Chapter 2

Background

Contents

List of Tables

Chapter 2
Background

INTRODUCTION

In recognition of the growing importance of preserving our prehistoric and historic heritage, over the last 80 years Congress has enacted a variety of laws to protect and preserve U.S. cultural resources. These laws include, among others, The Antiquities Act of 1906,[1] The Historic Sites Act of 1935,2 The National Historic Preservation Act of 1966, as amended in 1980,3 The Archaeological and Historical Preservation Act of 1974,4 and The Archaeological Resources Protection Act of 1979.[5] The ability of Federal agencies to carry out provisions of these laws rests increasingly on discovering and using cost-effective advanced techniques, methods, and equipment for prehistoric and historic preservation.[6]

Nearly every congressional district contains federally managed prehistoric and historic structures, landscapes, and archaeological sites. This assessment was requested by the House Committee on Interior and Insular Affairs to assist the Committee's legislative authorization and oversight of Federal preservation efforts.[7] The Subcommittee on Public Lands has initiated a major oversight review of the national historic preservation program. The results of this assessment should support the Subcommittee's efforts to review how the use of technology, including methods and techniques, as well as tools and equipment, can assist historic preservation. In this report, **preservation technology refers broadly to any equipment, methods, and techniques that can be applied to the location, analysis, interpretation, management, conservation, and protection of prehistoric and historic sites, structures, and landscapes.**

In order for preservation professionals and the general public to appreciate and learn from the record of past human behavior, these cultural resources must be preserved for both the present and the future. As the National Historic Preservation Act notes:

> . . . the preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, esthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans.[8]

Yet, in recent years the stresses on cultural resources have increased dramatically. The identification of such stresses and the desire to limit their deleterious effects has led to an increased interest in the development of technologies for prehistoric and historic preservation.

This report provides an overview of preservation technologies. It also assesses a variety of policy options related to the use of these technologies and suggests improvements in implementing current policy. More specifically, the report: 1) identifies and discusses effective current technologies for prehistoric and historic preservation; 2) evaluates promising new technologies that could be applied; and 3) suggests areas for research and development. The report also identifies and assesses nontechnical constraints on the use of technologies. Finally, it explores the use of preservation technology in other countries.

---

[1] Public Law 59-209; Stat. 335; 16 U.S.C. 431-433.
[2] Public Law 74-292; 49 Stat. 666; 16 U.S. C. 641-467.
[3] Public Law 89-665; 810 Stat. 915; 16 U.S. C. 470.
[4] Public Law 93-291; 88 Stat. 174.
[5] Public Law 96-95; 93 Stat. 712; 16 U.S. C. 470.
[6] See U.S. Department of the Interior, "The Resource Protection Planning Process," Preservation Planning Series, September 1980, for concepts that define historic preservation.
[7] "The physical remains of our heritage, both prehistoric and historic, are unique, non-renewable resources. It may be that new methods and technologies, including some of those developed in the space program and other high technology endeavors, could be put to use to help us better understand and manage these resources and the information they can provide us. Accordingly, we ask that the Office of Technology Assessment undertake a study of technologies for the identification, recordation, interpretation, protection and management of prehistoric and historic sites." From the requesting letter, Sept. 10, 1985, signed by Morris K. Udall, Chairman, Don Young, Ranking Republican Member, John F. Seiberling, Chairman, Subcommittee on Public Lands, and Ron Marlenee, Subcommittee Ranking Republican Member.
[8] National Historic Preservation Act of 1966, as amended, Sec. 1 (b) (Purpose of the Act), para. 4.

The assessment focused on technologies for: 1) locating, identifying, surveying, and analyzing prehistoric and historic structures, sites, and landscapes; and 2) conserving and protecting them. It does not address the preservation of paintings, books, and other artifacts, except insofar as technologies used for their preservation are applicable to structures, sites, and landscapes. The assessment also considers technologies for storing, sharing, and retrieving historic preservation information.

PREPARATION OF THIS REPORT

In order to identify and refine the many preservation issues discussed in this report, OTA convened a series of five workshops, held at OTA between December 1985 and April 1986. For each workshop, OTA selected participants from government, academia, and private enterprise with a broad range of expertise in the use of preservation techniques, and experience in public policy. Observers from a variety of Federal agencies and public and professional interest groups also attended and contributed to the discussion.

Each workshop identified and examined preservation technologies appropriate to the specific subject under discussion, and discussed impediments to their effective use, Workshop participants developed and discussed a long list of issues related to the use of technologies for prehistoric and historic preservation. They also examined how Federal, State, and local agencies, the universities, and the private sector use preservation technologies, and suggested a variety of options for improving historic preservation policy and implementation.

Technologies for Preserving Archaeological Sites and Structures

Many U.S. prehistoric and historic cultural resources in the United States are buried or submerged. This workshop identified and examined technologies for locating, recording, analyzing, and preserving archaeological sites. It dealt only briefly with underwater archaeology.

Archaeology is the scientific study of structures, artifacts, and other material remains of earlier peoples, and of the ways in which they adjusted to their environments and modified the landscape. The results of such studies enable archaeologists to draw inferences about past human activities and behavior. In the Americas, prehistoric archaeology refers to the study of cultural materials from native peoples who inhabited these continents prior to about A.D. 1500.[9] Historic archaeology treats materials of peoples who have lived in the historic period, for whom written records also exist.

Although curiosity with regard to the practices of other cultures plays a strong motivating part in the discipline of archaeology, the opportunity to broaden our understanding of how people have responded to the challenge of wresting a living from the Earth is also important. Both prehistoric and historic archaeology share the goals of locating, analyzing, and protecting cultural material. Sites, or loci of concentrated human activity,[10] which are the focus of much archaeological research, may range from a simple surface scatter of stone tools and toolmaking remains to a complex of wood and stone structures covering many acres (table 2). They may be found on the surface, partially covered by earth or water, or entirely buried or submerged. All sites include, as an important part of their makeup and meaning, some portion of the surrounding landscape.

---

[9] The precise delineation between prehistoric and historic periods varies depending on the region under consideration.

[10] Some archaeologists have argued that because the boundaries of any given site are arbitrary, and that the definition of a site depends on regional analysis, the site concept is deficient as a research and management tool. See, for example, R.C. Dunnell and William S. Dancy, "The Siteless Survey: A Regional Scale Data Collection Strategy," *Advances in Archaeological Method and Theory,* vol. No. 5, Michael B. Schiffer (cd.) (New York: Academic Press, 1983), pp. 267-287. Although OTA recognizes the term's limitations in adequately reflecting the object of archaeological research, OTA nevertheless uses it for this study in the absence of a more precise and generally accepted term.

Table 2.—Representative Prehistoric and Historic Archaeological Sites

- agricultural terraces, canals, and raised field systems
- battlegrounds
- boats
- burials
- causeways
- cities
- dwellings
- farm steads
- fences and stone walls
- field houses
- footpaths
- gardens
- hunting blinds
- hunting camps
- kill sites
- lithic scatters
- manufacturing sites
- mills
- mounds and earthworks
- plant processing sites
- quarries
- ritual structures
- roadways
- rock art sites
- ships
- stone alignments and forms
- stone fences, corrals, fishweirs
- submerged villages
- trash dumps
- villages and towns
- water control features

SOURCE: Office of Technology Assessment, 1986.

Archaeological research and preservation are extremely complex and involve individuals from a variety of disciplines (table 3). They are also highly labor-intensive. Much archaeological research involves excavation in which scores of laborers are required to dig, sift, examine, and collect a variety of cultural and environmental remains. Archaeological analyses require the curation, storage, and handling of many kinds of information and artifacts, as well as consideration of many different ecological and cultural variables.

Prior to proceeding with fieldwork, archaeologists must develop a research rationale and plan appropriate to the archaeological resources under investigation. Archaeologists depend on the development of technologies that simplify the process of gathering and processing data and improve the quality of archaeological information. Such developments are especially welcome if they lead to lower costs.

Table 3.—Representative Disciplines Participating in Prehistoric and Historic Preservation

- anthropology
- archaeology
- architectural history
- architecture
- art history
- astronomy
- biology (including palynology)
- botany
- chemistry
- climatology
- ecology
- engineering
- folklore
- geography
- geology
- geomorphology
- geophysics
- history
- hydrology
- land planning
- landscape architecture
- maritime history
- materials science
- physics
- volcanology
- zoology

SOURCE: Office of Technology Assessment, 1986

Archaeologists have a strong interest as well as a responsibility to preserve sites even after they have been excavated, as archaeological data still remain in the architecture and in the cultural deposits not excavated in the site.[11] In addition, considerable information may exist in the site for which extraction techniques have not been developed.[12]

Technologies for Underwater Archaeology and Maritime Preservation

Because the technologies for locating, surveying, analyzing, and protecting submerged cultural resources differ substantially from those used on land-based archaeological sites, OTA convened a separate workshop to consider them. This workshop discussed the special problems related to underwater archaeology and maritime preservation.

The specialty of underwater archaeology has developed in the last three decades and still has relatively few qualified practitioners.[13] The study

[11] As a result of the expense of excavation, as well as the desire to preserve as much information as possible for future archaeologists to study, few sites are ever totally excavated (see Chapter 3: *Research,* for further discussion of this point).

[12] For example, archaeomagnetic dating techniques (see *Chapter 3:* Research) were not developed until the 1970s. Yet many sites excavated before the 197os could yield additional information by using such techniques on them today,

[13] Before the 1960s, less than a dozen scientists were engaged in underwater archaeological activities anywhere. Even 10 years ago only two dozen archeologists directed their research toward submerged cultural resources in the United States.

of underwater prehistoric and historic cultural materials is possible in large part because a variety of advanced technologies have been brought to bear on the identification, recovery, analysis, and conservation of these important remnants of U.S. heritage. Such resources may include not only shipwrecks and their contents, but also inundated villages, towns, even cities, farms, warehouses, piers, and wells. They may also include sites that were once submerged, but are now located under dry land after a change in the course of a river channel, or those incorporated within landfill extensions. As one archaeologist, who specializes in studying submerged cultural resources has put it:

> . . . **archeological theory and philosophy encompass all cultural remains wherever they may be found, including material** covered by water. The only difference between an underwater site and a site in any other environment is the techniques and methods required to investigate that site. [14]

Submerged and maritime resources constitute a significant part of the Nation's cultural diversity. Yet, the destruction of submerged cultural resources has intensified dramatically as a result of increased offshore drilling for oil and gas, dredging, pipeline laying, looting, and salvaging. Various water projects such as reservoir and dam building have inundated dry land and buried many other cultural resources, Until recently, however, submerged and maritime resources have been largely neglected by both government and the historic preservation community.

Technologies for Preserving Historic Structures

An important part of the historical record of the United States consists of structures (the so-called "built environment"). This workshop discussed a variety of technologies that are used for the identification, physical analysis, interpretation, and protection of historic structures. Among other things, the workshop discussion focused on preservation techniques related to cyclical maintenance of historic structures and determination of the causes and extent of materials failures.

Historic structures, which include houses, public buildings, bridges, monuments, as well as others represent to the general public the most obvious and important tangible reminders of the diversity and richness of the country's cultural heritage.[15] The U.S. historic preservation movement began over 100 years ago, when a group of private citizens, the Mount Vernon Ladies' Association of the Union, led by Anne Pamela Cunningham, recognized that the Virginia home of George Washington constituted a national historic treasure. The association worked to acquire the property when neither the State nor Federal governments would accept the responsibility of caring for it. The association still holds stewardship over Mount Vernon and has prevented encroachment on the grounds and surrounding lands by purchasing real estate, and securing easements from nearby property owners.[16]

The National Historic Preservation Act, "encourages the public and private preservation and utilization of all usable elements of the Nation's historic built environment," not only buildings that have belonged to men and women significant in U.S. history. In 1976, the first of a variety of tax incentives to encourage the rehabilitation of qualified historic structures became available, all of which have been highly effective in promoting the goal of preserving historic structures.[17]

Because the number of both privately and publicly owned structures actually designated as historic and listed on the National Register of Historic Places individually or as elements of listed historic districts is ever increasing, the scope of the technical problems associated with restor-

---

"'Introduction" *Underwater Archeology in the National Park Service,* Daniel Lenihan (cd.) (Santa Fe, NM: Division of Archeology, Southwest Region, 1974), p. 1.

[15] **A** structure is a work made up of interdependent and interrelated parts in a definite pattern of organization. Generally constructed by man, it is often an engineering project. " *How To Apply the National Register Criteria for Evaluation* (Washington, DC: National Park Service, U.S. Department of the Interior, June 1982).

[16] Albert Rains, Chairman, and Laurence G. Henderson, Director, *With Heritage So Rich* **(A** Report of a Special Committee on Historic Preservation Under the Auspices of the United States Conference of Mayors With a Grant From the Ford Foundation) (New York: Random House, 1966).

[17] See U.S. Congress, General Accounting Office, Fact Sheet for the Chairman, Subcommittee on Public Lands, Committee on Interior and Insular Affairs, House of Representatives, Tax Policy and Administration, Historic Preservation Tax Incentives, August 1986.

ing and rehabilitating them becomes ever more challenging. in the absence of regular maintenance, which is ultimately the best and most economic approach to saving historic structures, only a limited range of often expensive treatments and singular skills are available. New conservation techniques and products must undergo careful testing and evaluation before being applied.

Table 4 represents areas of significance and activity used by the National Register of Historic Places. These areas of significance reflect a range of historical contexts within which the Nation's development can be understood and the historical value of prehistoric sites, structures, and landscapes can be established.

Technologies for Preserving Planned Landscapes and Other Outdoor Sites

Landscapes, whether in the form of highly structured designed landscapes such as parks and gardens, or less well-defined "cultural landscapes," such as historic farms or prehistoric shaped earthworks,[18] are an important part of U.S. cultural heritage. In order to focus attention on the technologies for preserving landscapes, this workshop primarily examined technologies associated with the preservation of planned landscapes. However, it also discussed technologies for the preservation of cultural landscapes and rock art sites.

[18]For example, see the overview of prehistoric earthworks presented in William N. Morgan, *Prehistoric Architecture in the Eastern United States* (Cambridge, MA: MIT Press, 1980).

Table 4.—Areas of Significance and Activity Represented by Historic Structures

• agriculture	• health/medicine
• archeology	• industry
• architecture	• invention
• art	• landscape architecture/ horticulture
• commerce	
• communications	• law
• community planning and development	• literature
	• military
• economics	• performing arts/theater
• education	• philosophy
• engineering/technology	• politics/government
• entertainment/recreation	• religion
• environment	• science
• ethnic heritage	• social history
• exploration/settlement	• transportation

SOURCE: US. Department of Interior, National Park Service, "How To Apply the National Register Criteria for Evaluation," Washington, DC, 1984

The landscape preservation effort is relatively new.[19] The historic preservation movement has established and refined methodologies for preserving structures and archaeological sites over the past 50 years and has only recently begun to turn its full attention to landscapes.[20] The term "landscape" does not even appear in the categories of sites that are eligible for nomination to the National Register of Historic Places.[21]

Landscapes have a profound effect on our lives. Throughout human history, societies have both affected and been affected by their physical surroundings.[22] The result of such interactions is a landscape. Although different landscapes exhibit distinct characteristics, because landscapes may lack clear boundaries and include structures and sites as well as natural components, landscape values may be elusive, making precise and standard definitions difficult to achieve i n practice .23

Establishing a progression of landscape types based on the scale of intentional human intervention can assist in developing common definitions. At one end of such a scale is the *wilderness,* where natural processes predominate, In a wilderness landscape, human activities certainly exist, but they do not appreciably modify the

[19]See the discussion in w. H. Tishler, "The Landscape: An Emerging Historic Preservation Resource, *The Association for Preservation Technology Bulletin* 11, No. 4, 1979, pp. 9-26,

[20]See UNESCO, "Recommendation Concerning the Safeguarding of the Beauty and Character of Landscapes and Sites. Adopted by the General Conference at its 12th session, Paris, Dec. 11, 1962, for a relatively early attempt to define landscape preservation values.

[21]See J. Timothy Keller and Genevieve P. Keller, "How To Evaluate and Nominate Designed Historic Landscapes, " *National Register of Historic P/aces Bulletin* 18 (Washington, DC: National Park Service, U.S. Department of the Interior, in draft), for a discussion of types of designed landscapes.

[22]See the discussion in Hiroshi Daifuku, "1 ntroduction, *The Man-Made Landscape* (Switzerland: UNESCO, 1977).

[23]Part of the difficulty in defining the term is illustrated in the following: In general parlance, we use landscape in the broadest sense to mean environment (including both natural forms and those achieved by art). However, landscapes are often considered simply the ambiance of buildings, as when we speak of "landscaping a building." In that sense, landscapes then become equivalent to nature, in spite of the fact that in order to achieve such a landscape, the natural forms must be molded to a plan. For example, in the eyes of some observers, President Jefferson's home, Monticello, is a landscape of which the central building is the most important part. Others consider only the form and structure of the house and ignore its ambiance.

landscape.[24] We might call the next stage in the progression settlement patterns, as human manipulation of the earth becomes more obvious but there is no conscious planning. As humans manipulate the land for particular purposes reflective of their cultural values, such settlement patterns merge into *cultural landscapes.* Characteristically, the cultural landscape is the product of many groups or individuals working interdependently within a broad cultural context. Finally, the designed or p/anneal lanclscape,[25] in which the scale of manipulation of the earth is high, is a subset of the cultural landscape that reflects the conceptual model of a single individual or small group of individuals. All of these landscape types, whether wilderness landscapes, cultural landscapes, or designed landscapes, mirror values of the peoples who live within them.

[24] In most cases, it is not correct to talk about an untouched natural landscape. Even hunter/gatherer societies may have deliberately burned the grasses, and otherwise altered the landscape over time. For example, see Clive Gamble, "The Artificial Wilderness, " *New Scientist,* Apr. 10, 1986, pp. 50-54.

[25] Because designed landscapes are generally thought of as deriving from a high art tradition, certain historical vernacular landscapes might be overlooked or considered of less historical importance than, for example, formal gardens. However, folk traditions are design traditions that involve master builders and sophisticated learning and wisdom. It is therefore extremely difficult to separate vernacular landscapes from design intention and from planning.

Technologies for the Physical Protection of Prehistoric and Historic Sites

This workshop identified the various human and natural threats to cultural resources and discussed a range of technologies that could be used to mitigate or eliminate them. A major component of this workshop dealt with the educational programs and technologies for alerting the public to those threats and to the importance of historic preservation. The workshop also explored impediments to effective utilization of technologies for assuring the physical security of structures, sites, and landscapes. Technologies related to the following categories were considered:

- problem identification and analysis,
- stress or threat evaluation and resolution,
- public education and interpretation, and
- data treatment and archives.

Following each workshop, OTA staff summarized the discussion, expanding, where possible, on the points offered by participants. These were then reviewed by workshop participants as well as by others in the preservation community. The final workshop reports became the basis for the chapters that make up this report.

COMMON PRESERVATION ISSUES

During the first four workshops OTA concluded that many of the issues raised are common to historic preservation as a whole. The concluding fifth workshop on protection enlarged on these common issues. This section presents and analyzes such common issues.

Cultural resources are unique, nonrenewable resources subject to continual stress from human and natural agents. The recognition of the need to limit such stresses and manage the cultural resources base, within the context of other competing uses for the land, has led to the development of a body of knowledge, practices, and techniques called cultural resources management (CRM).[26] CRM is the process of preserving our cultural heritage (sites, structures, artifacts, records, landscapes) for the benefit of the American people through the application of management skills within the political process.[27] it "is the primary context within which most professional or avocational archaeologists [and other preservation professionals] address the public nature of the resources and their treatment. "[28]

[26] See, William D. Lipe, "Value and Meaning in Cultural Resources," *Approaches to the Archaeological Heritage,* Henry Cleere (cd.) (Cambridge: Cambridge University Press, 1984), pp. 1-11, for an exposition of the relationship of historic cultural resources to human values.

[27] L. E. Wildesen, "Cultural Resource Management: A Personal View, " Practicing *Anthropology 2(2),* 1980, p. 10. For a general discussion of cultural resources management, see Don D. Fowler, "Cultural Resources Management, " *Advances in Archaeological Method and Theory 5 (New* York: Academic Press, 1982).

[28] Ruthann Knudson, "Contemporary Cultural Resource Manage-merit, " *American Archaeology Past and Future,* **D.** Meltzer, D. Fowler, and J. Sabloff (eds.) (Washington, DC: Smithsonian Press, 1986), p. 395.

Prehistoric and historic preservation (and therefore CRM) rely increasingly on the application of a wide variety of technologies, many of which are discussed in chapters 3 through 6. Technologies can extend the scope of our understanding and care of U.S. cultural heritage by improving the quality, quantity, type, and usefulness of data gathered. They can also improve the authenticity of restoration, and the long term effectiveness of conservation and maintenance.

The boundaries between the practice of archaeology and the preservation of historic structures and landscapes are becoming increasingly less distinct. Professionals in all these disciplines apply many of the same technologies to the study and conservation of sites, structures, and landscapes. They should be aware of the assistance each discipline can give to another. For example, it is impossible for the landscape architect to reconstruct and rehabilitate with accuracy an 18th century formal garden without the professional assistance of archaeologists.[29] Architects can help archaeologists to understand some of the choices prehistoric peoples made in the construction of houses and sacred buildings.[30]

A wide array of techniques and associated equipment already exists for the discovery, analysis, and conservation of cultural resources. A core of experienced professionals is also available. Yet a variety of educational, institutional, managerial, and cost barriers inhibit the introduction of new methods, techniques, and equipment. **Preservationists in all preservation disciplines share problems of obtaining access to information about technologies, training, and coordination of research on technologies.** They also share the constraints of inadequate and decreasing funding and lack of coordinated implementation of Federal policy.

The following common issues identify and describe some of these barriers. OTA did not attempt to list the issues in priority order.

[29]Paul Brace, "Archeological Resources and Land Development: A Guide To Assess Impact, " *Landscape Architecture Technical Information* Series *5, No.* 1, September 1984.

[30]See Ralph Knowles, *Energy and Form* (Cambridge, MA: MIT Press, 1974), which discusses energy-related design choices prehistoric peoples have made, as revealed in the remains of their buildings.

ISSUE 1:

Too few preservation practitioners and managers who contract with them have sufficient experience with advanced technologies.

This stems from a variety of causes, principal among which are the difficulty in obtaining reliable and accurate information about new techniques, the lack of educational programs to train preservation practitioners in their use, and their great expense. The complexity of some advanced technologies means that most practitioners must depend on the work of trained specialists.

For example, no project to restore a major historic structure can proceed without the involvement and interaction of individuals from several disciplines—architects, historians, structural engineers, and perhaps, chemists. No one individual can acquire the necessary expertise to tackle every task. Yet the project manager must be knowledgeable enough about the techniques, methods, and equipment used to make informed decisions about their use. Acquiring such expertise requires additional training and accessible sources of information. It is important for preservation professionals to keep abreast of the range of increasingly more sophisticated technologies, and who is using them.

Archaeologists and landscape architects share similar problems obtaining and assimilating information on new technologies. In underwater archaeology, the extremely high costs of acquiring and using appropriate new technologies have severely limited the opportunities for their use in the field. Training opportunities are therefore limited as well.

Assimilating information on new technologies requires appropriate education and training. New technical information becomes available almost constantly from science and industry. Yet, too few preservationists have even minimal training in natural science and engineering. Few training programs or courses apparently offer either information or hands-on experience with technologies. Nevertheless, archaeologists, and historians who specialize in the study of tangible cultural resources and are charged with studying and interpreting a site, structure, or landscape should have a general knowledge of the technologies, and their capabilities and limitations.

ISSUE 2:

Few **standards exist for the use of some new preservation techniques.**

This is unavoidable in the research and testing stages of a new technique or instrument. Once it becomes part of the repertoire, standards should be developed and promulgated. Even those preservationists who are experienced in the applications of new technologies have experienced difficulty tracking the rapid growth and proliferation of some advanced techniques and methods. Because there exists no national, central clearinghouse for critically evaluating historic preservation technical information, and no institution, or group of institutions, specifically charged with charting and sponsoring the research, development, testing, and use of advanced technologies, standards have often not been set.

At present, because few standards exist for new archaeological field methods, in some cases, research funds are not well used. In the preservation of historic structures, the lack of adequate standards has led to occasional unfortunate experiences with some "high-tech" solutions to the problems of restoring, rehabilitating, and maintaining such structures (see *Chapter 4: Restoration, Conservation, Maintenance, and Protection* for examples). Many of these approaches, developed to serve other fields, have proved ineffective and unsuitable for conservation. Until the results of applications made in the laboratory and the field are assessed and available, many preservationists will for the most part remain wary of new techniques.

In cases where the volume of product sales is potentially large, for example, with techniques for stabilizing and extending the life of wood, stone, or other structural materials in wide use throughout the United States, the marketplace may serve to dictate the need for standards. Nevertheless, even with growing private sector interest, the preservation field would benefit from an organization that would provide leadership for the development of standards, and stimulate research into the behavior of new products or the benefits and drawbacks of new techniques. Such an organization would be most useful where the overall market tends to be small, as with many archaeological techniques.

ISSUE 3:

There is a strong need for better coordination in the use of new technologies for preservation.

As noted, the basic analytical tools and a core of professionals are available. However, there is no existing permanent organization of national or regional scope with the knowledge and resources required to assemble a network of collaborators and consultants prepared to tackle specific scientific problems associated with preservation. Much of what is being accomplished is ad hoc or piecemeal, often in the universities. Although some preservation work is of excellent quality, there is a lack of overall direction by Federal and State agencies, as well as a lack of communication among research specialists and agency planners and managers,

Because prehistoric and historic preservation involves many different disciplines and many different agencies at all levels of government, coordination of preservation activities is often difficult. The agencies with primary responsibility for leading preservation efforts have considerable independence and relatively few incentives for coordinating their activities directed toward developing new technologies or funding their use. Even regional offices within the agencies have great autonomy. Because agency staffs tend to be small and underfunded, they have little incentive to increase their workload by coordinating with other offices, as they view such initiatives as difficult and time-consuming. Although such autonomy does allow regional offices to tailor programs to meet their own needs, lack of adequate coordination and information transfer can result in lost opportunities to apply new and more efficient techniques. Some agencies have greater access to advanced technology and information than others.[31]

---

[31] For example, the Army historic preservation office has access to highly capable mapping systems, not generally available in other agencies.

Better coordination among Federal and State agencies would result in more effective technology transfer and application of technology. The Federal grant awarding mechanism for supporting state historic preservation programs could be used to further and enhance such coordination.

ISSUE 4:

New techniques are slow to become part of preservation research planning and research design.

New technologies, many of which provide new categories of information,[32] must be fully integrated into the data-gathering process. Difficulties of integration result in part from lack of training, but also from the rapid changes that take place in some new technologies. For example, the rapid changes in remote sensing technologies, driven by the technology's potential for mineral exploration, forestry, and agriculture, are outstripping the ability of most preservationists to keep up.

ISSUE 5:

The application of older, well-understood technologies is often inadequate.

Although certain new technologies may lead to advantages for preservation, too much emphasis on their use may divert effort from more effective use of traditional methods and tools. For example, a variety of efficient, simplified techniques are available for organizing and storing moderate amounts of records. Yet, regional Federal agency offices often maintain incomplete, disorganized and unprotected document collections and inadequate archaeological site files, use poor methods for curating collections, have not adequately identified cultural resources, and do not provide adequate protection for known sites, even with more traditional methods.

[32]For example, in archaeology, the information on an ancient climate provided by analysis of stable carbon isotopes in wood, instead of the older, well-established technique of analyzing fossil pollens, or data on celestial alignments provided by archaeoastronomy.

ISSUE 6:

Many traditional preservation methods will continue to be useful, effective, and economical.

Participants in each of the OTA workshops emphasized that certain traditional technologies for preserving historic structures will continue to be useful, effective, and economical. For example, periodic or cyclical maintenance still provides the best line of defense against many kinds of threats.

in general, the more advanced, and often more expensive, technologies are of high utility for the discovery and documentation phases of preservation. These include nonintrusive and nondestructive methods such as remote sensing, and infrared and X-ray analysis. Traditional technologies, including some truly historic methods, tend to be more applicable to the restoration and conservation phases of the preservation process.

ISSUE 7:

In certain areas, technologies used by other countries may represent significant advances over U.S. practices.

Many other countries, particularly those of Europe, have long engaged in historic preservation coordinated through ministries of culture, which, whether regionally or nationally focused, have supported the research, development, and use of appropriate techniques for preserving prehistoric and historic sites, structures, and landscapes. Preservation efforts among the industrialized nations, through such organizations as the United Nations Educational, Scientific, and Cultural organization (UNESCO), International Council on Monuments and Sites (ICOMOS), and international Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) have accelerated dramatically in response to growing environmental threats. Some of these efforts have resulted in the development of techniques, methods, and equipment that are more advanced than U.S. technologies.

For example, archaeologists in the United Kingdom and some European countries have generally been highly innovative in developing advanced technologies. The universities also offer an archaeological curriculum that includes train-

ing in the natural sciences.[33] In part, this is the result of the fact that in Europe, archaeology is not necessarily thought of as a subdiscipline of anthropology, as it is in the United States, but as a science and art in its own right. The Europeans have used remote sensing methods, including aerial photography and photogrammetry, since the early decades of this century.[34] In addition, the application of magnetometry and electrical resistivity to ground survey began earlier in Europe. Even some developing countries, such as Indonesia, Peru, and Turkey, which lack the financial resources for extensive preservation of their cultural heritage, have made widespread use of photogrammetry for documenting their public buildings.

Two outstanding underwater archaeological and maritime conservation efforts in Sweden and England are providing models for the Monitor preservation project in the United States. These two efforts illustrate the level of commitment, time, energy, expertise, and funding that are necessary in first-rate conservation of submerged cultural resources. The Wasa is a well-preserved Swedish warship built in 1628 and recovered virtually intact from Stockholm Harbor in 1961. It was the first such recovery of its type and size ever realized and has proved the model for subsequent ship recovery projects. Most of the advances in technology for the long-term conservation of submerged materials were achieved during its rescue.[35] The Mary Rose, a Tudor warship built in 1545, was recovered in 1982 near Portsmouth, England. The effort that went into its preservation represents an excellent model of interdisciplinary research and project management.

West German methods of recording historic structures (so-called measured drawings) are far more complete and result in more accurate and detailed drawings than U.S. methods. European countries have also made extensive use of stereo photogrammetry to make high-quality drawings of buildings, monuments, and historic landscapes. They also use photogrammetry to monitor secular changes in buildings and landscapes,

The European preservation community has been very active in using various forms of remote sensing for studying landscapes. For example, the city of Amsterdam used an airborne infrared camera to detect ailing trees in historic parks. Many stresses to plants, trees, and shrubs are apparent in the infrared before they appear at visible wavelengths. In the United States, such techniques have been used to detect crop stress in corn and other agricultural commodities.

Foreign experiences with preservation techniques, methods, and equipment should be examined closely for possible transfer to U.S. applications. The United States would also benefit by increased cooperation with other nations in developing and testing new preservation methods,

[33] For example, the University of Bradford in England.

[34] However, within the United States, recent advances, stemming in part from the advent of remote sensing from space (in 1972) and the development of the associated computer software have enhanced the U.S. application of such data for archaeology.

[35] *The MONITOR National Marine Sanctuary in Perspective*, Dr. Nancy Foster, Chief, Sanctuary Programs Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration.

A CENTRALIZED CONSERVATION FACILITY

The previous discussion led all five workshops to conclude that a new institution (or expansion of an existing institution's mandate) or center is needed that would foster the research and development of advanced technologies, the training of professionals in their use, and the dissemination of accurate technical information. Several museums maintain first-rate analytical facilities for

conserving artifacts, but no comparable facility exists for conserving sites, structures, and landscapes.

Chapters 3 through 6 discuss numerous preservation Problems that such a center might work on. As discussed in more detail in the concluding chapter, most workshop participants agreed that a center for preservation technology should be federally supported, primarily because of the large stake the Federal Government has in fostering and guiding excellence in preservation.

ORGANIZATION OF THE REPORT

During the workshops, and especially in preparing the draft workshop reports, it became clear that the boundaries between each broad subject area are becoming increasingly indistinct. Those who seek to preserve prehistoric and historic sites, structures, and landscapes share many problems in obtaining access to information about technologies, training, and coordination of research in new techniques. In addition, they share most of the same technologies. Finally, they all experience the constraints of ever more limited funding and lack of coordinated Federal policy and implementation. Hence, it seemed appropriate to organize this report, which focuses on preservation technologies, around the issues raised by the technologies themselves, and how they are applied in the various stages of the research and preservation process, rather than force discussion of these issues into a disciplinary mode.

The Chapters

Chapter 3: *Research* explores issues concerning technologies utilized in discovering, recording, and analyzing sites, structures, and landscapes. Many of the most dramatic recent advances in applying technologies to preservation, such as remote sensing, geographic information systems, and predictive modeling, have been made during the discovery stage of the research process.

Chapter 4: Restoration, Conservation, Maintenance, and Protection explores the many techniques, methods, and equipment required for conserving and protecting cultural resources for future research, interpretation, and public enjoyment. The primary concern expressed by the many contributors to this study is the rapidity with which historic structures and landscapes, as well as archaeological sites, are being destroyed as a result of land development, vandalism, looting, erosion, and other human and natural causes. This chapter discusses the cultural resources management and law enforcement issues related to such losses, and presents several advantages and limitations of technology in mitigating them.

Computers are only beginning to affect profoundly the conduct of prehistoric and historic preservation. *Chapter 5: Preservation /formation* examines the part computers and other technologies for storage and retrieval of data and information play in preservation.

Educating the public, who provide most of the funding for prehistoric and historic preservation, on the results of preservation research and treatments, is a crucial component of prehistoric and historic preservation. *Chapter 6: Public Education* addresses the role technologies play in public education, and making such learning enjoyable as well as meaningful.

The Federal Government provides much of the leadership for historic preservation. *Chapter 7: Technology and Preservation Policy* examines the issues raised in the previous chapters and discusses options for improving the implement ion of current Federal preservation policy. It also suggests and analyzes new policy avenues Congress might wish to explore. Finally, it discusses State, local, and private sector contributions to preservation.

OTA selected a review panel, composed of participants from each workshop, to review the final draft of the report. In addition, the draft was sent to a variety of others, both within and outside of government, who reviewed selected portions.

OTA is grateful to the workshop participants and to the many others from Federal, State, and local agencies, the universities, private firms, and organizations who provided information or reviewed portions of this report in draft. Their helpful and timely comments and suggestions are an important part of this report.