mutal, regional coordinator of the PNUD/UNESCO Proyecto Regional de Patrimonio Cultural y Desarrollo, organized four courses on the conservation of monuments in Cusco, Peru,[6] and some of the instructors in the first course participated in the Second International Symposium on the Conservation of Mud-Brick Monuments in 1976, again in Yazd. This symposium included papers on the conservation of earthen sites in Peru by Giacomo Chiari and José Correa Orbegoso, wattle and daub conservation by John Warren, and conservation work at Lothal, India, by R. Sengupta, among others.

In 1979 the Center for the Research and Application of Earth Architecture (CRAterre-ENSAG) was born after a meeting between Hugo Houben and Patrice Doat, a student at the École Nationale Supérieure d'architecture de Grenoble (ENSAG).[7] Coincidentally, also in 1979, Alejandro Alva, a participant in the 1976 UNESCO/PNUD course in Cusco, Peru (his country of origin), was hired as a staff member of ICCROM and assistant coordinator of the Architectural Restoration Course (ARC).[8] That same year, the International Committee for the Conservation of Mud-Brick (later the International Scientific Committee on Earthen Architectural Heritage—ISCEAH) was created, and its first president was archaeologist Cevat Erder, later ICCROM General Director (1981–88).[9]

At the Third International Symposium on Mud-Brick (Adobe) Preservation, organized in 1980 in Ankara, Turkey, papers were presented by some previous symposium participants and new experts, including Alejandro Alva, Anthony Crosby, Constance Silver, and

5. UNESCO World Heritage Convention, "In Memoriam: Hugo Houben (Founder of CRAterrre)," UNESCO World Heritage Convention News (2021), https://whc.unesco.org/en/news/2255.
6. Proyecto Regional de Patrimonio Cultural UNESCO/PNUD, *Cursos de Restauración de Monumentos: Conservación de Centros-Sitios Históricos, Documento Sumario Cusco 1975–78* (Lima, Peru: UNESCO, 1979).
7. Terra 2022, "January 2022 Virtual Lead-Up Event, Earthen Architectural Heritage: CRAterre's Vision and Practices," https://www.terra2022.org/website/8033/eng/virtual-events-january/.
8. Jukka Jokilehto, *ICCROM and the Conservation of Cultural Heritage. A History of the Organization's First 50 Years, 1959–2009, ICCROM Conservation Studies* 11 (Rome: ICCROM, 2011), 84.
9. ICOMOS, 34.

Group photo of participants in the Terra 2008 Conference, held in Bamako, Mali. This was the first Terra Conference in Africa, and it convened over 450 specialists in fields linked to the conservation of earthen architecture. Photo: J. Paul Getty Trust.

Roberto Samanez. Some of these papers grew out of research conducted in response to a series of questionnaires prepared and delivered by Giorgio Torraca at the first and second symposia with the intention of identifying areas for further study, such as materials testing. In 1977 a regional meeting on adobe preservation was organized in Santa Fe, New Mexico, by US/ICOMOS, which was attended by several laboratory experts. A third questionnaire was circulated with the objective of promoting testing of the materials and standardization of testing procedures.

After the success of its courses in Cusco, the PNUD/UNESCO Proyecto Regional de Patrimonio Cultural y Desarrollo organized a fourth symposium in Peru in 1983, in collaboration with ICCROM, the Instituto Nacional de Cultura del Perú (INC), the UNESCO World Heritage Centre (WHC), the Ford Foundation, ICOMOS, and the Italo-Latin American Institute. This international symposium included a training workshop on the conservation of adobe and a traveling exhibition about adobe in the Americas and around the world. Jeanne Marie Teutonico, Franca Helg, Seymour Lewin, Ricardo Morales Gamarra, Gilberto Reyes, Sergio Rojo, Todd Rutenbeck, Paul Schwartzbaum, André Stevens, Jacques Vérité, and Julio Vargas (who introduced the topic of conservation of earthen sites in seismic regions) presented papers.

In 1984 CRAterre-ENSAG started its two-year Diplôme National de Spécialisation et d'Approfondissement en Architecture (DSA), and two years later it created its research laboratory. Alejandro Alva and Hugo Houben met during the mid-1980s, and in 1987 they coordinated the Fifth International Meeting of Experts on the Conservation of Earthen Heritage (no longer just mud-brick), which was held in Rome. The Getty Conservation Institute (GCI), represented by Frank Preusser and James R. Druzik, presented the GCI and Queensland Museum laboratory research program results on several techniques and materials for the preservation of archaeological and historic adobes. The Queensland Museum was represented by Neville Agnew (currently a GCI senior principal project specialist).

In 1989 ICCROM signed an agreement with CRAterre-ENSAG to develop a long-term program for the preservation of the earthen architectural heritage, known as the GAIA Project.[10] The agreement resulted in over five years of cooperation between the institutions for the development of postgraduate training courses on earthen conservation at ENSAG and as part of the Architectural Conservation Course (ARC) at ICCROM. Under the coordination of Alva and Houben, the First Pilot Course on the Preservation of Earthen Architecture took place in Grenoble in late 1989. Other instructors of the course included Patrice Doat, Hubert Guillaud, Thierry Joffroy, Pascal Odul, Jeanne Marie Teutonico, and Marina Trappeniers.

After participation in the Fifth International Meeting, the GCI, with New Mexico State Monuments and the US National Park Service—and joined by ICCROM and CRAterre-ENSAG—organized in 1990 the Sixth International Conference on the Conservation of Earthen Architecture in Las Cruces, New Mexico, known as Adobe 90. Adobe 90 helped develop what had been relatively small and specialized meetings of experts into truly international conferences, greatly expanding the number and geographic distribution of participants and papers and producing substantive publications that helped validate the work of the field. The next conference in 1993 in Portugal published over one hundred papers. Additionally, targeted symposia were organized to address specific issues. Two organized by GCI staff included the Conservation of

10. Jokilehto, 98.

Decorated Surfaces on Earthen Architecture (DSEAC) in 2004 at Mesa Verde National Park (under the leadership of Leslie Rainer) and the GSAP colloquium at the Getty Center in Los Angeles in 2006 (under the leadership of Mary Hardy). To date, twelve international conferences have strengthened collaboration, created regional networks, generated partnerships, and produced proceedings. The GCI has organized the Thirteenth Congress, to be held in Santa Fe, New Mexico, in June 2022 in collaboration with the Vanishing Treasures Program of the National Park Service and the University of Pennsylvania, Stuart Weitzman School of Design.

The second phase of the GAIA project (1989–95) included development of an international bibliography on the preservation and rehabilitation of earthen architecture.[11] In 1996 the GCI—under the initiative of Erica Avrami—joined GAIA, and the TERRA project was born. The three institutions then organized the 1996 and 1999 Pan-American Courses on the Conservation and Management of Earthen Architectural Heritage (PAT) in Trujillo, Peru, in collaboration with INC-La Libertad, led by its director, Ana María Hoyle.[12]

The international symposia, conferences, and congresses organized to date, as well as training courses like the PAT, have strengthened collaboration and created international, regional, and local networks, such as ISCEAH, Proterra, and Mediterra. In 1994 John Hurd and Pamela Jerome, each with international expertise on the conservation of earthen sites, were elected president and vice president of ISCEAH, respectively. During their tenure, they reshaped the committee and over nine years developed five themes to further advance research (in use, archaeology, technology, landscapes, and seismic). Julio Vargas (2015–17), Mariana Correia (2018–20), and Maddalena Achenza (2021–present) have followed in leading the committee, which has played an important role in sponsoring what are now called Terra World Congresses.

In 1998 UNESCO created the chair on Earthen Architecture, Constructive Cultures, and Sustainable Development, a network of more than forty institutions (including universities, research centers, and NGOs) in Africa, the Americas, Asia, and Europe, and managed by the Architecture, Environment & Constructive Cultures Research Unit at ENSAG. The main objective of the UNESCO chair is to promote within the international community the development and dissemination of scientific and technical knowledge for the conservation of earthen architecture.[13]

Participants at the 6th International Conference on the Conservation of Earthen Architecture, held in 1990 in Las Cruces, New Mexico, examining test panels. Known as Adobe 90, the conference marked the transition from relatively small, specialized meetings into truly international conferences, greatly expanding the number and geographic distribution of participants and papers. Photo: Neville Agnew, GCI.

11. CRAterre/EAG/ICCROM, *Bibliographie sur la préservation, la restauration et la réhabilitation des architectures de terre/Bibliography on the Preservation, Restoration, and Rehabilitation of Earthen Architecture* (Rome: ICCROM, 1993), https://www.iccrom.org/sites/default/files/2018-02/1993_bibliographie_terre_56802_light.pdf.
12. Jokilehto, 112–13.
13. https://terra.hypotheses.org/.

INTERNATIONAL PROJECTS AND WORLD HERITAGE EARTHEN SITES

The first implementation project to include international cooperation was carried out by ICCROM under the sponsorship of Piero Gazzola. In 1968 ICCROM launched a project for testing preservation techniques for mud-brick structures, which continued into the 1970s, in cooperation with the Institut royal du Patrimoine artistique in Belgium and the Institute of Mineralogy and Archaeology of the University of Turin. Laboratory testing took place in Brussels, and field tests were conducted at the Samarra and Choche archaeological sites, the ziggurats of Ur and Aqar Quf, and Tell Omar in Iraq, in collaboration with the department of antiquities. The first phase was concluded in 1972 at the time of the Yazd conference.[14]

With the success of the Iraqi project, the resolutions of the 1976 Second International Symposium encouraged further development of pilot projects. These were carried out between 1976 and 1980 at the archaeological site of Chan Chan in Peru, and at the Spanish Colonial Mission San José of Tumacácori in Arizona. There is little information about the work at Chan Chan during this period, but a paper about work done at Tumacácori was presented at the 1980 symposium.

The development of international projects focused on earthen heritage sites reflects the nomination of such sites to the World Heritage List, a process that normally involves study of the site and preparation of a management plan. Currently there are 89 earthen sites out of the 897 sites on the World Heritage List—10 percent. Of the 52 sites on the list considered endangered, 14 are made of earth—27 percent. The first earthen sites nominated and declared World Heritage Sites were the City of Quito in Ecuador and Mesa Verde National Park in Colorado, both inscribed in 1978. The year the greatest number of earthen sites were nominated was 1987 (probably in part because five international symposia had occurred by then) with a total of seven nominations, from Bolivia, China (two), Mexico (two), Morocco, and Oman. The earthen site most recently nominated was Babylon in Iraq in 2019.[15]

The Mogao Caves in Dunhuang, China, was one of the sites nominated in 1987. The GCI started working in the early 1990s on site stabilization at Mogao, where windbreak fences were installed to mitigate windblown sand, and monitoring of both environmental and color stability of the earthen wall paintings was carried out. During the 1990s, the GCI also conducted the Getty Seismic Adobe Project to develop and test minimally invasive and easily implemented techniques to avoid the collapse of historic earthen structures during seismic events. These techniques were later implemented at Rancho Camulos and Casa de la Torre in California.

The Elamite holy city of Tchogha Zanbil in Iran was nominated in 1979. In 1995 the Cultural Heritage Division at UNESCO sent a team of experts to the site, launching the conservation of Tchogha Zanbil in collaboration with the Iranian Cultural Heritage Organization (ICHO) and with the participation of CRAterre, led by Hubert Guillaud. Conservation work and regional training courses were carried out until 2002, resulting in a comprehensive action plan for the site.[16]

Two early leaders in the conservation of earthen architecture: Alejandro Alva (top), who spent more than twenty-five years at ICCROM, and Hugo Houben (bottom), a founder of CRAterre; both are seen here speaking at Adobe 90. Photos: Neville Agnew, GCI.

Also in 1995, the Center for Architectural Conservation (CAC) at the University of Pennsylvania, Stuart Weitzman School of Design—founded in 1991—initiated its long-term involvement with the US National Park Service, working at Mug House at Mesa Verde National Park in Colorado. The CAC, under Frank G. Matero, has worked at the archaeological sites of Casa Grande, Arizona; Bandelier and Fort Union, New Mexico; Catalhoyuk, Turkey; Cliff Palace, Long House, Farview House, and Spruce Tree House, Mesa Verde National Park, Colorado; and the historic Mission San José of Tumacácori, Arizona. Over twenty-five years, the CAC has developed model projects on earthen finishes, conservation praxis, laboratory testing, and management plans.[17]

The development of the Chan Chan management plan in 1996 is an early example of a holistic and comprehensive approach for the conservation of earthen archaeological sites. Led by Carolina Castellanos and Ana María Hoyle, it became a model for other earthen archaeological sites. This approach was implemented at Joya de Cerén in El Salvador by Françoise Descamps of the GCI, and at Tel Dan in Israel by Erica Avrami, also with the GCI. In 2006 Mohamed Boussalh from the Centre de Conservation et de Réhabilitation du Patrimoine Architectural Atlasique et Subatlasique—in partnership with CRAterre-ENSAG and with financial and technical support from the WHC—began developing an action plan for the Ksar of Ait-Ben-Haddou in Morocco,[18] followed by conservation interventions from 2016 to 2019.

In 2009 ICCROM, the WHC, and CRAterre-ENSAG launched an initiative in Africa. The Africa 2009 project—led by Lazare Eloundou Assomo, current WHC Director and ENSAG

14. Jokilehto, 49; Giorgio Torraca, "An International Project for the Study of Mud-Brick Preservation," in *Conservation of Stone and Wooden Objects: Contributions to the 1970 IIC Congress, New York* (London: IIC, 1971), 47–58.
15. https://whc.unesco.org/pg_friendly_print.cfm?cid=31&order=year.
16. Hubert Guillaud, Yasuyoshi Okada, and Abdolrasool Vatandoust, *Chogha Zanbil* (Paris: UNESCO, 2003); Junko Taniguchi and Farzin Fardanesh, "Tchogha Zanbil: Conservation Challenges of an Earthen Ziggurat Monument," in *World Heritage* 48 (Paris: UNESCO, January 2008), 36–41.
17. http://www.conlab.org/.
18. Mohamed Boussalh, "Ksar of Ait-Ben-Haddou: Hopes and Perils," in *World Heritage* 48 (Paris: UNESCO, January 2008), 19–25.

Participants in the 2004 Conservation of Decorated Surfaces on Earthen Architecture colloquium visiting Cliff Palace at Mesa Verde National Park in Colorado. Photo: Claudia Cancino, GCI.

alumnus—sought to improve conditions for the conservation of immovable cultural heritage in sub-Saharan Africa by integrating it into a sustainable development process. It aimed to create better policies and legal frameworks for conservation, increase professional capacity, and improve communication among African institutions working in the field. The project stimulated the development of a cross-continent network and produced several publications and conference papers.[19] A similar Central Asian Earth initiative was led by CRAterre-ENSAG from 2002 to 2012.[20]

After successful international collaboration in conservation projects, institutional endeavors have been carried out by CRAterre, the WHC World Heritage Earthen Architecture Programme (WHEAP), and the GCI's Earthen Architecture Initiative in Abu Dhabi, China, Iran, Mali, Morocco, Oman, Peru, Saudi Arabia, South Korea, Turkmenistan, and the United States, among others. The results of some of these projects have been published in scientific journals and international conferences.

WHAT IS NEEDED

Unquestionably, earthen built heritage conservation has advanced in the last fifty years. Research and field projects have demonstrated the importance of management planning, materials characterization, understanding of construction techniques, in situ and laboratory testing, and compatible materials for the conservation of earthen sites.

However, conservation approaches to address the preservation of vernacular earthen heritage, the impact of climate change on earthen sites, and conservation engineering or long-term maintenance and monitoring plans have not been fully developed. These topics are only now being addressed by the conservation field as a whole and by professionals working on earthen sites. Furthermore, few projects try to tackle earthen site conservation holistically.

International institutional collaboration has demonstrated that more can be achieved by working together. There are a great many national organizations that if united could initiate programs to take on challenges regionally. While individual projects can solve specific problems, it is important that the field first identifies what is needed to advance earthen site conservation and then promote projects to address those needs through research, implementation, training, and capacity building, as well as through the dissemination of relevant information. The Terra World Congresses are an opportunity to connect institutions internationally and to identify areas for further research.

It is important for ISCEAH to collaborate further with other international scientific committees, given that conservation of earthen sites doesn't occur in isolation and is normally combined with risk preparedness, wood conservation, vernacular architecture, or historic cities. ICOMOS is trying to facilitate collaboration between its scientific committees, and ISCEAH should seek to identify areas of common interest.

Although conservation projects generally have a process for implementation, there is a need to internationally adopt a specific process for earthen site conservation. Members of ISCEAH have been discussing the development of a charter that would contain such a methodology.

The role that visionaries played in the development of the field of earthen conservation has been extremely significant. Besides acknowledging their contribution, it is important to recognize that leadership is an attribute that needs to be passed along by each generation and that will continue to play an important role in the advancement of the field. Piero Gazzola, Jean Dethier, Hugo Houben, Alejandro Alva, Jeanne Marie Teutonico, and John Hurd, among others, were not accidentally at the right place at the right time. They *made* it the right place and time. They all had a vision that turned into projects, which then turned into work that institutions have carried out for decades. It is up to us to build on their legacy.

Claudia Cancino is a senior project specialist in the GCI's department of Buildings and Sites.

Kasbah Taourirt, headquarters of Centre de Conservation et de Réhabilitation du Patrimoine Architectural Atlasique et Subatlasique (CERKAS) in Morocco. CERKAS is a member of the UNESCO chair on Earthen Architecture, Constructive Cultures, and Sustainable Development—a worldwide network of more than forty institutions. Photo: Scott S. Warren, for the GCI.

19. Jokilehto, 132.
20. Hubert Guillaud, "A Global Challenge: Preserving Earthen Architecture," in *World Heritage* 48 (Paris: UNESCO, January 2008), 4–15.

ANCIENT TRADITIONS, MODERN EDUCATION

Capacity Building for Earthen Heritage Conservation

BY BENJAMIN MARCUS

BUILDING WITH EARTH IS AN ANCIENT PRACTICE that in most regions of the world has been passed down from one generation to the next through experience and oral tradition. While the transfer of knowledge often still relies on tradition, the links to the skills of the past have increasingly frayed because of greater reliance on contemporary building materials and technologies. Keeping earthen building traditions alive requires not only the preservation of traditional knowledge, but also formal training and education at the local level and within the context of communities, universities, vocational training, and other forms of capacity building and raising awareness.

This article examines education and training for the conservation of earthen architecture. While many institutions and specialty groups teach skills for constructing new buildings with earth, few delve into the conservation, maintenance, and management of historic earthen structures. Some of the actors, courses, and thematic trends in education and training for the conservation of earthen heritage are described here. Also highlighted are some of the gaps, along with suggestions for future directions and opportunities.

CONSERVATION COURSES

Beginning in the 1970s, a group of nonprofit, governmental, and academic institutions based in Europe and North America led the field in teaching both new construction and conservation of earthen heritage. More recently, the teaching of earthen architecture as a topic has grown to form a part of many university curricula, and training courses addressing aspects of earthen heritage can be found around the globe. However, comprehensive education covering the range of skills necessary for conserving earthen sites remains rare.

Since its founding in 1979, CRAterre-ENSAG in Grenoble, France, has promoted and taught the skills of earthen architecture, both new building and conservation. CRAterre's post-master's DSA (Diplôme National de Spécialisation et d'Approfondissement en Architecture) degree in Earthen Architecture, Building Cultures, and Sustainable Development is one of the world's only accredited programs fully devoted to earthen architecture. This program includes several modules on conservation and sustainable management of architectural, archaeological, and historical heritage, producing master's degree–accredited specialists equipped to address conservation issues in historic earthen buildings.

In collaboration with CRAterre, the Getty Conservation Institute (GCI) and ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) collaborated over many years to develop several courses for earthen heritage conservation. Beginning in the early 1980s with the Adobe '83 workshop followed by a pilot course in 1989 and three international courses in 1990, 1992, and 1994 (known respectively as PAT89, PAT90, PAT92, and PAT94), the partners attempted to address what was viewed as a global lack of opportunities for education in the conservation of earthen sites. These were followed in 1996 and 1999 by regionally targeted courses in Peru. More recently, ICCROM through its Sharjah, UAE–based ATHAR program has hosted professional short courses on conservation of earthen heritage and has offered a new master of science degree in cultural heritage management that incorporates into its teaching the earthen heritage of the region.

The GCI, with its more specific focus on the conservation of historic buildings and sites, has also recently organized dedicated training for the conservation of earthen heritage through the one-month International Course on the Conservation of Earthen Architecture, first held in Abu Dhabi and Oman in 2018 and organized in partnership with the Department of Culture and Tourism (DCT)—Abu Dhabi. In addition, the World Heritage Centre's World Heritage Earthen Architecture Programme (WHEAP), conducted between 2007 and 2017, aimed for the improvement of the state of conservation and management of earthen architecture sites worldwide, including supporting training and capacity building through conferences and courses, such as the regional site managers' workshop in Djenné, Mali.

Participants in the 2018 International Course on the Conservation of Earthen Architecture visit the earthen village of Al Sulaif near Ibri, Oman. Photo: Benjamin Marcus, GCI.

UNIVERSITY AND OTHER INITIATIVES

Beyond this group of largely nonprofit and governmental actors, universities play an important role in teaching about earthen architecture and its conservation. At the university level, earthen architecture often appears in the curricula of architecture schools as a sustainable, low-cost solution for residential construction. Of major importance is the UNESCO Chair, Earthen Architecture, Constructive Cultures, and Sustainable Development, inaugurated in 1998 by CRAterre in collaboration with the UNESCO Division of Higher Education.

The main goal of this UNESCO Chair is to accelerate the dissemination, within the international community, of scientific and technical knowledge on earthen architecture in environmental and world heritage, as well as human settlements and housing. The UNESCO Chair involves forty partners in twenty-three countries on five continents. However, the teaching of heritage conservation within these programs is limited, with greater emphasis placed on design and new construction. Similarly, programs devoted to conservation of built heritage or historic preservation often expose students to earthen materials, but rarely focus on the range of specific skills and techniques needed for holistically addressing earthen heritage.

At the university level, the University of Pennsylvania master's degree in historic preservation offers an overview of earthen architecture conservation, and students are exposed to earthen materials through practical site and laboratory work. At Tongji University's Architectural Conservation Laboratory in Shanghai, students gain practical experience with a variety of materials, including earthen materials and grouts. In addition to numerous research projects in earthen architecture, the Escola Superior de Galicia's Architecture degree has included courses such as Diagnosis and Intervention Technology for Conservation and Restoration, with a module focused on earthen architecture conservation practice. Also in Spain, the Universidad Politécnica de Valencia's Instituto Universitario de Restauración del Patrimonio houses the UNESCO Earthen Architecture Chair and initiatives such as SOStierra and ResTAPIA, which focus on cataloguing and preserving earthen heritage and include practical hands-on courses, as well as seminars and doctoral projects in conserving earthen heritage. At the University of Potsdam, students of general building conservation are offered an elective course on Earthen Building Conservation. Also in Germany, Bauhaus University in Weimar provides courses on damage, interventions, and rehabilitation of earthen buildings. In Sardinia, the University of Cagliari's department of engineering offers a master's degree in conservation of environmental and architectural heritage, with modules on the conservation of earthen heritage. In Morocco, l'Ecole Nationale d'Architecture in Marrakech (ENAM) offers education in preservation of built heritage, including seminars, conferences, and hands-on workshops on the conservation of the earthen *kasbahs* (citadels) and *ksours* (fortified settlements) of the region.

In South America, universities in Peru, Chile, Argentina, and elsewhere address building conservation, with educational modules for earthen heritage included in several curricula. The Pontificia Universidad Católica del Perú offers a special focus on the structural testing and stabilization of historic buildings, including earthen buildings and archaeological sites.

Beyond the university setting, professional and community organizations dedicated to earthen architecture provide a large part of the training available, including some components related to preserving earthen buildings. For example, CAPTERRE (Centre Algérien du Patrimoine Culturel Construit en Terre) in Algeria offers workshops on the rehabilitation of earthen buildings using the region's extensive historic *ksours* as a practical resource. These trainings include capacity building and qualification of workers for the restoration of earthen heritage in collaboration with CRAterre. Similarly, Cornerstones Community Partnerships in New Mexico preserves earthen buildings by providing preservation and maintenance knowledge through community-based restoration projects. Cornerstones also teaches the Taller Internacional de Conservación y Restauración de Arquitectura de la Tierra (International Workshop on the Conservation and Restoration of Earthen Architecture), which is a cross-border training initiative organized by Mexico's Instituto Nacional de Antropología e Historia (INAH) and the US National Park Service's Vanishing Treasures Program, in partnership with the University of Arizona and the University of New Mexico. This practical workshop convenes experts to share current best practices and case studies, and to engage in dialogue with participants in order to extend knowledge and techniques to communities, institutions, and professionals charged with conserving earthen architectural heritage. Fundación Altiplano—an analogous organization based in Arica, Chile—collaborates with communities and regional governments to conserve Andean earthen heritage sites, including religious buildings. The group offers training in earthen architecture conservation with the aim of sustainably developing rural communities. Another notable recent course was the First International Workshop on Earthen Architecture, World Heritage City of Yazd: Conservation Problems and Challenges, held in Iran and organized by Yazd Municipality in collaboration with CRAterre and an international group of supporters.

These are just a selection of the many independent organizations and groups promoting the restoration and conservation of earthen heritage.

A site visit to Hili 2, an Iron Age earthen archaeological site in the United Arab Emirates, during the International Course on the Conservation of Earthen Architecture held in 2018. Photo: Nicole Declet, GCI.

TRENDS AND OPPORTUNITIES

Despite the number of programs and groups focused on teaching aspects of earthen architecture construction, there remain few opportunities to specifically study conservation of earthen heritage. Looking back at the thematic areas for education and training in the field—beginning with the Adobe '83 workshop—one observes a gradual shift from specific technical concerns of material properties, treatment products, methods, and interventions, to a growing emphasis on documenting cultural contexts of earthen heritage places and participatory decision-making. The PAT courses, for example, bridged these themes with a focus on material properties and interventions for earthen sites while including a significant component on the role of collaborative values-based decision-making in site management. More recently, regionally focused courses such as that held in Yazd, the GCI-DCT earth course, and ATHAR's programs have increasingly highlighted not only technical aspects but also larger issues, such as risk management for earthen sites and the role earthen architectural heritage plays in the sustainable development of traditional communities.

Many programs and workshops that do teach some aspect of conservation focus on specific technical or regional challenges, such as documenting vernacular settlements, structural analysis and stabilization, and earth-based finishes and grouting, to name a few. However, a continuing challenge facing the field is the failure to recognize the conservation of earthen architectural heritage as a unique discipline requiring its own study and a specific methodology. Too often it is considered a subset of general preservation studies, or an afterthought related to training in new earthen construction. Those courses that do cover conservation offer little discussion of the complex issues facing earthen settlements, including abandonment and its economic causes, such as the decline of agricultural practices that supported these communities.

Participants in the 1996 PAT96 earthen architecture conservation training course conducting a rectified photography exercise at Palacio Tschudi, Chan Chan, Trujillo, La Libertad, Peru. Photo: Leslie Rainer, GCI.

At the local, community-based level, concerted efforts are needed to retain, record, and transmit knowledge and skills being lost in many traditional building cultures. To address this challenge, not only are capacity building opportunities needed for the professionals (e.g., architects, engineers, archaeologists, and conservators) who manage earthen heritage-related projects; also required are efforts to ensure the continuation of current knowledge by highlighting existing skills and training new workers and craftspeople in earth conservation–related techniques and materials. This effort must involve government ministries that are often tasked with managing such sites but do not typically have access to the necessary training and skills.

Looking to the future, opportunities exist for greater collaboration among organizations already providing training. Renewed collaboration between the largest institutions, the improvement and sharing of didactic materials, and the transfer of knowledge from one generation of professionals to the next are all priorities. Another important opportunity is to integrate the too-often distinct aspects of the earthen architecture world—conservation and new building—by developing conservation and maintenance-focused teaching modules and curricula for the university level that can be taught in architecture and engineering programs.

To address the perception of earth as a poor material and the systemic loss of earthen settlements, targeted teaching is needed in the adaptive reuse of earthen structures that demonstrates how historic earthen buildings can be upgraded and modernized to revitalize the historic core of heritage cities. In concert with this educational effort, planning mechanisms and guidelines that protect and highlight historic earthen towns and villages are necessary. To achieve this goal, dedicated regional model courses are needed at multiple levels, from community-based initiatives aimed at youth and residents, to professional-level courses for city managers and urban planners tasked with caring for earthen heritage. While recent regionally focused courses such as those organized by GCI-DCT, CRAterre and ATHAR addressed areas with significant earthen heritage and a lack of training opportunities, a renewed international effort would broaden the reach of these courses and provide training accessible to more practitioners working with earth.

Another important objective is the training in norms and guidelines for seismic retrofitting of earthen structures and the dissemination of those training materials. By embracing the educational adaptations developed as a result of COVID-19, the field has an opportunity to adopt new online modalities of education that grew during the pandemic and can be further advanced to reach audiences in developing countries that might not be able to physically attend courses.

Finally, new strategies and capacity building initiatives are necessary to tackle growing challenges to built earthen heritage, such as sustainable tourism, post-conflict and disaster recovery, and climate change. These issues demand new thinking and a renewed sense of purpose from the community of practitioners, governments, and organizations working to preserve our earthen architectural heritage.

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PRESERVING EARTHEN SETTLEMENTS IN OMAN

Conservation and Adaptive Reuse of Vernacular Heritage

BY SOUMYEN BANDYOPADHYAY

EARTHEN ARCHITECTURE CONSERVATION IN THE Arabian/Persian Gulf region has had a challenging path to tread for several reasons. The earliest conservation attempts focused on antiquities, probably owing to the enthusiasm of the great Orientalist academics and political agents of the time, as well as to a lack of interest in Middle Eastern vernacular architecture. Even then, laws for the protection of antiquities took a long time to materialize. In Saudi Arabia, for example, discussions that began with the encouragement of Harry Saint John Philby in the early 1940s finally resulted in the Regulations for Antiquities in 1972. Oman's National Heritage Protection Law of 1980 (Royal Decree 6/80) was one of the earliest to explicitly state the need to protect built heritage, even though the document is largely devoted to safeguarding archaeological sites and antiquities. Built heritage remained a poor sibling of archaeology.

Preservation of vernacular heritage, including settlements constructed of earth, was also undermined by the relentless modernization of the Arabian Peninsula from the 1950s onward, beginning with Kuwait, Saudi Arabia, and Bahrain, which saw many inland oasis and coastal sites unrecognizably transformed. Beginning in the 1970s, the capital cities of the Gulf began attracting populations away from the hinterlands with new government jobs, as well as with the lure of better housing and infrastructure. On weekends and during festivals, the mainly male workforce returned to their families, now located in modern neighborhoods on the outskirts of largely abandoned traditional earthen villages and towns (*harah/bilad*). The loss of an indigenous workforce, both male and female, and the consequent loss of traditional knowledge, such as gardens husbandry (largely left to imported laborers), significantly affected oasis agriculture.

The periodic water table loss due to poor rainfall was not unusual in Arabia, as we know from the disappearance and reappearance of 'Ayn Zamzam, the sacred spring associated with the Ka'ba. However, the rate at which new settlements drew on subterranean water sources to meet the increasing demands of the mushrooming and often poorly considered and positioned planned settlements had a devastating effect on ancient irrigation systems reliant on wells (*bir* or *tawi*) and underground channels (*qanat* or *falaj*), leading to the destruction of significant areas of date palm plantations. Vernacular mud buildings relied on regular maintenance but also on the constant exchange of humidity between the inhabitants and the fabric. The dehumidified structures, fragile and brittle, suffered further during heavy rain, which detached the wet and heavy render and hastened building collapse.

EARLY EFFORTS

Heritage protection in Oman is illustrative of what has occurred in other Gulf countries. Within the Arabian Peninsula, Oman presents a unique assemblage of well-preserved archaeological sites from the third millennium BCE. Over one thousand earthen and stone-built settlements, many dating from the seventeenth and eighteenth centuries, are a manifestation of Oman's preeminence in Indian Ocean trade. Several of the mud-brick mosques in Oman's central region are even older; one in the Nizwa oasis contains a decorated prayer niche (*mihrab*) from 1252, and several in Manah have prayer niches dating from the early sixteenth century.

Initial conservation efforts focused on isolated monuments, mainly forts and castles, drawing attention away from adjoining settlements, the raison d'être for their existence. The restoration of Jabrin Castle, a primarily earthen building, undertaken in 1983 by Oman's then–Ministry of National Heritage and Culture, later the Ministry of Heritage and Culture (MHC), sympathetically attempted to interpret the phases of its construction. However, it too had to remove a residential quarter for the guards (*askari*) to create visitor parking. Under the direction of international conservators, other sites adopted sometimes partially conjectural rebuilding approaches, undertaken in a desire to present a completed wholeness, and included some use of incompatible materials and reconstruction methods. Few sites were put to any use other than as museums.

As planning in the early 1990s focused on development of regional centers, many earthen vernacular settlements and oases in their vicinity missed out again. In Nizwa—the traditional intellectual center of Interior Oman (ad-Dakhiliyah)—a new town center was developed consisting of a rebuilt market (*suq*), new commercial premises, and a mosque, but it did not include the adjoining and historically significant earthen settlement, Harat al-'Aqr, and the wider oasis. The traditional hierarchy of settlements developed over centuries was also altered, and social networks were disrupted.

Bahla Fort, one of the largest earthen structures in Oman, was inscribed as a World Heritage Site (WHS) in 1987, followed shortly by the inclusion of the entire oasis, an ancient settlement already inhabited in the first millennium BCE. The UNESCO requirement for creation of a heritage management plan for the oasis led to the first significant

heritage audit in Oman in 2001–2, associated with the establishment of significance and threat, but the audit was understandably limited in scope because of a lack of detailed documentation. Large-scale audits with management plans in mind were subsequently undertaken for the capital, Muscat, as part of Muscat Urban Renewal, and at Harat al-'Aqr in Nizwa. These initiatives, including the Bahla WHS, are yet to be implemented. The Bahla Fort, on the other hand, in response to its 1988 inclusion on the List of World Heritage in Danger, has been the focus of extensive restoration for thirty years. Understandably, the integration of public-private partnership and stakeholder participation in conservation initiatives has taken time and continues to evolve. At Harat al-Bilad in the Manah oasis, the deserted earthen settlement had been purchased by MHC from its erstwhile owners for the first phase of restoration and rebuilding along its two main streets, but it was recently handed over to private operators.

A NEW APPROACH

The 2009 MHC publication of the inventory of traditional settlements (*harat*) marked an important change, followed by invitation for the documentation and management planning of selected ad-Dakhiliyah region settlements (2010–11) to selected Omani and United Kingdom university research centers. This included the Sultan Qaboos and Nizwa universities in Oman, and the Centre for the Study of Architecture and Cultural Heritage of India, Arabia, and the Maghreb (ArCHIAM), now based at the University of Liverpool. For the first time, detailed documentation of large oasis earthen settlements informed heritage management and conservation. In following seasons, additional sites were identified across the eastern ash-Sharqiyah and the southern Dhofar regions.

Systematic fieldwork-based survey documentation is essential for a significance assessment of earthen architecture sites. In the Gulf region, the process must consider the fair-weather window between October and March, often making a survey span two campaigns or more. Use of historical aerial photography helps to develop an initial zoning plan and morphological understanding, as well as to establish approaches for the oasis sites, which are often topographically challenging. In Oman, aside from covering the architecture and settlements via traditional surveying methods, the oasis irrigation infrastructure (*aflaj*)—spring sources, networks of open and covered channels, distributor nodes, and agricultural terraces—requires particular attention. This must be supported by comprehensive, sequentially conducted photo-documentation. Together, these approaches provide a thorough understanding of the morphology, scale, and physical characteristics of the settlements and their wider agrarian and natural context.

Aerial photography supported by Unmanned Aerial Vehicles (drones) has added a dimension to historic site documentation and analysis. However, dense date palm canopies at oasis sites can limit the usefulness of drone photography. Maintaining a database for such a huge volume of information is essential to produce usable orthographic digital documentation drawings and outputs using photogrammetric software on drone photography. A state of preservation and failure recording of existing original fabric must be carried out to map various failure types and establish a complete, up-to-date evidence base to guide conservation.

Ethnographic fieldwork complements drawn documentation, providing understanding of social structure and land ownership, crucial for the tribal societies of the Arabian Peninsula less reliant on documented history. Ethnographic data is usually collected through interviews with tribal elders, house owners, keepers of the *aflaj*, former master builders, and individuals. This helps identify spatial use and practices, including gender-segregated places for congregation, washing and praying, significant oral histories, *aflaj* irrigation management, and residents' aspirations for the future.

Analysis of the architectural documentation—triangulated with ethnographic, historical, and socioeconomic data—establishes the significances of heritage assets within a Historic Urban Landscape (HUL). The HUL approach seeks to determine the value of heritage assets to current and future generations, and to mitigate vulnerabilities. The significances identify the assets and associated socioeconomic and spatial practices for conservation and help develop policies central to heritage management and development planning. Stakeholder consultation is vital to the establishment of conservation goals; participation in planning helps develop mechanisms for prioritization and coordination of activities as well as good stewardship.

ADAPTIVE REUSE AND TOURISM MANAGEMENT

The heritage management and tourism development project at Misfat al-'Abriyin—a partially inhabited mountain oasis two hundred kilometers southwest of Muscat, with extensive earthen construction—is the first implemented adaptive reuse plan in Oman, based on a cohesive regional strategy and a significance-based master plan. In 2014 Oman's Ministry of Tourism commissioned the ArCHIAM research center at the University of Liverpool to create a Heritage Management and Tourism Development Plan for Misfat, which was completed in 2016. A team of architects, archaeologists, ethnographers, and tourism economists developed a strategy and master plan for the settlement's preservation and development, based on the HUL approach. Implementation of Phase 1 followed, supported by Bank Muscat's Corporate Social Responsibility scheme—the first realized public-private heritage initiative in Oman. The project was transferred to the Misfat Cooperative, Misfat al-Ahlia, in November 2020, in a ceremony held by the recently amalgamated Ministry of Heritage and Tourism, and Bank Muscat. In December 2021 the World Tourism Organization recognized the effort through its Best Tourism Village award.

The Misfat Cooperative, which evolved with the project, was integral to the process. Their involvement ensured that local needs and aspirations were incorporated, and that heritage assets and traditional customs were safeguarded, while helping achieve local consensus on proposed heritage and tourism development strategies. The children of Misfat participated in design workshops and expressed their aspirations about the sites earmarked for development. Their suggestions provided inspiration for the design team to develop rehabilitation, reuse, and restoration schemes for traditional structures and open spaces in Phase 1. In the process, the children learned the history and heritage of their village and gained awareness of the compelling need to safeguard it.

Based on fieldwork and ethnographic study—and a regional analysis of natural, archaeological, and urban heritage sites—

The mountain village of Misfat al-'Abriyin with its terraced agricultural landscape in the foreground. The village, which includes extensive earthen construction, has been the focus of a heritage management and tourism development project and is the first implemented adaptive reuse plan in Oman, based on a cohesive regional strategy and a significance-based master plan. Photo: © ArCHIAM.

ArCHIAM proposed a networked strategy, including a tourism focus. Traffic volume and tourism economics analysis led to a decision for residents-only parking in the historic site, with a tourist "gateway" downhill. A review of renewable energy technologies indicated the feasibility of taking Misfat off-grid. This should reduce fossil fuel dependency through a combination of domestic storage of solar energy with Lithium-ion batteries, power generation through coil turbines in irrigation channels, solar panels for water heating, photovoltaic panels for street lighting, and biogas produced from human and agricultural waste. In addition, passive environmental design measures were adopted in the developed buildings to maximize internal air movement, provide shade, and optimize rainwater drainage.

Phase 1 of the master plan is now realized through interventions that include the restoration, rebuilding, and adaptive reuse of the main gateway and adjoining dwelling into an information center, a culinary training place, and a restaurant, as well as restoration of a key civic space (Harat ash-Shua) and creation of resident parking. The approach adopted in the development of chosen sites seeks to preserve traditional fabric and spatial qualities by sympathetically marrying new use and construction into host structures. Conservation, reconstruction, and new build are conducted in accordance with international guidelines for heritage conservation and development. These tenets were rigorously followed:

- intact original spatial configurations were minimally altered to accommodate the new use, deploying, where possible, traditional construction materials and methods;
- existing dilapidated walls and floors were rebuilt with traditional material and construction techniques, based on documentation;
- collapsed walls and openings were rebuilt with traditional materials but contemporary construction techniques;
- new walls and openings were built with contemporary materials and construction techniques.

The designs aim to reinstate the buildings' values and impact by preserving the old "host" fabric and introducing new life into it through contemporary architectonic measures. In all the interventions, the old acts as the "carrier" of meaning, memories, and identity values. The new gives to the old fabric renewed meaning and relevance for contemporary living. The design works as much with typology and the visible traces of history, as with spatial perceptions and atmosphere, light, air, and water.

COMMUNITY ENGAGEMENT

Misfat al-'Abriyin marks an important shift toward community participation in Oman heritage conservation projects. The Cooperative grew from a solo bed-and-breakfast initiative in the early 2000s into the first heritage cooperative constituency in Oman, its membership expanding from five young activists to an affiliation of more than fifty households. The original bed-and-breakfast had a threefold increase in guests in 2019–20, and five new heritage-style bed-and-breakfasts have opened. Additional enterprises have emerged through community initiative, including a museum, a local honey and grocery store, and a café selling local crafts.

In nearby Al-Hamra oasis, a vast, largely seventeenth-century earthen settlement, a museum was established in 2005 by a community member in one of its oldest houses, Bayt as-Safa'. The community-driven Al-Hamra Initiative, launched in 2016, has led to further restoration at the museum and the creation of a bed-and-breakfast facility. A larger conservation-led heritage tourism project is now under consideration by the Ministry of Heritage and Tourism. In Harat al-'Aqr, Nizwa, a private company, Bawareq Nizwa International, manages twenty bed-and-breakfast facilities that have adapted vernacular dwellings through restoration and rebuilding. In Muql, in eastern Oman, a cooperative is focusing on development of tourism products and experiences, with the aim of conserving its tangible and intangible heritage. These are examples of how other communities are now taking advantage of the economic opportunities offered by heritage-led tourism to preserve their historic earthen architecture.

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DIGITAL TWINS AND REAL-TIME MONITORING

New Techniques for Analyzing Historic Andean Adobe Churches

BY RAFAEL AGUILAR

EARTHEN BUILDINGS ARE WIDESPREAD IN LATIN America, particularly in Peru, where plenty of architectural and archaeological heritage constructions of this material can be found throughout the country. Unfortunately, earthen historic buildings are particularly vulnerable to earthquakes because of the inherent brittle behavior of their structural systems, weak connections between structural elements, cumulative historical damage, and lack of proper maintenance. Moreover, South American countries located next to the Pacific Ocean are exposed to a high seismic hazard because of proximity to the Nazca Plate (an oceanic tectonic plate) along the coast and the presence of several local geological faults. As a result, historic earthen buildings in the region face serious seismic risk, with the potential for severe damage and even abrupt collapse during moderate to strong earthquakes.

Around the world, engineers and scientists are developing tools to assess the safety of existing buildings and to reduce their vulnerability. The application of new technologies in the field of structural engineering to better understand the behavior of the built environment—and, in particular, to assess the safety of existing infrastructure—includes utilization of reverse and forensic engineering techniques, the combined use of laboratory and in situ nondestructive tests, computationally aided numerical modeling, installation of different types of remote sensors, and even artificial intelligence and cloud computing for data processing and interpretation.

Presented here are examples of research being carried out at Pontificia Universidad Católica del Perú (PUCP) in these fields as part of a scientific network that includes other institutions in Latin America, the United States, and Europe conducting work related to the preservation of earthen architectural heritage. The application by PUCP researchers of up-to-date engineering techniques for

The ornate baroque interior of San Pedro Apóstol Church, which is located in the village of Andahuaylillas, Cusco, Peru. Photo: Engineering and Heritage Research, Pontificia Universidad Católica del Perú.

characterizing the condition of earthen structures complements the efforts of other disciplines that work in the challenging area of preserving our built heritage.

DIGITAL AND SMART 3D MODELS

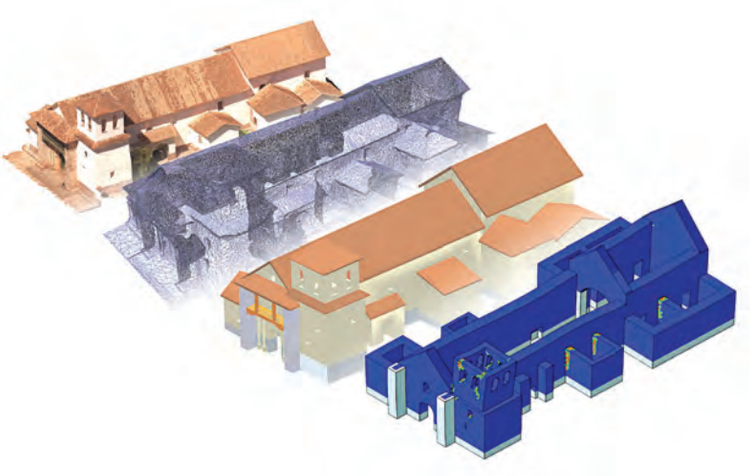
In recent years, new technologies in surveying and nondestructive testing have been developed to address structural issues by identifying in situ conditions of existing buildings. Reverse engineering—which enables the creation of digital "twins" (smart virtual models) of buildings based on information extracted from physical assets—provides effective tools that fit well into this context. In the field of conservation of architectural heritage, the use of digital twins has diverse applications, including the creation of virtual reality experiences for dissemination purposes or database preservation, smart documentation of architectural and structural features, smart monitoring using the internet of things, and even input for additive manufacturing (3D printing). In structural engineering applied to historic buildings, digital twins, combined with advanced computational analyses, can be integrated into evaluations that predict a building's behavior in a seismic event and thereby help guide preservation measures.

A methodology for evaluating the seismic vulnerability of historic adobe buildings based on the application of reverse engineering is now being used in Peru. The methodology enables the assessment of the safety of buildings under specific earthquake scenarios and is performed in three stages: engineering surveying, digital modeling, and predictive analysis. Surveying involves the gathering of engineering information, which includes historical information (with a particular interest in a building's past structural behavior and identification of hazards), geometrical assessment, characterization of the properties of the building's materials and structure, and mapping the building's damage condition. The creation of digital models includes generating 3D representations that can contain information about the building's geometry, textures, and colors. These digital models can even incorporate technical information, such as structural pathologies, material properties, and the state of conservation. Predictive engineering analyses are then conducted and include structural modeling, calibration of the model against experimental results, and performance verification. For structural modeling purposes, the geometry is simplified with engineering criteria that include the assumption of certain boundary conditions and connections among elements, as well as the assignment of material properties. A key step is calibrating these analyses in conjunction with a building's observed physical behavior, a process that is conducted through an iterative comparison against experimental tests. Once a structural model for a building is validated, engineering analyses can be carried out that evaluate a structure's performance in relation to specific hazards. In the case of earthquake analysis, this process helps to identify the collapse mechanisms that are most likely to occur and the most vulnerable elements in the buildings, as well as to estimate their response under earthquakes of different magnitudes.

Several adobe buildings in Peru are already being assessed by PUCP researchers using this methodology. One example is its application in a comprehensive seismic assessment of a sixteenth-century adobe structure—the San Pedro Apóstol Church, located on the main square of the village of Andahuaylillas, about forty-one kilometers southeast of the city of Cusco in southern Peru. The interior of the church is notable for its ornate baroque interior, including several mural paintings. The church building covers an area of twenty-seven meters by sixty-one meters and includes an enlarged nave, a presbytery, a bell tower, and several side chapels. The building is mainly composed of adobe walls with an average thickness of two meters, with an average height of ten meters for the main nave and an average height of twelve meters for the presbytery.

In this case study, information was collected through a series of nondestructive methods—terrestrial laser scanning, aerial photogrammetry, sonic tests, infrared thermography, and operational modal analysis. The information from laser scanning and photogrammetry enabled the creation of a 3D model of the church. Information from an existing damage survey and the results of the experimental testing program were incorporated into a Building Information Modeling (BIM) environment, which generated maps of the current state of the building. A 3D structural engineering model of the church was then created.

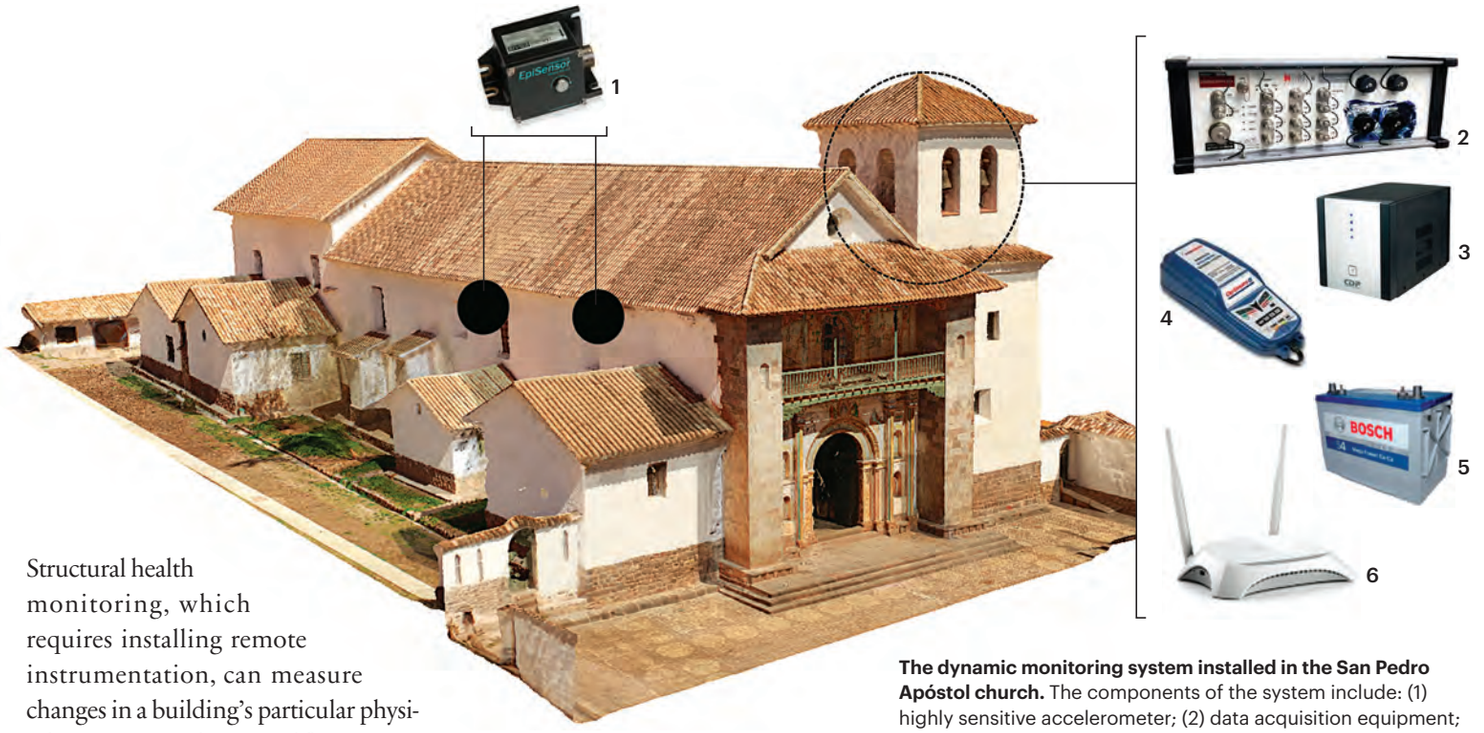
The seismic performance verification carried out with this model confirmed that the damage mechanisms most likely to occur during earthquakes would be the overturning of both front and rear facades, partial collapse of the tower, large cracking patterns in the triumphal arch, and partial out-of-plane failure of the longitudinal walls of the nave and presbytery. These mechanisms are similar to ones observed after earthquakes in other buildings of the same type.



Summary of the seismic safety assessment of the sixteenth-century San Pedro Apóstol adobe church—from the physical asset to the predictive 3D model. Image: Engineering and Heritage Research, Pontificia Universidad Católica del Perú.

ASSESSING STRUCTURAL HEALTH

Structural health monitoring is gaining increasing interest in the preservation of historic buildings as it facilitates remote diagnosis—a process similar in some ways to telehealth medicine—that can help make timely preservation decisions based on evidence. Structural health monitoring can also be used in a variety of ways, including detecting damage in real time, assessing the effectiveness of structural interventions, and assisting in engineering supervision during construction.



The dynamic monitoring system installed in the San Pedro Apóstol church. The components of the system include: (1) highly sensitive accelerometer; (2) data acquisition equipment; (3) uninterruptible power supply (UPS); (4) battery maintainer; (5) battery; and (6) modem. Image: Engineering and Heritage Research, Pontificia Universidad Católica del Perú.

Structural health monitoring, which requires installing remote instrumentation, can measure changes in a building's particular physical parameters and structural features over time. For the conservation of adobe structures, integrating this kind of monitoring into broader conservation strategies would be of extreme importance, as it would detect damage at an early stage, allowing timely maintenance and reducing the risk of abrupt failures.

In addition to the diagnosis, 3D modeling, and seismic performance verification, a comprehensive structural health monitoring program was implemented in the San Pedro Apóstol church in Andahuaylillas. This was carried out using an experimental approach that combined in situ dynamic instrumentation with highly sensitive accelerometers, remote communication, and smart cloud computing for automatic data processing and damage identification. Because of the cultural and historic importance of the building, a permanent monitoring system was installed in 2017. It provides a continuous record of the dynamic properties of the building (natural frequencies, modal shapes, and damping ratios), as well as of the environmental conditions (ambient temperature and relative humidity). Quantifying the influence of ambient conditions in the dynamic response of the buildings is decisive for the operation of the damage detection methodology because both damage and changing ambient conditions produce variations of dynamic properties.

An automated methodology was developed to perform the data processing of records acquired over five years of monitoring. The monitoring results for the church indicate an environmental influence on the building's dynamic properties. The results confirm a seasonal influence in the natural frequencies—the frequencies at which the building sways—resulting in a reduction of frequency values during the winter and an increase during the summer.

In addition, recent research shows that the variation due to ambient effects in adobe structures can be understood on two scales: long-term variations (monthly or yearly) and short-term variations (daily or weekly). For the San Pedro Apóstol church, on a long-term scale, the monitoring results indicate that natural frequencies can vary by up to 8 percent because of the influence of environmental conditions. On a short-term scale, the results indicate that the frequency variations can be up to 2 percent. Thus, the damage detection analysis considered a probabilistic approach aiming at identifying a possible anomalous structural behavior during the operation of the monitoring system. The analysis considered the comparison of the experimental data against a baseline that defined the healthy behavior of the structure incorporating the influence of external variables (such as environmental conditions). This damage detection methodology was successfully tested after a 5.2 Mw magnitude earthquake in October 2018, 110 kilometers from the church. The monitoring system indicated that no structural damage had occurred, which was confirmed by a subsequent visual inspection of the church.

ASSESSMENT AND PRESERVATION

The application of modern techniques to assess the structural performance of historical adobe buildings located in earthquake-prone regions offers those charged with caring for these structures greater information on which to base preservation measures. Among the many available techniques for accomplishing these tasks, reverse engineering and structural health monitoring strategies are particularly effective in characterizing a building's physical condition, including materials, structural systems, and damage state. The integration of the predictive structural analysis resulting from reverse engineering facilitates planning of more effective structural interventions and designing proper management of an adobe structure. When combined with long-term monitoring programs, timely maintenance programs can be designed, reducing the potential for unexpected structural failures and for human loss after catastrophic events.

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A DELICATE BALANCE

A Conversation about the Conservation of Earthen Archaeological Sites

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ANNICK DANEELS, an archaeologist and full-time researcher at the Institute of Anthropological Research at the National Autonomous University of Mexico, is a specialist on earthen architecture of the Gulf Coast of Mexico.

AQEEL AQEEL is head of historic buildings conservation at the Department of Culture and Tourism of Abu Dhabi, where he is responsible for the planning, design, and implementation of conservation measures for Abu Dhabi's Historic Environment.

They spoke in February 2022 with **JEANNE MARIE TEUTONICO**, the GCI Associate Director for Strategic Initiatives and Publications, and **JEFFREY LEVIN**, editor of *Conservation Perspectives, The GCI Newsletter*.

JEANNE MARIE TEUTONICO Let's start with the most general questions. What do you each see as the main issues in the conservation and management of earthen archaeological sites? And what do you consider the principal challenges to conserving them?

ANGELYN BASS I often work on National Park Service [NPS] sites, some that were excavated over a hundred years ago. They have a long preservation history, and with that a lot of issues with presentation. Some of these sites have been heavily stabilized. I've also been working on a Maya archaeological site where excavation is ongoing. Most of my point of reference is going to be sites that were excavated some time ago and are in federal protection, combined with lessons I've learned from sites under current excavation. Many of the sites under NPS management were constructed before 1450, prior to European contact, were partially excavated anywhere from 30 to 130 years ago, and are open to the public to some degree.

At each of these sites, earth is used in many different ways—as a structural material, either clay lump, adobe brick, or mortar for stone masonry—and as plaster for finishing walls, floors, and roofs. It's also used to construct built-in features for weaving and food production. Earthen materials are often well preserved in alcoves where they have natural protection from the weather, which is why so many precious details survive. You see the handprints and fingerprints left in the plaster and the mortar, and you find little remnants like hair and bits of fiber left in the floors from weaving activities. But these earthen materials are also highly ephemeral. They're prone to loss from natural causes—weather, climate change, and earthquakes—as well as from anthropogenic causes, such as heavy visitation, inappropriate preservation treatments, and even vandalism. Unfortunately, these national parks are underfunded and understaffed, and maintenance sometimes has been deferred. With climate change and the increase in storm intensity, this situation is becoming worse.

One of my concerns is the overtreatment that's occurred at many of the sites, especially those that have been excavated and exposed for decades. The national parks were tasked with opening these sites to the public, although not all of them were stable or resilient enough for high levels of visitation. When working with archaeological sites, it's easy to get into a crisis mode where there's pressure to repair and stabilize without really understanding what's to be protected and how. Over time these repairs and alterations accumulate, and their cumulative effect on material integrity often negatively impacts our experiences of these places. I think the biggest challenge is knowing how to respond in ways that preserve the legibility and the authenticity of these sites, and that respect the beliefs of the descendant communities, without foreclosing on values yet to be identified.

ANNICK DANEELS I came to earthen architecture as an archaeologist. I'm not a conservator, architect, or engineer, though in my projects I've worked closely with these specialists. I've been thinking a lot about the issues, and I see two main challenges. One is raising public awareness of archaeological earthen architecture. People simply don't know about earthen architecture—what it represents and how important it is. We really need to raise the awareness of archaeological earthen sites to get more funding and better research. The other thing needed is training. Training at all levels. There's very little professional training in the disciplines that should be collaborating in preserving earthen architecture—whether it's archaeology, conservation, or engineering. There needs to be training in analysis and diagnostic work, and greater publishing of reports on work so

that we can learn from things that didn't work. The problem is that in the past most treatments weren't well recorded, so it's hard to know what has and what hasn't been done. We also need to know how to administer such sites and to create management plans really geared towards the specifics of earthen architecture.

AQEEL AQEEL I'm an architectural engineer and have also worked in conservation for around eighteen years, basically in the United Arab Emirates [UAE]. The points made by Angelyn and Annick certainly are correct. These issues are essential. From my point of view, one of the main issues, especially for earthen archaeological sites, is the materials. In general, for living architecture, you have the flexibility to repair and to maintain easily and periodically. But for archaeological earthen architecture, it's challenging because you have issues with authenticity, which we need to retain. But at the same time, we need to preserve it for a longer time. Many archaeological excavations were done in the last fifty or sixty years. These excavations expose the sites to weathering factors that lead to deterioration over time. We lacked proper management planning during and after the excavations, and the result was the deterioration of the earthen material—and you can't intervene as easily as you might with other materials, such as stone.

TEUTONICO Earthen materials have real vulnerability, especially if they are unprotected. But this perception of vulnerability sometimes leads to over-intervention. How do you assess relative vulnerability so you can avoid reactive interventions driven by a fear that something is going to disappear?

AQEEL It's an important question. I think the assessment should be done in a way that clearly defines the causes. Of course, you need to define what's happening to the fabric of the building or the site, but then you must define the causes. It's different from site to site and place to place. For example, we have desertification here in the UAE, which is something you may not see in other areas. High-speed dry wind is also an issue. Knowing the causes of this problem will help to respond more efficiently by addressing the root cause.

DANEELS The best way to keep earthen archaeological sites safe is to not touch them—or, if you do excavation, rebury them. Reburial is probably the best approach and least invasive. But this is a paradox because it defeats the purpose of raising the awareness of these sites. People will only see mounds—mounds of grass and mounds of sand—so they won't realize what's there. To assess the importance of the architecture, you have to excavate, and the only way to raise awareness is to try to expose the architecture for what it is. But then you get into that whole spiral of problems of conserving the architecture, and you're back to square one.

JEFFREY LEVIN Do you see any way to address this paradox?

DANEELS I think by doing what the GCI has been doing—trying to select specific sites that can become showcases and provide resources for those sites. That includes good diagnostics, good definition of causes, good intervention, and a long-term management plan that includes attracting tourism so it raises awareness and there is money enough to maintain it. But then don't touch the other sites. It's a subtle balance.

LEVIN Angelyn, this question that Jeanne Marie raised with regard to assessing risks so you don't overtreat—what's been your experience in doing that kind of risk assessment?

BASS Measure, measure, measure, measure, measure! And how. We do it by assembling a team with skills appropriate for the conditions. With these alcove sites, there's always an archaeologist—preferably an Indigenous archaeologist. We frequently include a structural engineer, a documentation specialist, and a conservator, but the team depends on the specific questions we're trying to address. We have a new project at Canyon de Chelly where we're including a geotechnical engineer to measure movement of ancient middens that are the foundations for overlying structures, and we're bringing in an environmental engineer to look at climate change impacts. We have a chemist looking at the organic pigments that color the walls.

But in most instances, the greatest threats are structural. Most of these buildings no longer have roof frames, and they fracture into tall, slender wall segments. So we bring a team together to study the severity of threats and measure them. Lidar and photogrammetry have changed the way we measure, so now we can record the asymmetry of fragmented structures and create digital twins. With these models you can manipulate the support conditions, look at the forces acting on the structures, and arrive at rough measures of surviving structural capacity. We monitor and record movement with data-logging sensors, like tilt and crack meters, so we can measure the types and rates of change and prioritize the risks. Sometimes we discover that problems we thought were pervasive and serious are not a priority for treatment—this reduces the impacts of stabilization. Although sometimes it's difficult to achieve consensus about the priorities, we try to work according to the Burra Charter guideline of doing as much as necessary but as little as possible.

TEUTONICO Even if you understand what the risks are, do you have all the conservation strategies you need to deal with those risks, or is there still research that needs to be done?

DANEELS I would suggest that archaeological work be more connected with interdisciplinary analysis. In the project I've been working on in La Joya in Veracruz, the historically most recent construction had eroded, but the several earlier stages of construction beneath it were well preserved, which means they withstood the weathering. Yet nowadays, they wouldn't survive exposure unless we looked at ways to make them more resistant to erosion. I work in the humid tropics, where we have two thousand millimeters of rain a year, with heavy rain showers in the summers and strong dry winds in the winter. Really bad conditions, and yet everything is earthen architecture, which has stood for two thousand years. Clearly the builders addressed this problem, but

Photo: Courtesy of Angelyn Bass.

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we hadn't yet understood how. We started doing standard analysis, looking at mechanical properties and elemental composition, and then the chemistry to find organic additives. Finally, we focused on bitumen, asphalt emulsions, and proved that asphalt had been used as an additive in the adobe and in the plasters. So we started an experimental program, and it worked. An archaeological finding of pre-Columbian technology showed that asphalt was used and could be used again. We should learn more from the solutions that they invented thousands of years ago. I admit many sites have deteriorated because they were left exposed after excavations, but it's fascinating how much has survived in spite of it. Therefore, a thorough understanding of ancient technology will probably add to the conservation tool kit.

BASS We're doing the same thing, looking at ancient ways of building. If the structures have long survived, there're some clues in the materials as to why. We're analyzing relatively small samples of earthen plasters and structural materials to understand their composition, chemistry, and particle size distribution. Their microstructure often reflects the builder's intent. They chose earthen materials for a specific architectural function—whether for a floor that receives high levels of abrasion, or a wall plaster that generally sees less wear. We're starting to understand how these materials were sourced and mixed and why they're durable, and trying to model our treatments, primarily earthen fills, accordingly. Your research, Annick, is really valuable and relevant to how we're approaching the analysis of earthen materials we're working with.

In terms of research needs, we need more information on earthen grouts. How do we create them so they're lightweight, flow properly, and are strong? Do they provide the structural benefits that we want? Are they needed as often as recommended? Another research area is in reburial. How do we monitor the reburied environment, and how do we communicate to managers and archaeologists that while reburial is reversible, its success relies on maintaining an environmental equilibrium? Re-excavation is not a viable monitoring strategy.

TEUTONICO Regarding reburial, monitoring is certainly one issue. But methodologically, when someone says they want to rebury something, do they necessarily know how best to do it? Obviously, there are many different ways to rebury a site or a specific part of it.

BASS I intentionally used the word "rebury" instead of backfill because backfill implies simply throwing dirt from the site back into the trench. Often reburial designs and materials need to be engineered to address the environmental threats inherent in that site. In the US Southwest, we've had the benefit of the GCI's research on reburial at Chaco and Laetoli that's helped to create a framework to follow.

TEUTONICO And with climate change, reburial methodologies that work now may have to be altered. Monitoring of the reburial environment becomes increasingly important to ensure that new or changing conditions are addressed.

AQEEL I cannot agree more with what Angelyn and Annick said. Understanding the material composition is key because we need to know the recipe of the mix. It's not like stone and wooden buildings, where there is much less in terms of mix that's needed to guide intervention. Understanding material composition is important in designing solutions like grouting or consolidation. In the UAE, one of our challenges is that we don't have much of these materials left. Sometimes in the same site—like, say, a compound—we have two buildings with two totally different earthen materials. It's a challenge because we cannot use our existing earth and mix to intervene in a lot of sites. We need to understand the material and try to salvage some of the debris around the buildings to reuse it for solutions.

One research area is creating trial procedures for different applications that can help us achieve optimum solutions and mixes. We did that research for earthen archaeological sites because we suffered in the past from random building solutions that didn't accommodate the situation on the ground and caused more problems. We initiated a multiyear initiative for sheltering archaeological

sites, which came from guidelines based on environmental assessment. When you're an architect, you like to put your signature in the shelter design, so we've tried to give architects guidelines to focus on the main objective and minimize the visual impact while achieving the main function of protection.

LEVIN One thing I'm hearing here is that there is no one-size-fits-all with respect to the materials. You need to research the specifics of the site to understand what materials will be compatible with any intervention you engage in.

BASS The one-size-fits-all approach to site stabilization has been an issue at many archaeological sites in the US Southwest. In the past, there was often widespread, and perhaps overly optimistic, use of repair products like Portland cement amendments and spray-on water-repellent coatings of adobe walls, for example, which ten, twenty, forty years later have caused irreparable damage and have had to be removed. Many of these treatments complicate the study and interpretation of architecture. I don't know if you have this issue in the UAE, Aqeel, but it's a problem we need to tackle in the US. If site managers don't have the resources to study the architecture and test the repair materials, and if they can't fine-tune their repair strategies to specifically address the causes of deterioration, they shouldn't be recommending or applying treatments.

AQEEL In the UAE, the issue in the past was the lack of *any* treatment for thirty years after the first excavations. Later on, there were some attempts to protect or conserve the remains based on personal judgments but not on a methodical scientific approach. In 2006 we started using a more systematic methodology for preservation. Before that, most things were done based on personal opinions, or nothing was done at all. To achieve proper conservation and management of sites, we got lots of resources, and we contracted with specialized conservators or consultants or sometimes companies to deal with specific issues—sometimes for structural issues, sometimes for material issues. Sometimes we give them a whole project, but we still work in a very collaborative way to agree on the best solutions.

DANEELS I want to say something about reburial and shelters. Reburial is not always the solution, especially if a large part of the site has been excavated. That makes it extremely difficult to do effectively. If only very small parts of the site have been excavated, say by trenches, backfilling will be the softest way of protecting it. The best thing always is not to touch it. As for shelters, in my experience whatever type of shelter was constructed, sooner or later it produced side effects. It should be contemplated probably only for areas with mural paintings where no alternative exists. Shelters often affect the way people perceive the architecture, because it's roofed over when it wouldn't have been roofed over originally. And the problem with one-size-fits-all is that it not only doesn't work for earthen architecture. It doesn't work for stone architecture either. Interventions always have to be adjusted to the specific site and the specific conditions.

TEUTONICO Angelyn, you talked about the difference between conserving sites that have been excavated for some time, and conservation while a site is being excavated. In response to what Aqeel said about the neglect of excavated sites, what are the insights that have come from your experience with conservation during excavation?

BASS I've certainly seen many treatment successes at NPS sites. Approaches have changed with time, but the reason some of those sites are still standing is because of structural interventions made during the early twentieth century. But there are failures, as well, which often have to do with treatments that were applied too broadly, or that didn't address the causes of deterioration.

I've had the good fortune to work on a project at San Bartolo in Guatemala, which is a success story in terms of cooperation between archaeologists and conservators, and collaboration with stakeholders and communities. San Bartolo was a project where archaeologists recognized the site's importance, correctly identified some of the threats early on, and, from the beginning, combined conservation with excavation, which took place over eight years. There was time to be thoughtful about our choices. We'd often end the field season without completing the excavation work because we weren't in a position to complete the conservation. We were able to take time between field seasons to collaborate on solutions. It was an ideal project in many ways, but this isn't always how excavation projects go.

In general, I feel the goals of a project should drive the collaboration. If you're a conservator on an archaeology project, you're there to support the archaeology and the excavation, and to guide the team in a useful way. If it's a conservation project—like the GCI's project at Laetoli in Tanzania—the archaeologists are there to support the project's conservation goals. If you're clear about these roles at the beginning of a project and understand how the funding is to be used to meet those goals, it's often a more straightforward collaboration.

LEVIN Sounds like clarity in objectives, and patience, would be two principles to which to adhere if possible.

BASS And time, yes—and be prepared to go slowly at the beginning. The decisions we make early in these projects often have long-lasting effects.

TEUTONICO Do you think it is sufficiently understood that the conservators who work on wall paintings are not necessarily the same people who work on ceramics or, indeed, on earthen walls and building materials? Could the various specialties in conservation be better understood?

BASS When we started the Guatemala project, there was an assumption the wall painting conservators could do it all. But it quickly became clear that a broader range of skills was needed on site and in the lab. There's a learning curve in every large project, and we need to become familiar with other areas of

Photo: Courtesy of Annick Daneels.

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ANNICK DANEELS

expertise in order to engage in the work together. So much more can be accomplished when we do. But it takes time, and it's not as simple as it sounds.

DANEELS I completely agree. These are the ideal projects where communication exists and there is respect for the expertise of each team member and the project goals. My experience, at least in Mexico, has been that once the archaeologist has made the assessment of the site as being important and that it should be preserved and open to the public, the conservators, architects, museographers, and management officers come in and say, "Okay, you've done your work, you may go." And the archaeologist isn't consulted anymore. Most of the time feedback between the different persons within a project is rarely achieved. Archaeologists are the first ones to go because it's assumed they don't know about conservation, or architecture, or structural refitting, or museography. That's common. As Angelyn says, it's important to keep the dialogue open to have a successful preservation program.

BASS I'll offer an example of the importance of an archaeologist on a project. There are many important elements on the surface of a wall painting—the residues left from ritual events, for example. If conservators don't know these residues exist, they might remove them to clean the surface. We need archaeologists to help guide us about what's important and what needs to be preserved.

AQEEL I agree. We should be having a continuous discussion within the team—the archaeologists, the conservators, and the other specialists working on the site. I have an example similar to Angelyn's. Once, we were preserving a wall that had many cracks in it. But one crack wasn't really a crack. It was a joint between two walls, which is historic evidence of the construction method. If we hadn't had a proper conversation with the archaeologist, we'd have treated it as a crack and plastered over it and eventually lost this information. It's essential to have a continuous dialogue even if the archaeology team has finished its work.

TEUTONICO You all seem to be saying that an interdisciplinary team that works together throughout a project is critical to both the understanding and the conservation of a site.

AQEEL In some cases. Another example—we've had deep excavations, like twelve to fifteen meters, for an old water channel, which dates back twelve hundred years. This site required engineering input, as we have very sandy soil and needed to ensure the excavation pit was safe. We needed continuous conversation with specialists who maybe didn't work before on archaeological sites but could tell us more about the soil.

LEVIN One thing we haven't talked about is community engagement and consensus building in the management of these earthen archaeological sites. I'm interested in what each of you has to say on that.

DANEELS In Mexico there is a federal agency, the Instituto Nacional de Antropología e Historia [INAH], which has full power over everything archaeological. Projects must be approved by them, and they decide if a site is to be preserved or not. Most of the time they say no to earthen architecture because it's too complicated and there's enough tourism for sites with nice stone architecture. Now it's different in northern Mexico where we have World Heritage Sites like Paquimé and Camino Real de Tierra Adentro. Preservation of those particular sites is inspired by what's happening in the US Southwest, and there's been collaboration with the National Park Service. But throughout Mesoamerica we have important earthen sites that are not restored. They're just mounds, like La Venta, Izapa, and Tamtoc. Those are important sites, and they're open to the public, but what is shown is the sculpture, not the mounds. The mounds are just mounds. Community input or sponsor input is completely subordinated to what INAH decides. The only way to legally participate is as a nonprofit organization. If a community wants to promote its site for public view and for economic development, it will clash with INAH because they're

Photo: Courtesy of Aqeel Aqeel.

For all our projects—especially for the big projects regardless of whether they're archaeology, historic, or modern heritage—we have tried to engage as much as we can with stakeholders, community entities, and the government to do the proper assessment and to produce a good outcome.

AQEEL AQEEL

not allowed to make money out of it. All archaeology is the property of the nation, and so INAH decides. Any private sponsor who wishes to support a project in earthen architecture will have to do it through INAH. The money goes to INAH, and then they decide how to spend the money on the site.

LEVIN Angelyn, you alluded to the engagement of Indigenous archaeologists in some of the work you've done. What about the engagement of Indigenous communities at some of these sites?

BASS The National Park Service has a consultation process that's had varying levels of success. Sometimes an Indigenous community's input will be solicited before a project starts. More often it's after treatment options have been developed and they're presented to the Indigenous descendant groups for comment. It's a system that's changing. In your last issue of *Conservation Perspectives*, you had an article on guidelines for collaboration between museums and communities with respect to Indigenous materials. What I'd like are guidelines for archaeological sites with standing architecture. That would be so useful for conducting meaningful consultations and generating preservation outcomes that incorporate more of the tribal perspective.

We now have the first Indigenous Secretary of the Interior [Deb Haaland], who directs the National Park Service, and she's interested in diversifying the narratives about these places. For sites excavated decades ago, the archaeological analyses and interpretive narratives predate the consultation process. Since then, the narratives have changed, and more equity in site management decisions is needed. At the University of New Mexico, we're involving Indigenous students as archaeological and conservation interns. In addition, we provide Indigenous students with the opportunity for independent study and to create artworks inspired by the sites. We gain appreciation of these sites by experiencing them firsthand, and we want students to have those opportunities, as well.

LEVIN Aqeel, what's been your experience with respect to community involvement in site management?

AQEEL When we started doing conservation planning for historic buildings, we consulted the community to get their feedback on significance and their view for future use of the buildings. Later on we did a site management plan for a big site where we consulted the community and stakeholders. We have a big municipal park with different archaeological sites, and this park was used mainly for people to picnic. There wasn't much understanding of the archaeological components within the park, so we did a study with people using the park. With help from consultants from Italy, we did a survey to analyze people's views to help determine the future function of the park and the presentation of its archaeological components. For us, the definition of a community is not straightforward. We have a multinational group of people living in UAE, so when you say Indigenous community, do you mean only people from the place, or those who have lived in the UAE a long time?

TEUTONICO The challenge of identifying stakeholders is one that we often overlook, but it is, in fact, critical to the process, as is facilitating dialogue in a way that works for all the stakeholder communities.

LEVIN Aqeel, do you feel though that the principle of some level of engagement with the community, however one defines that, is one that you and your colleagues are embracing?

AQEEL Yes of course, as part of an assessment of a site's value—and also to determine its future function. We believe we now have the right approach. In the past ten years for all our projects—especially for the big projects regardless of whether they're archaeology, historic, or modern heritage—we have tried to engage as much as we can with stakeholders, community entities, and the government to do the proper assessment and to produce a good outcome.

RESOURCES
CONSERVATION OF EARTHEN ARCHITECTURE

ORGANIZATIONS

CRAterre. http://craterre.org/presentation/?new_lang=en_GB

Getty Conservation Institute. Earthen Architecture Initiative. https://www.getty.edu/conservation/our_projects/field_projects/earthen/

Getty Conservation Institute. Teaching Guidelines from the Pan-American Courses on the Conservation and Management of Earthen Architectural and Archaeological Heritage (PAT96 and PAT99). https://www.getty.edu/conservation/publications_resources/teaching/earth_arch.html

The Ibero-American Network of Architecture and Construction with Earth. PROTERRA. https://redproterra.org/es/?option=com_frontpage&Itemid=1

ISCEAH. International Scientific Committee on Earthen Architectural Heritage. https://isceah.icomos.org/

Pontificia Universidad Católica del Perú. Engineering and Heritage Laboratory. https://www.pucp.edu.pe/engineeringandheritage/

University of Minho. Institute for Sustainability and Innovation in Structural Engineering. https://www.isise.net/site/?module=site&target=home

University of Pennsylvania. Stuart Weitzman School of Design. Center for Architectural Conservation. http://www.conlab.org/

TERRA CONGRESSES, CONFERENCES, AND SYMPOSIA

For a listing of the Terra congresses, conferences, and symposia, go to: https://isceah.icomos.org/?page_id=183

The following Terra proceedings are available for free online:

6th International Conference on the Conservation of Earthen Architecture: Adobe 90 Preprints. http://www.getty.edu/conservation/publications_resources/pdf_publications/adobe90.html

Participants in the 2018 International Course on the Conservation of Earthen Architecture engage in a class exercise. Photo: Nicole Declet, GCI.

Terra 2008: The 10th International Conference on the Study and Conservation of Earthen Architectural Heritage. http://www.getty.edu/conservation/publications_resources/pdf_publications/terra_2008.html

To get all the Terra proceedings via interlibrary loan, search on: https://primo.getty.edu/primo-explore/search?vid=GRI

For libraries near you, search on: https://www.worldcat.org/

PUBLICATIONS

Des architectures de terre, ou, l'avenir d'une tradition millénaire by Jean Dethier and Centre de création industrielle (1981). Paris: Centre Georges Pompidou, Centre de création industrielle.

Bâtir en terre : du grain de sable à l'architecture by Laetitia Fontaine and Romain Anger with the collaboration of Patrice Doat, Hugo Houben, and Henri Van Damme (2009). Paris: Belin, Cité des sciences et de l'industrie.

Conservation and Rehabilitation Plan for Tighermt (Kasbah) Taourirt by Claudia Cancino, Benjamin Marcus, and Mohamed Boussalh (2016). Los Angeles: Getty Conservation Institute; Ouarzazate, Morocco: CERKAS. https://hdl.handle.net/10020/gci_pubs/cons_plan_taourirt

The Conservation of Decorated Surfaces on Earthen Architecture: Proceedings from the International Colloquium Organized by the Getty Conservation Institute and the National Park Service, Mesa Verde National Park, Colorado, USA, September 22–25, 2004, edited by Leslie H. Rainer and Angelyn Bass Rivera (2006). Los Angeles: Getty Conservation Institute. http://hdl.handle.net/10020/gci_pubs/decorated_surfaces_earthen_arch

Earth Construction: A Comprehensive Guide by Hugo Houben and Hubert Guillaud (1994). London: Intermediate Technology Publications.

Habiter la terre : l'art de bâtir en terre crue : traditions, modernité et avenir by Jean Dethier with Patrice Doat, Hubert Guillaud, and Hugo Houben (2019). Paris: Flammarion.

Palace Sculptures of Abomey: History Told on Walls by Francesca Piqué and Leslie H. Rainer (1999). Los Angeles: Getty Conservation Institute and the J. Paul Getty Museum. http://hdl.handle.net/10020/gci_pubs/palace_abomey

For publications of the Seismic Retrofitting Project of the GCI's Earthen Architecture Initiative, go to: https://www.getty.edu/conservation/our_projects/field_projects/seismic/related.html

For more information on issues related to the conservation of earthen architecture, search AATA Online at aata.getty.edu

GCI News

Project Updates

COLLABORATION WITH THE NATIONAL GALLERY OF VICTORIA

Recent guidance with respect to environments for collections—such as the Bizot Green Protocol and the ASHRAE chapter on "Museums, Galleries, Archives, and Libraries"—reflects the increasing importance of sustainability and reduced carbon footprint and environmental impact. One pragmatic strategy for achieving these goals is to shift away from prescriptive environments tightly centered on 21°C and 50% relative humidity (RH) and toward broader ranges of temperature (T) and RH for many types of objects.

Motivated by energy savings and energy security, as well as by an organizational interest in implementing environmental change, the National Gallery of Victoria (NGV) in Melbourne, Australia, is widening the environmental range in many of its galleries. This transition period presented an opportunity to examine the response of hygroscopic wooden objects when subject to expanding T and RH conditions.

The NGV and the Getty Conservation Institute (GCI) are collaborating on acoustic emission (AE) monitoring to assess the mechanical response of a sixteenth-century Flemish retable consisting of carved and polychromed wood and oil paint. This technique measures energy released by and propagated through a material that has undergone brittle cracking, and its high sensitivity can detect environmentally induced micro-change before damage is visible. Because of travel restrictions during the pandemic, it was decided to send the AE instrumentation to Australia and have GCI staff remotely train NGV conservators and guide installation of the instrumentation.

A 16th-century retable from Flanders in the collection of the National Gallery of Victoria (NGV), Melbourne. The NGV in collaboration with the GCI has installed an acoustic emission monitoring system with the retable display. Photo: Predrag Čančar, National Gallery of Victoria.

Custom-designed mounting system for an acoustic emission sensor on the 16th-century retable in the National Gallery of Victoria, Melbourne. Photo: Predrag Čančar, National Gallery of Victoria.

Complementing the in situ study of the retable's response to broader environmental conditions, the NGV and GCI are organizing a workshop later this year on AE monitoring that draws on the gained experience of our NGV colleagues. The dissemination of information on this analytical technique and its application provides a means of supporting more sustainable practice for regional galleries and other collecting institutions.

ARCADIA FUND SUPPORT FOR ARCHES PROJECT

Last fall, the GCI's Arches Project received a grant of $325,000 from the Arcadia Fund, a charitable trust of Lisbet Rausing and Peter Baldwin, to support internationalization of the open-source Arches Heritage Data Management Platform.

With support from the Arcadia gift, the GCI is working with Farallon Geographics, with whom it originally developed Arches, to build the internationalization enhancement. This extension to Arches will enable robust management and display of both data and user interfaces (UI) in multiple languages and scripts, and it will require a redesign of the Arches UI to accommodate scripts that read right-to-left, such as Arabic, Farsi, and Hebrew.

The GCI, partnering with World Monuments Fund, originally created Arches as an open-source data management platform freely available for organizations to independently deploy. Arches utilizes international standards for cultural heritage information and information technologies, is highly customizable, and can be configured for use by public agencies and policy makers, researchers and students, nongovernmental organizations, property owners, developers, visitors, and the public at large.

The Arcadia Fund is a London-based philanthropic foundation currently supporting projects recording endangered cultural heritage in more than forty countries, each of which is deploying the Arches platform. Arcadia projects can be found in the Middle East, North Africa, Central Asia, China, Nepal, Afghanistan, the Indus River Basin, the Maldives, Sri Lanka, Indonesia, Brunei, Vietnam, Mali, Senegal, Sudan, Ethiopia, Kenya, Tanzania, Botswana, and Zimbabwe.

NEW ARTIST DIALOGUE: FRED EVERSLEY

A short film on the artist Fred Eversley has been added to the Artist Dialogues series on the GCI website. Emerging from the Art in L.A. project, Artist Dialogues are edited interviews with Los Angeles–based artists that explore their materials, working methods, and views on the conservation of their work. Conceived to demonstrate the

complexity, diversity, and fluidity of contemporary art making, these videos serve as an entry point to their subjects' bodies of work, for both conservation professionals and the greater public.

Fred Eversley is a sculptor working primarily in polyester resin, which he shapes with centrifugal force and painstakingly polishes to create lenslike pieces, or parabolas as he describes them, which concentrate the various forms of energy around them. Among the most compelling features of his pieces are their optical properties, which change depending on the space, light, and viewer. Shot in Eversley's studio in Venice, California, the film includes the artist demonstrating the casting and finishing of one of his parabolas, outlining the evolution of color in his pieces, and discussing the clarity and longevity of his favored formulation of polyester. Contemporary footage is juxtaposed with archival video of the artist at work in the 1970s. The film can be found at https://gty.art/artist-dialogues

Photo: Maria Larsson. Courtesy of Fred Eversley.

Recent Events

CONSERVING MODERN HERITAGE COURSE

Conserving modern built heritage is a complex field with many new and specific challenges. To support those working in this field, several years ago the GCI organized an introductory course on the conservation of modern heritage to provide professionals with much-needed training. The course, developed in partnership with the National Center for Preservation Technology and Training, was offered over three days in 2018 and 2019 at the Getty Center in Los Angeles. Because of the disruption caused by COVID-19, 2020 training was canceled. To continue offering the course, GCI reconceived it as an online program with an expanded curriculum presented over four weeks in autumn 2021.

Through prerecorded video lectures and biweekly live sessions, participants were introduced to sound conservation methodology and how to apply it, including best practices for identifying, documenting, and protecting modern sites. The second part of the course focused on the history, deterioration, and repair techniques of common modern materials and systems, including reinforced concrete, interior finishes, windows, and curtain wall construction, utilizing case studies that demonstrated practical conservation solutions.

The course was taught by GCI staff and preservation professionals from private practice, the public sector, and nonprofit heritage groups. Twenty-one instructors shared their knowledge on a broad range of issues through lectures, demonstrations, and live sessions. The course was hosted on the GCI's online educational platform where participants watched prerecorded video lectures and completed short assignments. They then joined live sessions, engaged in Q and A and lively debates, shared their experiences, and participated in class exercises.

Offering the class online expanded our global reach, with forty-one participants from twenty-three countries. This wide range of professionals (architects, conservators, engineers, and building and facilities managers) formed a diverse group willing to share their valuable insights and experiences gained from conserving significant twentieth-century buildings around the world.

"OLD CITIES, NEW CHALLENGES" TRAINING COURSE

Between late August and early December 2021, the GCI successfully delivered online the fifth in a series of urban conservation training courses for twenty-five architects, urban planners, and other heritage practitioners in Southeast Asia. As in the previous in-person courses, which used the World Heritage city of George Town in Penang, Malaysia, this version of the "Old Cities, New Challenges" (OCNC) course was organized in partnership with Think City, a Malaysian nongovernmental organization that focuses on urban regeneration. Because of COVID-19, GCI and Think City offered the course as a remote learning experience; it was also decided to use the internationally recognized "Historic Urban Landscape" (HUL) approach as the course's conceptual framework. Despite the shift from an in-person to an online course, evaluations from participants, instructors, and organizers were highly positive.

Course organizers worked with a team of six instructors, most of whom had previously taught in the OCNC course and are experts in urban heritage conservation. A heritage economist and a cultural mapping sociologist complemented the knowledge of four conservation planners and architects, and four guest lecturers were also brought in to share case studies that addressed issues of climate change, the impacts of World Heritage inscription, and how the HUL approach was being utilized in particular cities.

One major pedagogical challenge was how best to record a series of short video lectures so that participants could access these resources independently, prior to a weekly, live, two-hour session organized for most Saturday mornings (in Asia). Think City organizers, working with a Malaysia-based video editing company, assisted the remote instructors in delivering engaging content. Roughly forty lectures were recorded, edited, and then uploaded to the learning management system that the GCI has utilized for several years. Saturday morning sessions were lively and stimulating, with questions answered about the previous week's lectures and with smaller-group discussions in breakout rooms.

A second pedagogical hurdle involved the historic places selected by participants as their "anchor sites." Using twenty-five sites instead of the one site in Penang of previous OCNC courses was initially daunting but ultimately successful, as participants were exposed to several historic contexts. In a final assignment, participants demonstrated their understanding of the HUL approach by applying it to their anchor sites.

The course addresses the need for trained urban conservation practitioners in the Southeast Asia region. The positive reaction to this new version of the OCNC course provides a useful basis for its next iteration, tentatively set for 2023, again in partnership with Think City.

Upcoming Events

EXHIBIT OF CONSERVED DE KOONING PAINTING

For the past three years, and as part of its ongoing Modern Paints project, GCI scientists have been collaborating closely with painting conservators at the J. Paul Getty Museum on an extensive technical study and conservation treatment of Willem de Kooning's *Woman-Ochre* (1954–55). Part of his controversial *Woman* series, the painting was donated to the University of Arizona Museum of Art in 1958, where it went on permanent display. On the day after Thanksgiving in 1985, it was cut from its frame and stolen, and it remained missing

GCI associate scientist Vincent Beltran performing microfade testing on Willem de Kooning's *Woman-Ochre*. Analysis revealed that some of the red passages in the painting have slightly faded over time. Photo: Courtesy of J. Paul Getty Trust. ©2022 The Willem de Kooning Foundation/Artists Rights Society (ARS), New York.

for the next thirty-two years. Recovered in 2017, the painting was brought to Getty in 2019.

Opening June 7, 2022, *Conserving de Kooning: Recovery of a Masterpiece* will display the newly conserved work alongside a look at GCI Science's role in the project. GCI staff employed a range of analytical techniques to investigate the materials de Kooning used and how he applied them to the canvas. Identifying his materials and techniques proved essential for understanding the condition of the work and in developing the appropriate conservation strategy. In particular, macro X-ray fluorescence helped map particular pigments across the work's surface; cross sections clearly showed de Kooning's extensive use of charcoal at several stages of the painting; organic analysis confirmed the wide use of alkyd-based house paints; and microfade testing was used to measure the light sensitivity of pigments and pinpoint any fading. The painting will return to the University of Arizona in fall 2022.

Willem de Kooning: The Artist's Materials is a related 2010 GCI publication by Susan F. Lake that offers an in-depth study of the paintings of de Kooning from the 1940s through the 1970s, aided by Getty's comprehensive scientific examinations of the artist's work.

GCI LAB RENOVATIONS

With an eye to the future, the GCI is embarking on a major renovation of its scientific laboratories and office areas at the Getty Center in Los Angeles. The goal is to significantly improve the GCI's scientific research capabilities.

The renovation includes reconfiguring the existing labs and open office areas to build a new state-of-the-art conservation science and materials research center that provides sufficient flexibility to accommodate future technological and methodological advances. Existing operations, research methods, and materials will be replicated in the modernized spaces, while retaining the capacity for growth and the acquisition of cutting-edge instrumentation.

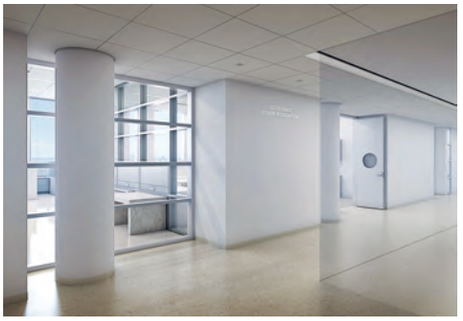
Among the changes to be made are:

- much better utilization of existing space, which will, among other things, enable the construction of three new walk-in environmental chambers especially designed to support the work of the Built Heritage Research and Preventive Conservation teams;
- significantly increased lab spaces for Built Heritage Research, and creation of two large, flexible, and open lab spaces that can be used for hosting workshops;
- separation of lab spaces into dedicated clean areas and those where dirt and dust are produced;
- grouping together pieces of instrumentation that are frequently used together, and separation of pieces of instrumentation that had interfered with each other;
- creation of several dedicated microscopy areas, along with a sample preparation area;
- improved visibility and access to the storage space of the GCI's Reference Collection, a repository of reference materials for use in the analysis of art objects;
- opening up lab spaces to each other to facilitate greater interaction among staff;
- expanding the number of workstations in the open office environments in both the administrative suite and the laboratories;
- decreasing the chemical storage footprint of the labs, increasing ventilation efficiency, and improving lighting;
- increasing lab visibility for visitors to the GCI by adding glass to corridor walls, which will also increase natural light in the corridor.

No significant changes have been made to the Institute's Science facilities since they were originally designed by Earl Walls Associates in the early 1990s as part of the Getty Center design team led by Richard Meier & Partners. Thus, this is the first major renovation of GCI Science laboratories and offices in well over a quarter century. Samuel Anderson Architects—who specialize in conservation and museum research labs, with projects at the San Francisco Museum of Modern Art, the Morgan Library & Museum in New York, and the Museum of Fine Arts, Boston—is providing the design and documentation for the GCI project.

Overall, the GCI's new laboratories—while retaining the integrity of the original Meier design—will be more functional and more open, welcoming staff and visitors alike to engage with the scientists and their work. Construction is anticipated to begin in June of this year and to be completed in mid- to late 2023.

Rendering of how the GCI's new Built Heritage Research lab will appear. Image: © J. Paul Getty Trust.



Rendering of how the corridor outside the GCI's new Built Heritage Research lab will appear. Image: © J. Paul Getty Trust.

Stavroula Golfomitsou. Photo: © Malin Arnesson.

Staff Update

STAVROULA GOLFOMITSOU: NEW HEAD OF GCI COLLECTIONS

Following an international search and a long and intense recruiting process, the GCI is pleased to announce that Dr. Stavroula (Voula) Golfomitsou has accepted the Institute's offer to become the new head of the GCI's Collections department. She fills the position left vacant when Kathleen Dardes retired from the GCI in 2020.

Voula is a conservator, conservation scientist, and educator. She earned her PhD in Conservation of Metals from the University of London and her undergraduate degree in Conservation of Antiquities and Works of Art from the Technological Educational Institute of Athens. She is presently a senior lecturer in conservation and coordinator of the undergraduate and postgraduate degree programs at the Department of Conservation of the University of Gothenburg, Sweden. In her career, in addition to teaching, she has managed laboratories at UCL Qatar, ICCROM, and the University of Malta, and has worked on research projects related to corrosion and conservation of metals and the cleaning of cultural heritage objects.

Voula sits on the editorial board of *Studies in Conservation*, *Journal of Conservation and Museum Studies*, and *Metalla*, and is on the scientific committee of the ICOM-CC Metals working group. She was a member of the IIC Council until 2020 and continues to work with IIC Regional Groups. She is currently coediting a book on cleaning in museums and heritage spaces, which will be published by Getty this year.

As head of GCI Collections, Voula will assume responsibility for the GCI's work in the area of movable heritage and collections, strengthen existing initiatives, forge new partnerships, and develop and implement future projects and areas of work. She will provide leadership, management, and vision for the department, and represent the GCI in the international conservation community. As a member of the GCI's senior staff, she will help set strategic priorities and ensure that the Institute's work is mission driven and addresses current and emerging challenges in the field. She brings to the job a keen intellect, a collaborative approach to work, strong communication skills, and an impressive network.

The staff of the GCI looks forward to welcoming Voula to the Institute this summer.

Sue Fuller. Photo: Bill Doggett, for the GCI.

Tribute

SUE FULLER (1931–2021)

Sue Fuller, a longtime member of the GCI's Administration staff, passed away in September 2021.

Sue was the ninth person hired by the GCI and among a handful of early employees who began work at the Institute prior to the appointment of its first director. At the time she retired in April 2002, she was the third-longest-serving staff member.

Sue spent her entire Institute career working in GCI Administration, beginning her tenure as secretary to the Institute's administrative services manager in the fall of 1984. During more than seventeen years with the GCI, she worked in all three of the locations the Institute occupied—first in the Ranch House adjacent to what is today the Getty Villa, then in the Marina del Rey facility, and finally in the Getty Center. In that time, she moved from secretarial to accounting duties that included responsibility for reviewing all GCI accounting and travel items, helping staff with everything from vendor payments to expense reimbursements. As the watchful and fastidious overseer of the Institute's expenditures, Sue earned the respect and the affection of the colleagues whom she served. A part of the GCI's early history went with her when she retired to spend more time with family, to travel, and to study.

The staff of the GCI offers its condolences to Sue's family.

Print & Online Publications

Print publications are available for purchase at shop.getty.edu. Online publications are available free at getty.edu/conservation.

PRINT

Clyfford Still: The Artist's Materials

Susan F. Lake and Barbara A. Ramsay

Among the most radical of the great American Abstract Expressionist painters, Clyfford Still has also long been among the least studied. Still severed ties with the commercial art world in the early 1950s, and his estate at the time of his death in 1980 comprised some 3,125 artworks—including more than 800 paintings—that were all but unknown to the art world. Susan F. Lake and Barbara A. Ramsay were granted access to this collection by the estate and by the Clyfford Still Museum in Denver, which houses this immense corpus today.

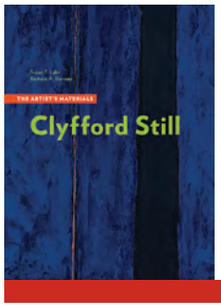
This groundbreaking book, based on the authors' materials research and enriched by their unprecedented access to Still's artworks, paints, correspondence, studio records, and personal library, provides the first detailed account of his materials, working methods, and techniques. Initial chapters provide an engaging and erudite overview of the artist's life. Subsequent chapters trace the development of his visionary style, offer in-depth materials analysis of selected works from each decade of his career, and suggest new approaches to the care and conservation of his paintings. There is also a series of technical appendices, as well as a full bibliography.

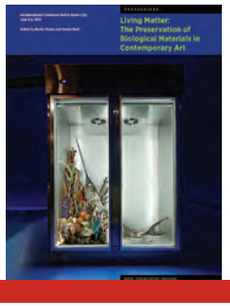
PRINT

Living Matter: The Preservation of Biological Materials in Contemporary Art, An International Conference Held in Mexico City, June 3–5, 2019

Edited by Rachel Rivenc and Kendra Roth

This volume is the first to address the conservation of contemporary art incorporating biological materials such as plants, foods, bodily fluids, and genetically engineered organisms.





Eggshells, flowers, onion peels, sponge cake, dried bread, breast milk, bacteria, living organisms—these are just a few of the biological materials that contemporary artists are using to make art. But how can works made from such perishable ingredients be preserved? And what logistical, ethical, and conceptual dilemmas might be posed by doing so?

Because they are prone to rapid decay, even complete disappearance, biological materials used in art pose a range of unique conservation challenges. This innovative book probes the challenges associated with displaying, collecting, and preserving these unique works of art. The twenty-four papers from the conference present a range of case studies, heavily featuring the artist perspective, as well as conceptual discussions, thereby affording a comprehensive and richly detailed overview of current thinking and practices on this topic.

With contributions by conservators, scholars, curators, and artists, *Living Matter* is the first publication to broadly address these provocative issues, exploring the role of biological materials in the creative process and presenting a wide variety of possible approaches to their preservation.

ONLINE

Seismic Retrofitting Project: Simplified Calculations for the Structural Analysis of Earthen Historic Sites

Paulo Lourenço, João Pereira, and Daniel Torrealva
In collaboration with Maria Pia Ciocci, Federica Greco, Giorgos Karanikoloudis, and Claudia Cancino, 2021

This publication is designed to assist engineering professionals who deal with the assessment and analysis of historic earthen structures using simplified calculations. Based on simple calculations developed as part of the Testing and the Modeling phases of the GCI's Seismic Retrofitting Project (SRP) by the Escuela de Ciencias de Ingeniería at the Pontificia Universidad Católica del Perú in Lima, and TecMinho at the University of Minho, Portugal, respectively, this volume develops a blueprint assessment approach to provide a simpler, faster, and lower-costing analysis for immediate screening of historic earthen buildings. This structural assessment, based on a simplified geometric approach, also helps conservation professionals to prioritize further studies—if necessary—with respect to the seismic vulnerability of buildings. Several application examples are provided in the report regarding the different analysis methods used. These highlight the possibilities of analysis methods for the structural assessment of historic masonry buildings made of earth and the design of strengthening techniques.

This publication is the last in the SRP series on the safety assessment of historic earthen sites. Other reports in the series are *Recommendations for Advanced Modeling of Historic Earthen Sites* and *Modeling of Prototype Buildings*.

ONLINE

Microfading Tester: Light Sensitivity Assessment and Role in Lighting Policy

Vincent Laudato Beltran, Christel Pesme, Sarah K. Freeman, and Mark Benson, 2021

This volume addresses the need for didactic material on the use of the microfading tester (MFT) in the cultural heritage field, with chapters on color science, MFT basics and practice, and lighting policy. It seeks to establish a baseline of knowledge for prospective and current MFT users, as well as stakeholders involved in lighting policy; reflect the range of current MFT practice with respect to operation, data collection, and interpretation; and promote regional and global dialogue about MFT practice to foster a self-supporting user community.

MFT is an analytical technique used to determine an object's light sensitivity. Introduced to the cultural heritage field by Paul M. Whitmore, Xun Pan, and Catherine Bailie in 1999, MFT rapidly induces and monitors color change by exposing the sample surface to a high-intensity, stable, and focused light spot and simultaneously examining the affected area using a spectrophotometer. The predictive information provided by MFT can reshape lighting policy through the lens of risk management.

The GCI has sought to support and advance MFT practice, hosting an MFT experts meeting in 2018 and developing collaborative MFT training workshops in 2019.

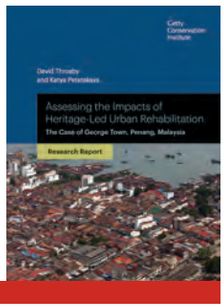
ONLINE

Networking for Rock Art: Global Challenges, Local Solutions

Edited by Neville Agnew, Janette Deacon, Nicholas Hall, Terry Little, Tom McClintock, Peter Robinson, Sharon Sullivan, and Paul Taçon

This third volume by the Rock Art Network (RAN) presents the successes and challenges faced by rock art managers, researchers, conservators, and caretaker communities from around the globe, and presents how they are addressed through local action. A principal tenet of RAN is the potential for improved collaboration between professionals and communication with the public to positively affect the preservation of the world's rock art. Over fifty entries detail how RAN members have engaged each other, the public, and the heritage to pursue this vision.

Arranged within a framework of its last two colloquia held in 2018 and 2019, this is the third in a series of GCI-organized rock art publications presenting the work of RAN. In 2018 RAN members visited rock art sites in California and Texas and gave a series of presentations at the GCI. In 2019 the colloquium was held in France and Spain, visiting subterranean sites and their replicas, which are world renowned and draw significant numbers of tourists. During these two meetings, RAN cemented its vision for the future of rock art preservation and charted a course for the organization's future sustainability and contributions to the field.



ONLINE

Tools for the Analysis of Collection Environments: Lessons Learned and Future Development

Annelies Cosaert, Vincent Laudato Beltran, Geert Bauwens, Melissa King, Rebecca Napolitano, Bhavesh Shah, and Joelle Wickens
Edited by Annelies Cosaert and Vincent Laudato Beltran

Building on its prior work in preventive conservation, the GCI's Managing Collection Environments Initiative organized a December 2019 meeting to discuss environmental data analysis and visualization tools. Meeting participants represented tool users and developers from a range of disciplines, including conservation, engineering, architecture, data science, and building physics. Focused largely on air temperature (T) and relative humidity (RH) data, which are commonly collected in the cultural heritage field, the meeting sought a framework to support development and use of data analysis tools. This publication summarizes the meeting's discussions and provides an entry point into a broader dialogue about preventive conservation tools.

The collection environment, including T and RH, is an important consideration in formulating management strategies that can have a long-term effect on collections and institutions. To meet specific needs, sensor manufacturers and select heritage institutions have developed a variety of tools to analyze environmental data. While most users rely on a single tool, expanding access to a suite of tools with complementary approaches offers a more holistic view of the data and improves communication with stakeholders. Further, the continued evolution of these tools and the creation of new tools should be a collaborative effort between tool developers and staff managing museum environments to ensure that tools are intuitive and easy to use, widely accessible, and supported by effective didactic materials.

This publication explores the perspectives of collection care professionals, educators, engineers, and computer scientists on data analysis, and presents overviews of data analysis and visualization techniques, as well as existing T and RH analysis tools. It also examines the benefit of integration with related data sets; the importance of effective dissemination, education, and collaboration; and future tool development.

ONLINE

Assessing the Impacts of Heritage-Led Urban Rehabilitation

David Throsby and Katya Petetskaya

Fifty years after the establishment of the World Heritage List, there are growing concerns about the implications of World Heritage inscription, such as intensified tourism, increased property values, and displacement of residents. In 2019 the GCI proposed using George Town in Penang, Malaysia, as a case study to assess the impacts of the 2008 World Heritage inscription of this city, where since 2012 the GCI has partnered with a local nongovernmental organization, Think City, to conduct a series of urban conservation short courses for midcareer professionals in the ASEAN region (see page 27).

During 2019, Think City conducted a periodic, in-depth social census in George Town, asking residents, businesses, and visitors what they felt about the effects of World Heritage listing. Knowing this census would be conducted, the GCI invited the Australian heritage economist Professor David Throsby (a professor in the Department of Economics at Macquarie University in Sydney), along with Katya Petetskaya (the Research Project Director in the Department of Economics), to assess the impacts of George Town's urban rehabilitation by studying the data from the Think City census. After conducting a stakeholder workshop in George Town, Throsby and Petetskaya suggested adding a few questions. Their assessment of the social, economic, and cultural impacts of the World Heritage designation in George Town concluded that most respondents were strongly committed to a "heritage-led rehabilitation" (versus one driven by tourism development), and that despite some negative consequences the positive results of designation outweighed the drawbacks. Throsby and Petetskaya employed an analytical methodology they had previously used in the countries of Jordan, Lebanon, Saudi Arabia, and Georgia. This GCI publication describes their methodology and provides a data-driven series of results.

For more information about the work of the GCI, see getty.edu/conservation and

CONSERVATION PERSPECTIVES
THE GCI NEWSLETTER

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Conservation Perspectives, The GCI Newsletter is distributed free of charge twice a year to professionals in conservation and related fields and to members of the public concerned about conservation. Back issues of the newsletter, as well as additional information regarding the activities of the GCI, can be found in the Conservation section of the Getty's website, getty.edu/conservation.

The Getty Conservation Institute (GCI) works internationally to advance conservation practice in the visual arts—broadly interpreted to include objects, collections, architecture, and sites. The Institute serves the conservation community through scientific research, education and training, field projects, and the dissemination of information. In all its endeavors, the GCI creates and delivers knowledge that contributes to the conservation of the world's cultural heritage.

The GCI is a program of the J. Paul Getty Trust, a cultural and philanthropic institution dedicated to the presentation, conservation, and interpretation of the world's artistic legacy.

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CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER

The Great House at Casa Grande Ruins National Monument in Coolidge, Arizona. The protective shelter over this fourteenth-century multistory earthen structure, built and used by the ancestral Sonoran Desert People, was designed by Frederick Law Olmsted Jr. and constructed in 1932. Photo: ©Neil Dixon, The Front Standard Photography.

Conservation
Research
Foundation
Museum