CCI

The Journal of the
Canadian Conservation Institute

Volume 1 /1976

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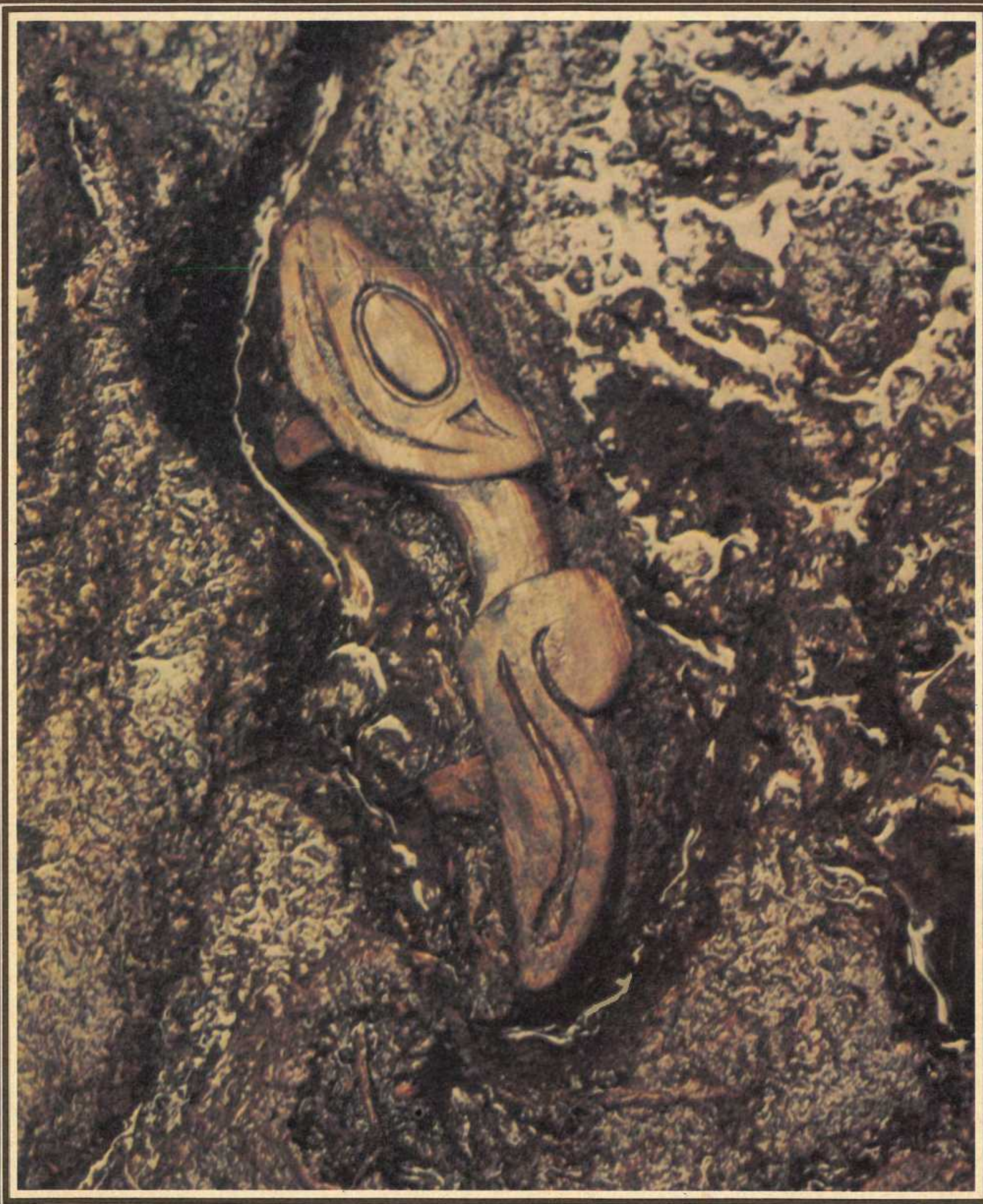

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Volume 1 1976

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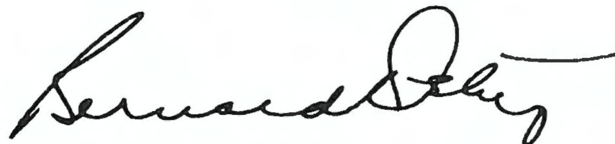
COVER: Carved cedar handle, approximately 1,600 years old, embedded in water-soaked soil at the Lachane Site, Prince Rupert Harbour, northern British Columbia. The difficult problems of preserving such saturated artifacts are the focus of a major new field of research at the Canadian Conservation Institute. [pages 29 and 30]

A Message from the Secretary-General

It was anticipated in 1972 that the new museums policy of democratization and decentralization would substantially increase the study, exhibition and circulation of artifacts in museums across Canada. However, to have considered increasing the use of collections without providing for their conservation would have been irresponsible. Hence, the Canadian Conservation Institute was established as an integral part of the National Museum Policy.

Still in its early phases, and having only just settled into its new headquarters, the CCI has much to do. For example, three regional offices remain to be established and priorities are being reviewed in light of first experiences. Regretfully, the impetus to development has been slowed for the present due to the federal restraint programme. Yet, as a result of the CCI's work in only three years, the preservation and care of collections are now considered an essential part of the responsibilities of any gallery, museum or historical institution. The CCI is being built on a strong foundation, and is providing its specialized, professional services to many hundreds of museums and galleries across Canada.

It is fitting that the story of the development of the excellent conservation services and research programmes at the CCI be told and made available to directors, curators, conservators and the interested public in Canada and abroad. Moreover, the regular publication of this journal in the future will ensure that the advances we are making in conservation processes and research are made known to those most concerned with this essential aspect of modern museums.



Bernard Ostry,
Secretary-General

National Museums
Canada

A Message from the Director

As this is the first issue of our new publication, it would seem an opportune moment to say a few words about the Canadian Conservation Institute and its role in heritage conservation in Canada.

Prior to the establishment of the CCI in 1972, there had been a growing awareness amongst those concerned with the care of historical artifact and fine art collections in Canada that all was not well with the state of their collections. At that time, the number of qualified conservators in Canada totalled not more than thirty.

It was against this background that the CCI was established as part of the democratization, decentralization and preservation policy of the National Museums of Canada, a Crown Corporation of the Canadian Government, comprising the National Museum of Natural Sciences, the National Museum of Man, the National Gallery, and the National Museum of Science and Technology. The programmes of the corporation include the Museum Assistance Programmes, the National Inventory of Collections and the Museumobile Programme, as well as the CCI.

In an October 1972 public announcement, the then Secretary of State, the Hon. Gérard Pelletier, said:

> To have national treasures to display at all, means that we must maintain and restore them. There is an immense and urgent need for the establishment of conservation and restoration laboratories throughout the country. As a whole, the national cultural heritage is in such a state of neglect that if remedial action is not taken quickly, the value of the collections will diminish greatly in the next ten years, particularly in the small and medium-sized museums. We have prepared an immediate plan of action: the establishment of a Canadian Conservation Institute with a complementary network of satellite laboratories.
>
> The Canadian Conservation Institute would be a laboratory conducting research into methods of preserving, restoring and transporting all types of cultural objects. The role of this Institute would be fourfold: to conduct research based on Canada's special needs, to train specialists in this field, to provide consultant services for museums, individuals and institutions possessing objects forming part of the cultural heritage, and to direct regional service laboratories. We propose locating service laboratories in five regions: the Atlantic, Quebec, Ontario, the Prairies and the Pacific. These would be under the aegis of the Canadian Conservation Institute, but there would be provision, through the setting up of advisory committees, for consideration of recommendations from provincial and local museums and authorities when establishing priorities for each region.

The headquarters and the centres for the Atlantic and Pacific regions have now been established. But, due mainly to government fiscal and manpower restraints, the time allotted for the establishment of the three other regional laboratories has been extended to 1978-80.

In order to maximize our currently available resources, we have integrated as much as possible the scientific research on conservation and the conservation services of the Institute so as to give each discipline the opportunity to understand first hand the problems of the other. This, we hope, will lead to greater advances in conservation generally, and especially in the five major areas of conservation research we will be pursuing during the next five years. These research programmes include water-logged wood, Indian rock art, iron corrosion, dammar varnish, and exhibition case design and environmental controls.

As conservators, we realize that we spend a lot of time preaching to the converted and, while it is our intention that this periodical be aimed primarily at the conservation profession, we hope to make its interest and circulation as wide as possible, especially amongst our curatorial colleagues. This first issue is devoted to telling you, our readers, what the CCI is and what we are trying to do. The survey of lighting conditions in Canadian museums is only one example of the kinds of reports we plan to publish in this journal. Future issues will contain articles on studies of conservation techniques and analyses of related materials, along with a *notes and queries* section.

Finally, I would like to say that this journal could not have been produced without an immense amount of work by all my colleagues, to whom my thanks are due. A special word of thanks is particularly appropriate to our hard-working editor Roy Allen Vontobel. I am also most grateful for the constant help and encouragement, in all our endeavours, of the Assistant Secretary-General (Programmes) of the Museums Corporation, Jennifer R. McQueen, and of the Secretary-General, Bernard Ostry.

Brian V. Arthur

Brian V. Arthur, Director

INTRODUCING CONSERVATION

The tangible evidences of the past can be found in the exhibition halls and storage rooms of museums, archives and public and private collections all over the world. Great numbers of people flock to museums to see the real objects from prehistoric times and the works of artists and craftsmen of earlier centuries. Man's curiosity about himself seems as natural as it is intense. To better understand the present and future of mankind, we seek out the record of our past.

In order that these vestiges of the past survive our generation, and generations yet to come, it is necessary to preserve and protect them. The causes of the deterioration and neglect of the works of man are many and complex. Next to natural disasters — floods, fires, volcanic eruptions — or simply the passage of time, mankind poses the greatest threat to the cultural record. Monuments and artifacts have frequently been the first victims of clashes of ideology, of nationalism or of religious zealotry. Less dramatic, but equally irreversible, has been the loss of images of great beauty and importance through neglect, thoughtless vandalism and by the pursuit of progress.

Nor does the museum always constitute a safe haven for the objects of our heritage. Acquisitions often suffer from a lack of funds for their proper storage or from mishandling. The dangers which well-meaning but ill-conceived display techniques represent are well documented. Even the welcome increase in the numbers of museum visitors often spells danger for the objects of their interest.

The knowledge exists to cope with the generally harsh treatment museum objects have thus far received. And, this knowledge is expanding. But unless those outside the profession learn to appreciate that conservation must be an on-going process of top priority, future generations will have little material evidence of their past and no yardstick by which to judge their progress.

Conservation no doubt had its beginnings in remote Antiquity, whenever and wherever the peculiarly human penchant for saving and learning from what has gone before arose. Early conservation practices may have stemmed from religious motivations, from reverence toward long-dead ancestors, images of gods, and the like. The contributions of science also began early, as when Archimedes revealed a forgery by evaluating (with his theory of specific weights) the gold content of the crown of King Hieron II in the third century B.C.

The Italian Renaissance fostered the conservation and protection of monuments, sculptures and various collections. In 1603, Peter Paul Rubens restored several paintings for the Duke of Lerma. In late 17th-century France, some paintings were lined by a restorer named Lamorlet, according to the inventory record of the Royal Collection. However, the technology of conservation as it is known today really flowered during the 18th century, when such techniques as the transposition cradling of paintings and the cleaning of engravings were utilized.

Michael Faraday and Louis Pasteur in the 19th century helped initiate the first modern collaboration of science with conservation. In 1888, the first laboratory of conservation was founded in Berlin at the Staatliche Museum, followed in 1919 by the Conservation Department of the British Museum in London. The systematic scientific approach to conservation was firmly estab-

lished within a few years with the creation of well-equipped laboratories at the Louvre (Paris) in 1925, the Fogg Art Museum (Cambridge, Massachusetts) in 1927, the Boston Museum of Fine Arts in 1930, the Metropolitan Museum (New York) in 1931, the National Gallery of Canada in 1933, and many others.

Such museums, whether their collections encompass the fine arts, archaeology or natural history, do not exist as mere storehouses but as institutions of public education in its broadest aspects. However, to fulfill this role requires more than just the effective display of aesthetically and scientifically significant objects, for the complex and often arduous task of protecting these collections takes priority. If a museum destroys its collections through neglect, irreparable loss occurs which no amount of exhibition expertise can rectify.

Concern about the responsibilities of museums, including the care of their collections, has been a growing phenomenon of recent decades. The need for more conservation services and greater scientific appreciation of conservation problems has been faced in several ways. Besides scientific laboratories in museums themselves, departments have been set up in many universities to train personnel in the special skills of conservation. Moreover, international organizations have emerged to coordinate and promote conservation efforts in nations all over the world. The International Institute for the Conservation of Historic and Artistic Works (London), the International Centre for the Study and Restoration of Cultural Property (Rome), and the Conservation Committee of the International Council of Museums (Paris) are examples of these.

In public museums and galleries in Canada, as in most countries, the responsibility for custodianship is generally that of the curator. The responsibility for conservation and restoration is that of the conservator. The duties and professional responsibilities of the two, however, are not entirely exclusive. There is much that the conservator (and the conservation scientist) can do to assist and advise the curator and, likewise, much that the curator can do to reciprocate. Possibly because the work of the curator in the collection, interpretation and mounting of exhibits is more visible, it is better understood by the public than the conservator's work, though perhaps no less easily defined. For the purposes of this publication, however, what conservation is and what a conservator does are the central and more important questions.

The Chief Conservator of the British Columbia Provincial Museum, Philip Ward, has provided an excellent definition of what conservation is: study and research; consolidation and stabilization of artifacts; cleaning, repair and storage; handling and transportation methods; and environmental control.

The Fine Arts Laboratory. Pacific Conservation Centre, Vancouver, British Columbia.

Understanding how materials behave — the diversity of materials from which objects of every conceivable sort are made — is a fundamental prerequisite of conservation. It is essential whether the conservator works in a laboratory or, as in the case of buildings or monuments, in the field. "All of these procedures are directed to one end: the preservation of artifacts by stabilizing them to prevent further deterioration." (See *Keeping The Past Alive*, available from the British Columbia Provincial Museum, Victoria, B.C. This booklet eloquently describes each aspect of conservation mentioned above.)

Conservation cannot be fully appreciated without understanding the relationships between three elements: the conservator, the artifact or work of art, and what processes the first applies to the second. Together they characterize the design of a particular conservation laboratory. The interplay of these elements would be a purely academic matter, except that limitations are inherent in the capabilities of human beings to process antiquities for the purpose of preserving them. Indeed, research in conservation processes is aimed primarily at understanding and overcoming these limitations.

Uppermost in the conservator's attitude, then, is recognition of the need for continual study of ways to improve one's conservation procedures and restoration skills. The conservator must take great care in appraising the special requirements of each individual object, for in conservation there is no such thing as a standard treatment. Consolidation and stabilization must be aimed at retarding the deterioration of specific types of materials resulting from any and all foreseeable changes in environment which might occur. Cleaning, which is not nearly so simple a process as it may seem, must be done in ways which will not cause excessive abrasion or alteration. And, it often takes a practiced eye to determine what is dirt and what is patina on an object. Furthermore, the conservator must differentiate between too much restoration and just the right amount, however that may be defined. The extremes range from total restoration (in which the danger of altering the original concept of an object is ever-present) to "sympathetic" restoration that respects the integrity of the artifact.

"An ounce of prevention is worth a pound of cure" is more than an old saying in the mind of the conservator; it is a guiding principle. An enormous amount of damage to artifacts can be avoided simply if proper steps are taken. In museums, artifacts and works of art exist in an artificial environment which, unless properly controlled, may bring about rapid deterioration of objects. A piece of basketry which, under certain stable conditions, may have survived for thousands of years in an archaeological site, might fall to pieces in a few short years in the radically different climate of a museum. Curator, conservator and conservation scientist must work together to control temperature, humidity, ultraviolet radiation, chemical and biological reactions, and disturbances caused by human activities, all of which contribute to the destruction of valuable collections. At the same time, the conservator, who often finds a solution to a complex problem by drawing from a variety of sources, must appreciate the financial limits within which museums must operate.

Conservation is not all glamour and sophistication; it is hard physical labour, requiring a great deal of time and patience. But its rewards are so immense that no amount of drudgery or frustration could seriously detract from them. Above all is the conviction that a contribution to this field is a contribution to a greater understanding of civilization and its artistic and cultural achievements.

The future of conservation in this country, and therefore the future of our heritage, lies in two principal areas: the education of both layman and museum worker in the fundamentals of conservation, and the development of a broad-based corps of professionals trained in the special fields of conservation. In setting our priorities, we must fully realize the tragedy which the loss of a portion of our cultural history would entail. Unless adequately backed by financial and human resources, the conservation profession cannot cope with the growing dimensions of its assigned task.

What follows in this introductory issue of the CCI Journal hopefully will help to further understanding of the field of conservation and the work of conservators and conservation scientists. It offers some perspective on the Canadian Conservation Institute and its efforts to provide service, training and research in Canada.

Lynn Ogden
Ian Wainwright
Roger Roche

CONSERVATION SERVICES

It would be as easy to summarize the role of Conservation Services as it would be to briefly describe the art history, aesthetics, and material culture of five continents and a myriad of cultures in history and prehistory. Conservation Services is part of an international community of those involved in the conservation of cultural objects, although concentrating on artifacts and works of art of particular significance to Canadians. Few strict distinctions can be made between the various divisions at the CCI, for their responsibilities and problems frequently overlap. The divisions described here are recognized for practical purposes.

Archaeology and Ethnology Division

Sir John Franklin's last Arctic expedition left England in 1845 with two ships, H.M.S. Erebus and H.M.S. Terror, and a crew of 133 officers and seamen. After a promising start to his search for the Northwest Passage, the explorer wintered on tiny Beechey Island in Barrow Strait to the northwest of Baffin Island; there three of his crew died and were buried. From recovered documents, it is known that Franklin himself died suddenly somewhere farther westward on June 11, 1847, and probably all members of the crew had perished by 1848. During the following decades, many expeditions courageously set out to discover the fate of Franklin's party. One such group camped further south along the coast of Beechey, where they built a storehouse — all the while the number of graves on the island increased. These ensuing explorations and more recent investigations leave no doubt about what happened to Franklin's men. Only the grim details of the expedition's final days are left to the imagination.

From the graves on Beechey Island, four wooden grave markers with carved inscriptions have been found. Being upright structures, they were weathered considerably over the past hundred years or so by abrasion from windborne ice particles. (Most artifacts lying exposed on the ground surface, whether from archaeological sites or from the remains of early explorations, typically are weathered and scattered over time by the rigours of the Arctic climate.) Continued abrasion of the grave markers would have soon obliterated the remaining lettering, so it was decided to remove them and place them in a museum after suitable conservation treatment to stabilize them has been done. Replicas have been set up at the grave sites to replace the originals, and conservation treatment of other wood and metal objects remaining at the site also will be necessary.

Tugging delicately, a conservator peels off the top half of the rubber mold which will be used to make a cast of a grave marker.

Two of the Beechey Island grave markers are now being treated at the CCI's Archaeology and Ethnology laboratory, and two others will be arriving shortly. As a first step, the woods were identified. A badly worn marker from the grave of an unknown crew member was made from a species of elm. The other, from the grave of one John Torrington, was of *Maulikara* sp., commonly known as bullet wood, a tropical or semi-tropical hardwood native to the West Indies and parts of South America. This wood was used by the British Admiralty for the frames and keels of ships. Besides the above-ground level abrasion, the wood had suffered even greater deterioration of those portions (10 cm) which were below ground down to the level of permafrost. What had been embedded in permafrost, however, was in remarkably good condition.

Before molds for replicas could be made from the originals, the 10 cm portions representing the zone between permafrost and ground surface required consolidation. This was accomplished by injecting the wood with an acrylic resin in solution, while the fragile surface was treated with a polyvinyl acetate emulsion to strengthen it. A silicone rubber was used to make the molds, and casts were produced with epoxy resin. In order that the replicas appear natural as they become weathered — for when they are set up at the graves they will be subject to the same abrasive forces as the originals — it was imperative that the colour of the casts be uniform throughout. To make them sufficiently rigid, the hollow casts were filled with polyurethane foam. Stainless steel rods anchor them in the ground.

Two of the Beechey Island graves, solemn reminders of the hardships faced by early Arctic explorers. The original marker of seaman John Torrington is on the right in this 1972 photograph.

The grave markers of Beechey Island were carved by men who knew the spectre of lonely death in a remote frozen wilderness as a constant companion. As such, they provide substance to a stirring page out of Canada's history. Yet, these graves are only one example of many sites where fragile original artifacts can no longer be exposed to the elements but must be treated and then housed in a museum if they are to survive. The replacement reproductions made by CCI conservators can be detected from the originals only under close scrutiny, and convey as fully as possible the meaning of the artifact in its original situation. Such reproductions sometimes are used for museum display also, as in instances where an artifact might be damaged during a travelling exhibition or where more than one of the same artifact might be needed for a certain display design.

The problems of artifact conservation are frequently complex, as this field includes a wide variety of museum objects made from an equally wide range of materials: wood, metals, glass, ceramics, stone, bone, ivory, fur, skins, leather, basketry, shell and feathers. Many of these objects are decorated with diverse grounds, paints and varnishes, which add to the treatment difficulties.

The cast of John Torrington's grave marker is set in place. Anchor rods of stainless steel, buried in the coarse, shoreline gravels and locked in permafrost, buttress the replica against high winds and driven ice.

The Archaeology Laboratory at the CCI.

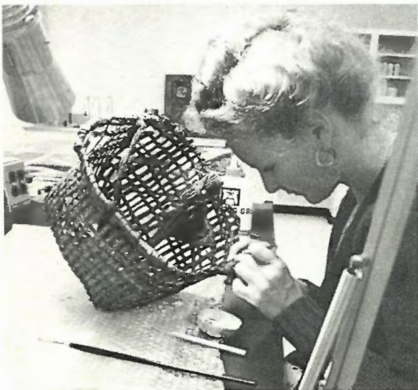
Moreover, such objects generally were designed for use and not for permanence in the sense that "art" objects are. Artifact conservators, therefore, often require the cooperation of experts from other conservation divisions as well as Analytical Research Services in order to identify and solve the numerous problems these materials present.

In the Ethnology Section, particular problems arise because so many of the objects treated are made from perishable substances. And, often a number of different materials may have been used in the construction of a single artifact. The large and elaborate masks of the native peoples of Canada's West Coast are a good example of this. One now at the CCI is a Tsimshian bird mask collected in 1927 at Kitwancool, British Columbia, by the noted ethnologist Marius Barbeau.

Like many used in the rites and performances at coastal villages during the winter season, this mask has several moving parts. The upper parts of the long narrow beak are spring-loaded and swing out to either side on leather hinges, revealing a carved human figure lying face down in the lower beak. A clock mainspring, one end of which is fastened to the neck of the figure and the other inside the head of the mask, pulls the figure rapidly to an upright position when the beak is opened. When the mask arrived at the CCI, it was dusty and much in need of repair. One of the leather hinges on the beak was worn through completely, while the other was just barely intact. The mainspring had ripped through the vegetable fibre cord that held it to the neck of the human figure and had sprung back inside the head. The strip of spring steel attached to the inside of the moveable portions of the beak had snapped where it was bent 180 degrees at the base of the beak. And, the coiled spring which had encircled this strip of steel also had snapped and had slid off about half its length.

The curator involved wished to have the mask restored to working condition, if possible. This, however, presented an interesting problem. If the broken spring steel strip was repaired and working as originally intended, the two sides of the beak would tend to fly apart rather violently. While this spectacular effect would be very suitable for a Tsimshian ceremonial, it was decided after due consideration that it would not be desirable in a crowded storage area, not for the mask itself, the objects around it, or the individual who happened to "set it off".

Carefully retwining the rim of a Bella Coola basket from British Columbia [below], a conservator uses the original material softened in distilled water. The binocular microscope aids in examining the corrosion layer on a short-bladed iron knife from Zaire [bottom]. Both artifacts are in the collection of the National Museum of Man, Ottawa.



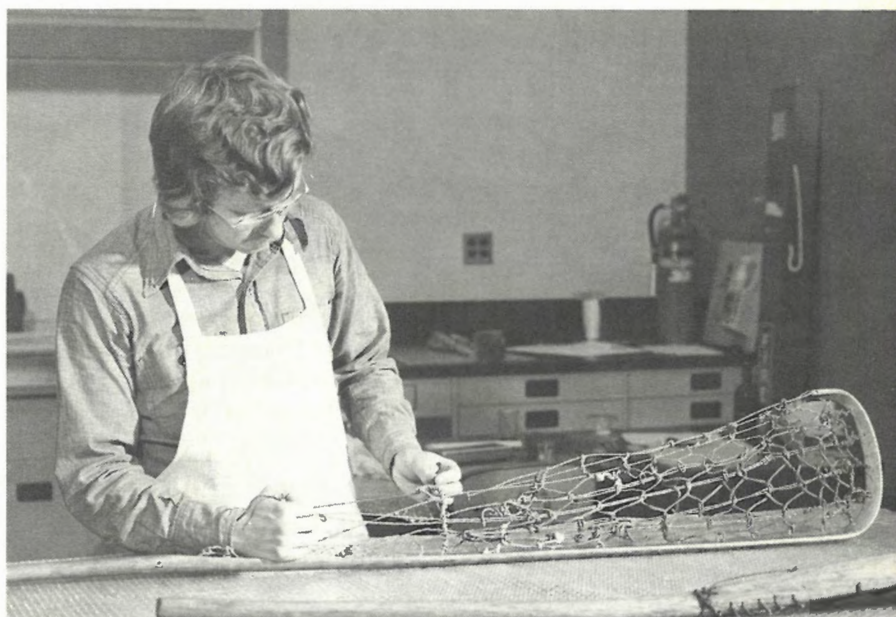
The coiled spring was replaced in its proper position around the spring steel strip, but the strip itself was not repaired. The beak can now be opened easily by hand, but will not fly open abruptly. The mainspring was reattached to the neck of the human figure with several twists of thin steel wire hidden under the original fibre cord. The break in the cord was repaired, using a polyvinyl acetate solution, and realigned with the mainspring by several strands of cotton thread tinted with watercolour to match the original red ochre. Chrome-tanned leather was cut to serve as backing for the original hinges, which were carefully removed along with the tacks holding them. To stabilize the tacks and prevent further corrosion, they were given several coats of tannic acid solution, followed by a coat of lacquer. The leather hinges with their new backings were then replaced and the tacks driven back into their original holes. Finally, all remaining ferrous metal tack heads and a ferrous metal strip on the back of the mask were given several coats of tannic acid solution and a coat of lacquer. The mask now can be placed on exhibition, looking and operating much as it did in the Tsimshian ceremonials, and when in storage will not pose a threat to itself or surrounding artifacts by its somewhat explosive nature.

In the Archaeology Section, objects usually arrive in a more advanced state of deterioration than those in the Ethnology Section. Parts of artifacts made from extremely perishable organic materials, such as fur, skins, feathers or fibre, may be too badly decomposed to be restored or may even have disappeared entirely. Metal surfaces are often totally obscured by corrosion products, and present a challenge to the conservator. The cleaning of corroded bronze, for example, often is done by hand under a binocular microscope, a job which requires a great deal of skill and patience. Once a satisfactory cleaning has been achieved, revealing a maximum if not all of the original surface detail within the patina, the object is stabilized chemically to prevent further corrosion.

Stabilization of iron objects involves the removal of chloride ions, which in normal humidities greatly accelerate the rate of corrosion. This is done by boiling in distilled or ionized water. When no more chlorides can be detected in the water, the object is dried and a protective coating applied. Frequently some

The Tsimshian bird mask [left and above], an artifact made from a variety of rather perishable materials, was collected in 1927 at Kitwancool, British Columbia, by ethnologist Marius Barbeau. National Museum of Man collection.

To restring an Iroquois lacrosse racket, the conservator must determine the technique originally used. From the Six Nations Reserve at Brantford, Ontario. National Musuem of Man collection.



additional restoration is needed to give the object sufficient mechanical strength to withstand being transported and displayed.

Various sorts of ceramic and glass artifacts require special conservation procedures. Often the surfaces of vessels or other ceramic bodies must be consolidated; fragments of pottery, for example, must first be strengthened before a complete vessel can be assembled from the deteriorated pieces. Selection of the proper repair materials for these processes is critical to obtain satisfactory — and reversible — results. In many cases, filling gaps from missing pieces must be done to provide mechanical strength or to make the form complete. Restoration to re-integrate these gap-filled areas is normally called for as well.

Finally, techniques which archaeologists have developed for recovering perishable artifacts from water-logged sites have presented an entirely new conservation problem. From sites in British Columbia, for example, archaeologists have been able to recover items of wood and basketry which have been submerged in water-logged soils for as much as thousands of years. If these objects are simply allowed to dry out, serious and irreparable damage occurs rapidly. The preservation of these materials demands unique methods and facilities which are presently being planned and should soon be installed for this work.

Charles Hett
Stan Frydryn
Tom Stone

A steady hand and extraordinary patience are needed to put together a fragile glass vial in many pieces. The vial is of Near Eastern origin, 4th century, from the Redpath Museum, McGill University, Montreal.

Fine Arts and Polychromes Division

On Christmas Day, 1975, disaster struck the Hastings County Museum in Belleville, Ontario. In the reception room of Glanmore House, deserted during the holidays, a radiator burst, spraying water and drenching paintings, books, and furniture. Within days, most of the paintings became unrecognizable, as humidity and water penetrated minute cracks in varnish and lacquer, leaving a highly opaque appearance. Moisture seeped inside the supports and paint layers. Blisters formed on the paint surfaces, causing paint to flake away; furniture warped and moulds quickly developed on books and documents. One painting — *Portrait of a Girl* (late 19th century, attributed to Cecilia Couldery) — was nearly obliterated. It was a scene of devastation enough to give a curator nightmares.

Instinctively one might have set about to salvage the objects by moving them to a heated room and attempting to clean them up in various ways. Thanks to the alertness of the curator, however, nothing was done to the objects other than removing the paintings from the walls. Instead, all available ventilators were hastily collected from the attic and put into the rooms, allowing fresh air circulation to dry the soaked pieces.

At this stage, the CCI was informed of the mishap and a team was dispatched to the scene to assess the damage. The most seriously damaged objects were transported immediately to CCI Headquarters. Another painting in the Couldery collection, a seascape mounted on cardboard, was severely warped by moisture. Only swift attention would save it, for its paint was literally "popping away". All retrievable pieces of paint were carefully picked up off the floor and sent to the CCI, there to be patiently put back in proper position.

The treatment of four vandalized paintings from the Manitoba Legislature Building involved various time-consuming processes. Removing layers of discoloured varnish [left] was a particularly tedious task. In the close-up [upper left], Edward VII appears to be stepping into a cleaned area. Slashes in these paintings were filled with large strips of canvas, and the paint layers around each cut had to be carefully consolidated. A rigid new lining was later impregnated onto the back of each original canvas.

Today nearly all of the objects are back on display. And, automatic valves on the radiators in the museum were replaced by unbreakable manually-operated valves to avoid repetition of such a disaster.

Thus, by the application of the proper salvage and restoration measures, the Fine Arts and Polychromes Division averted what otherwise might have been a catastrophe. This particular incident, while in itself unique, is nevertheless no more unusual than many in the day-to-day work of a fine arts conservator. Rescue operations and more routine projects involving studio paintings, panels and murals, as well as polychromed and unpolychromed sculptures are normal activities. Both heritage pieces and modern Canadian works, primarily from the provinces of Quebec, Ontario and the Prairies, are treated.

Two senior and five junior conservators, following the traditional master-apprentice approach, utilize the most modern techniques and developments in the field of fine arts conservation, and strive to meet the most exacting standards of treatment. Prior to treatment, the conservator must take adequate time to create a genuine rapport with a work of art. Respect for the integrity of the object is rule number one. Emphasis is thereby put on aesthetics and on the strictly objective revival of the artist's concept; the conservator cannot in any way modify the original, regardless of his motives. Furthermore, the conservator must apply treatments which are reversible; he must avoid the use of materials which cannot be removed in the future without harm to the object. Only by adhering to these principles can the conservator fulfill his obligations in correctly assessing the condition of a work of art and in determining the most appropriate treatment procedures.

Works of art are all-too-often the victims of senseless acts of vandalism. Four large paintings, including Edward VII *by the Canadian artist Victor A. Long, were slashed in December, 1974, in the Manitoba Legislature Building in Winnipeg. The photograph taken before treatment [left] shows one large cut near the king's foot. Shipped in crates of thin plywood, this painting unfortunately suffered additional damage in transit to the CCI. The fully restored painting is on the right.*

Works of art suffer damage of many different sorts stemming from a wide variety of causes. They undergo physical and chemical transformations such as the cracking and fading of pigments with age, the discolouration of varnishes, the stretching and shrinking of canvas, and the ravages of decay in general. They are attacked by insects, moulds and other organisms. And, besides the effects of neglect, they too often succumb to accidental damage through careless handling and sometimes to outright vandalism.

Another recent assignment of the Fine Arts division shows, by an incidental though by no means infrequent by-product of the restoration process, how important is the working relationship between the conservator and the art historian. This project concerned a painted panel depicting *Venus and Cupid*, property of the Winnipeg Art Gallery in Manitoba. Acquired in 1948 at an auction in London, England, the painting had been attributed to the late 16th-century Flemish school of Frans de Vrient Floris or Willem Kay.

Considered a conservation priority, the panel was flown to Ottawa for immediate treatment. The crate was not opened until three days after its arrival at the CCI to allow the painting to gradually adjust itself to its new environment. According to the technical history: "A photograph taken in 1956 shows that at that time the painting was still intact. In 1965, severe splits and cracks were first observed, indicating that the panel had undergone dimensional changes resulting in the blistering of paint." These problems were readily overcome.

However, prior to treatment considerable time had been devoted to determining the internal structure of the panel by means of ultraviolet fluorescence and infrared photography. In general, these examinations substantiated the attribution suggested by the art historian, although they did reveal that the artist's preliminary design underlying the finished painting was executed in an early rather than late 16th-century style. Moreover, many interesting *pentimenti* (changes in the artist's concept as he painted) clearly became evident.

In dealing with very large paintings, many additional problems arise. One of the biggest in Canada is a mural 25 feet long and 8 feet high by Senaka Senanayake of Sri Lanka (Ceylon), depicting a village scene, rice cultivation, rubber gathering and other rural activities in the artist's homeland. Painted especially for the Ceylon Pavillion at Expo '67, it was later donated to Canada.

Because of its huge size, an adequate place to display the painting was not easily found. Arrangements ultimately were made for it to go on extended loan to St. Mary's University Art Gallery in Halifax, Nova Scotia. First, however, it came to the CCI for complete treatment.

Portrait of a Girl, *attributed to Cecilia Couldery, before and after treatment of severe water damage. The blanching effect of the damaged painting resulted from moisture trapped between paint layers and varnish. Collection of the Hastings County Museum, Belleville, Ontario.*

Mammoth mural by Sri Lanka artist Senaka Senanayake. Owner: Secretary of State of Canada; on loan to St. Mary's University Art Gallery, Halifax, Nova Scotia.

Polychromed sculpture of wood, French provincial, 17th century. This piece, depicting a seated bishop, had undergone dimensional changes causing the wood to split and paint to flake off in numerous areas. Large cracks were filled with strips of wood. Collection of le Musée d'art de Joliette, Québec.

When the canvas was unrolled, it was apparent that the painting had been stored for some time in a wet area. The canvas was buckled badly, and patches of paint were gone. And, besides numerous scratches on the surface, there also were 23 bullet holes made with a small calibre gun. It would seem that someone had been using the rolled-up painting for target practice!

A special worktable had to be custom-made for the enormous canvas. All around the edges of the painting, five-inch-wide strips of extra canvas were laboriously sewn by hand. By these new edges, the painting could later be stretched rigidly onto a specially-made expandable frame. Bullet holes and scratches were repaired and inpainted, and a new lining applied to the canvas. Then it was carefully rolled onto a wide-diameter cylinder to be shipped to Halifax. Prior to the gallery opening in June this year, the painting was put on the new stretcher and varnished.

The opening ceremony at St. Mary's University was an important event for both the Canadian and Sri Lanka people, one in which the Fine Arts division at the CCI was pleased to play a key part.

Peter Vogel

Artistic and Historic Works on Paper

It is ironic that written history exists primarily on some of the most perishable of all materials man has used for keeping records. Paper, papyrus and parchment are quickly and completely destroyed by fire and water, are easily stained, and become brittle with age. Fungi and insects attack them, and ultraviolet light and air pollution cause severe damage. Neglect, improper storage, and even well-meaning conservation attempts (for example, mending with various kinds of cellophane adhesive tapes) take their toll.

Nevertheless, all three of these materials have been known to survive for many centuries under certain conditions, mainly low humidity. The oldest examples of paper come from China of the second century A.D., while parchment and papyrus were of earlier origin, especially the latter which has been used in Egypt for documents since about 3000 B.C. Paper-making was well established in Europe by the 14th century and, as the invention of printing in the 1450s greatly increased the demand for paper, it rapidly replaced the other two as the basic material for written communication.

Although made by different processes from different raw materials, both paper and papyrus are composed of cellulose. Parchment is a protein substance, being made from animal skins. The conservation techniques applied to all are similar, however, and since the majority of objects treated by the CCI's Paper lab are on paper, we will confine our brief discussion mainly to it. The most common works are prints, drawings, maps, watercolours, historic photographs, handwritten documents on either paper or parchment, and medieval illuminated manuscripts on paper or parchment. Japanese and Chinese paintings on paper or silk are treated, as well as Near Eastern items such as Turkish or Persian miniatures. With the recent arrival of a new staff member, we can now undertake the restoration of books.

Japanese screens consist of several layers of paper over a wooden framework. Paintings, on silk or paper, are attached to each panel and, finally, silk brocade. For treatment, all of this must be removed. On these screens [right], the body colour of hands and faces were painted on the reverse side to give a translucent effect, and stripping off the thin paper backings [above] had to be done with great care so as not to disturb this paint. New linings of extremely fine Japanese mulberry paper are applied with a thin paste [below]. Late 19th-century Japanese byobu; collection of the Public Works Department of Canada.

As soon as a work of art or historic document arrives, it is photographed and a report on its condition is placed on file. This is a standard procedure in all conservation divisions. If the art work is fragmentary, the photograph is used as a guide for reconstruction. A method of treatment is proposed by senior staff members, according to the type of art work involved and its condition. In many cases, works of art — unframed, framed with no glass, or framed with glass subsequently broken — have accumulated layers of surface dust and grime from years of lying about an artist's studio or on the shelves of art dealers or bookshops. Before any treatment begins, this dirt must be removed. It is usually done with rubber granules, which are rolled over the surface, lifting the grime without disturbing the medium, whether pencil, ink or watercolour. Pigments and inks are tested to determine whether or not they are fugitive. If they are unstable, a suitable fixative is applied.

In the past, pressure sensitive tapes often were used for mounting and repairing works of art on paper, and with time the adhesives on such tapes discolour the paper, harden (making the paper brittle), or both. Tests are done to find the most suitable solvent for removing tape and stains. In some cases, paper is discoloured from water stains or merely from age, and this is removed by washing in water baths. Then, more stubborn stains are removed by a bleaching process, using non-aqueous, gaseous, or other dissolving agents. The bleach must be thoroughly removed in order to eliminate the possibility of further bleaching action which might occur from extremes of climate.

Often a document or work of art may be torn or have portions missing. These are usually repaired with the same kind of paper used in the original or with thin Japanese paper. Nylon also is used, and occasionally silk gauze, depending upon the work.

One of the major causes of the deterioration of paper is its acidity, which brings about a chemical reaction in cellulose leading to degradation and loss of mechanical strength. Acidity may stem from the manufacturing process (as when acidic substances are used for sizing), it can be transferred from one paper to another in close contact, or it may result from other contamination acquired during aging. Airborne pollutants such as sulphur dioxide, a by-product of the burning of fossil fuels, convert to acid when absorbed by paper. Residues from bleaching, adhesives used in repairs, and even binding materials used by an artist can cause acid impurities to form.

If the lasting quality of the paper is to be assured, this acidity must be removed. It is done in various ways. The simplest is to treat the paper with a mild alkali in water, which neutralizes the acid and also leaves a buffer compound which helps absorb any traces of acidity acquired in the future. In cases where inks or pigments might be affected by the action of water, the conservator must use a non-aqueous treatment method. When the paper has been de-acidified, the work usually is mounted on a mat or placed in a folio of acid-free ragboard.

During the past year, many Canadian art treasures on paper, parchment and silk, as well as a number of historical documents, have undergone treatment at the Paper Conservation lab. Some of the most outstanding are: a sketch sheet attributed to Eugene Delacroix (Norman MacKenzie Art Gallery, Regina, Saskatchewan); a large pastel drawing by Napoléon Bourassa (Musée du Québec, Québec, P.Q.); two large design sketches by Ford Maddox Brown, for stained glass windows (Beaverbrook Art Gallery, Fredericton, New Brunswick); and a 17th-century Japanese kakemomo (scroll) ink painting on silk, *Kannon* (Art Gallery of Greater Victoria, Victoria, British Columbia). Fifty pencil drawings by the 19th-century painter of Indian life and the prairies, Peter Rindisbacher, were treated (for the Glenbow-Alberta Institute, Calgary, Alberta), as well as 102 sketches by the English landscape painter Anne Langton, who lived in Canada during the early 1800s (for the Fenelon Falls Public Library, Fenelon Falls, Ontario).

While the work on these important art pieces rarely fails to interest and challenge the CCI's paper conservators, occasionally an unexpected project sends prickles of real excitement through the lab — the kind that comes from sharing in a remarkable discovery. On the 20th of October last year, a small metal cylinder and its contents were flown to the CCI from Yellowknife in the Northwest Territories. It had been recently discovered by members of the Polar Shelf Project in a rock cairn at Cape Majendie on Devon Island high in the Arctic. Cape Majendie was one of the stop-overs used by Sir John Franklin's ill-fated expedition of 1845-48 and by a rescue expedition led by Captain Edward Belcher, one of the many search parties sent out during the following 12 years.

A late 19th-century edition of Milton's Paradise Lost, *with illustrations by Gustave Doré, was one of the numerous volumes recently damaged by water in an unavoidable accident at the Ottawa Public Library. It was possible to save the original leather binding; the conservator is here removing the spine in one piece, a difficult process. The book will be taken apart in sections, the pages washed and sized, and then rebound.*

Because parchment warps and buckles readily from changes of climate, particularly of moisture content, documents of this material commonly need reflattening. This is done by placing the document in a stretcher after it has been dampened by carefully controlled methods.

Examination of the cylinder's contents, which had thawed completely during the trip south, was started almost immediately upon arrival. Inside was a flattened rolled-up piece of soggy paper-like material, 4 inches long, covered with a considerable amount of rust and what seemed to be silver foil in patches. There apparently had been another, but it was in many broken pieces. Examination of these fragments revealed that they were part of a document which had been placed in the container by one of the Arctic expeditions of the 1800s; some handwriting could be detected.

The main problem was to find a way to unfold the rolled-up object without destroying it. Even under the closest scrutiny, there seemed to be no way in — no fold joints or tucks. Finally, the outer cover was painstakingly cut away with a scalpel, revealing a blue-coloured paper. Slowly, the outer layer of wrapping was removed. The blue stick of paper at first appeared to have no end at all, but after much probing one was found and the unravelling began. There were 32 folds, and upon the opening of each, everyone present expected to see something.

As many of the CCI staff and several members of the Polar Shelf Project gathered around, excitement mounted. When the last fold opened, a document appeared. The printed portions could be read, but the handwriting was difficult to decipher until the paper dried out and the ink darkened. It was signed by Captain Edward Belcher, commander of the Arctic Expedition, and had been left in the cairn on 27 July 1853.

The printing describes the expedition's progress and activities from August 1852 to the time the document was signed, including a list of lands proclaimed in the name of Her Majesty Queen Victoria as new territories of Great Britain. Despite the sober tone of this report, later history records that the hardships of this voyage seemed to tax Belcher beyond his abilities as expedition leader. In May 1854 he ordered four ice-bound ships abandoned, apparently without sufficient justification. Nevertheless, though he was later relieved of his command, he was knighted in 1867 and became an admiral in 1872. Perhaps the side of the story penned by Belcher's own hand could afford him a more honourable place in the annals of Arctic exploration. The document from Cape Majendie is part of that story.

David Dudley

The report left by Captain Edward Belcher on Cape Majendie in July, 1853.

On the 18 day of August 1852, H. M. S. Assistance, and Tender, Pioneer, under the direction of Captain Sir Edward Belcher, Commmanding the Arctic Searching Squadron, passed up this Channel and Wintered in Northumberland Sound Lat. 76. 51. N. — Long. 97. 0. W. —— He afterwards explored, and took possession of lands, up to North Cornwall, in Lat. 77. 40. N. in the name of Her Most Gracious Majesty Victoria Queen of Great Britain and Ireland &c &c.

In the spring of this year 1853, he pushed his parties to the S. W. up to Melville Island, and ascertained from a report from Captain Kellett, the safety of H.M.S. Investigator, and Crew at Banks Land.

His own Exploration, to the East and North East, carried him to the communication with Wellington Channel, 15′ N. W. of Point Hogarth: The communication of Jones Strait with the Polar Sea, and the addition of the Victoria Archipelago, to Her Majestys teritories in the Polar Regions.

The Assistance will return to Cape Becher, and Beechey Island, at the earliest possible chance after the roturn of the S. W. division, hourly expected.

One Marine died of abscess of lungs, during the winter, otherwise the crew have continued healthy, and no casualties of note.

Edward Belcher, Captain.

July. 5. 1853 Commanding Arctic Expedition.

[H.Briant. Printer H. M. S. Assistance.]

Furniture and Wooden Objects Division

The most recently established division of the Conservation Services programme deals primarily with the conservation and restoration of furniture, furnishings, and domestic and industrial crafts, dating from the 15th to the 20th century. Other kinds of wooden objects, many unique to Canada's cultural heritage, are treated as well: "totem" poles and other large unpolychromed wooden sculptures, dugout canoes, and interior architectural detailing, to mention but a few. One also may find musical instruments, of all ages and from all parts of the world, in this division's laboratory.

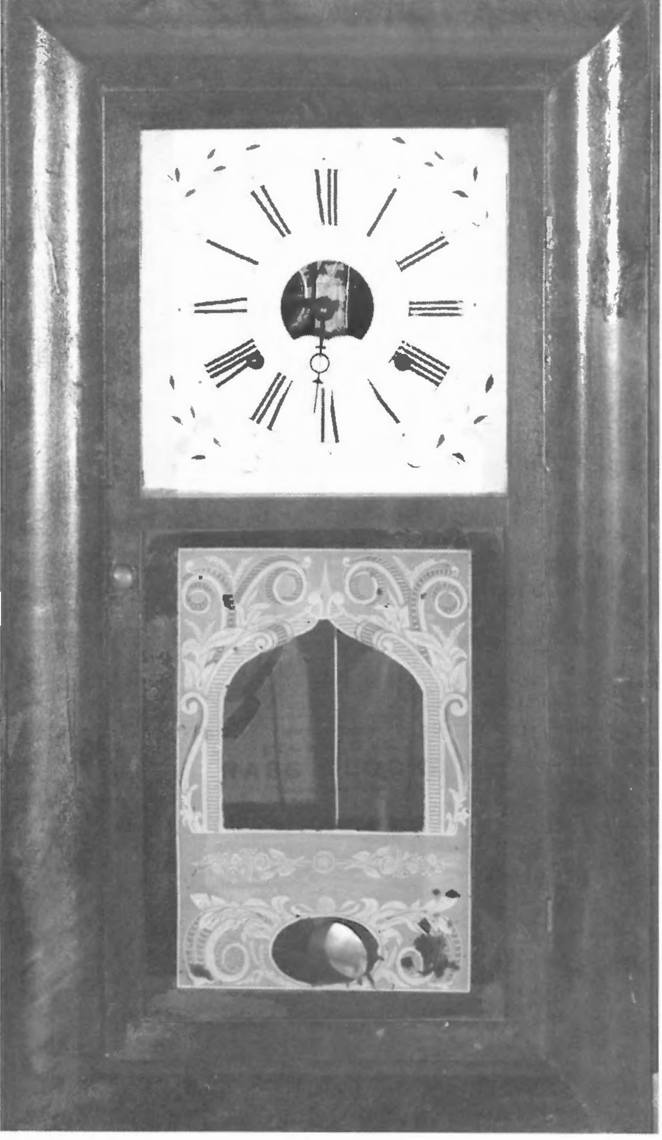
The diversity of materials and methods of fabrication found in these various objects daily challenges the conservator's ingenuity and skill. While some objects are made solely of wood, the majority are of wood used in combination with other decorative materials such as ivory, brass, bone, mother-of-pearl, and with different finishes such as paints, stains or varnishes. Many pieces of furniture, for example, are constructed from different species of wood, each chosen by the craftsman for its unique properties. Then they may have been covered with native Canadian veneers or those of a more exotic variety. Finally, surfaces could be painted or stained, and finished with one of several types of natural varnishes or oil.

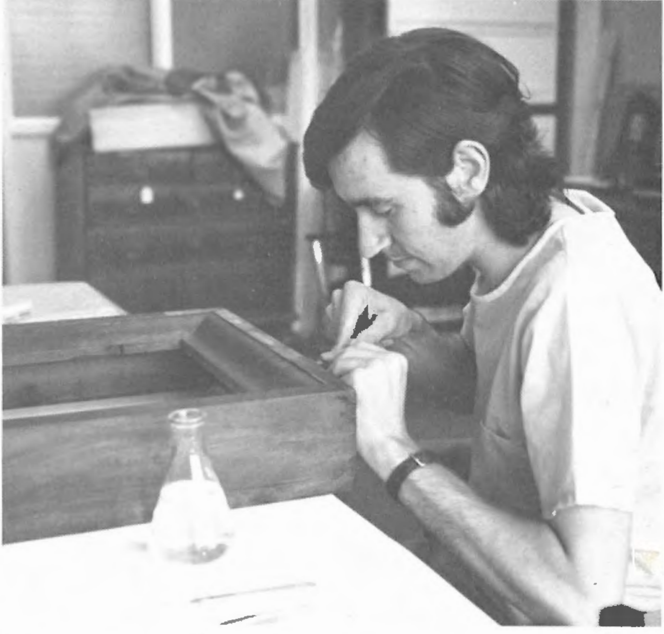
A *Seth Thomas* eight-day brass clock, recently restored at the CCI, offers a good example of the diversity of materials one encounters in many decorative art objects. This lovely clock dates from about 1850 and is in the collection of the Bytown Museum in Ottawa. Its condition when it came to the CCI was very poor indeed; several successive layers of darkened and disintegrating shellac hid the original beauty of the African mahogany-veneered pine case, while numerous pieces of the actual veneer itself had been lost. The manufacturer's paper label on the inside of the case was blackened and embrittled with age, and the transfer decorating the glass door of the case would before long have been totally lost due to cleavage. Several chips lost from the clock's painted face had been repainted in a crude fashion and, finally, the weight-driven brass works were damaged and did not function. After routine examination and documentation were carried out, the various clock components were distributed to several service divisions for treatment.

Treatment of the discoloured and disintegrating *Seth Thomas* label brought a surprise, for two labels were revealed, one glued over the other. Gluing the labels directly to the acid-producing pine backboards of the case had caused the paper to become friable and darkened, a condition not improved by a subsequent coat of varnish. Both labels were bleached, de-acidified and then backed with Japanese paper. Following several tests, a suitable method for treating the damaged transfer (decalcomania) was found, and the bubbled film subsequently readhered to its glass ground. The clock's face was cleaned of dirt and grime, and carefully inpainted where necessary.

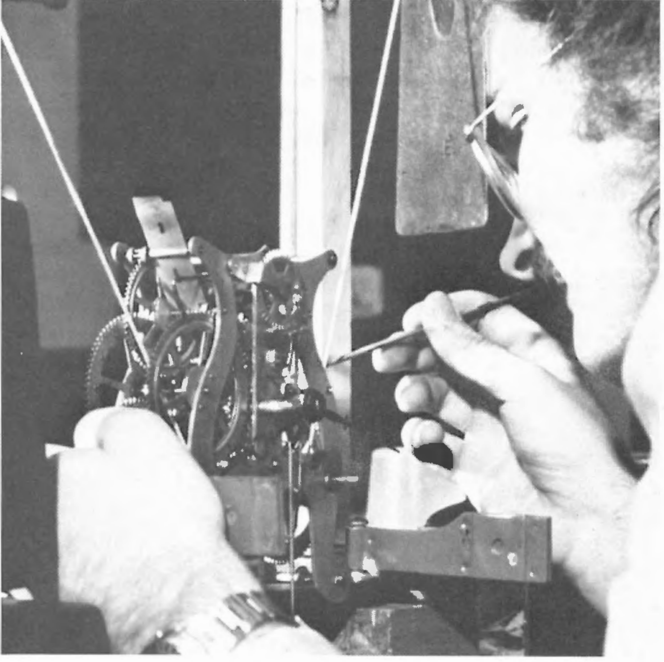
The clock works were dirty and had suffered from a previous repair attempt, which left internal rods disarrayed and some teeth bent. The misplaced parts were rearranged, the damaged teeth were repaired, and after cleaning and oiling, the mechanism was rendered functional. A new bell coil was made, and the shiny pendulum rod, which had been recently replaced, was toned down somewhat so as to match the other metal parts.

Before actual work was begun on the veneered clock case, all woods used in its manufacture were identified. This is a standard procedure for any wooden





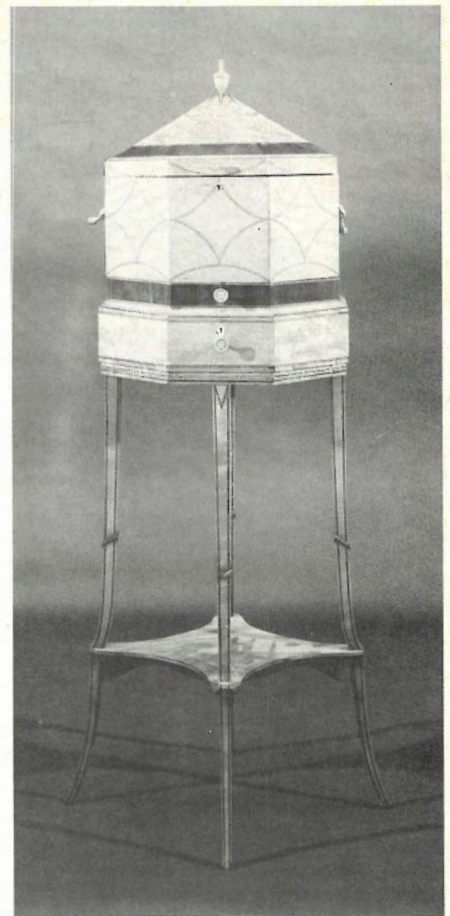
Often the expertise of several conservators from different divisions will be called upon to treat various components of an object, such as the Seth Thomas *eight-day clock. Clockwise from the upper left: clock before treatment; a Furniture and Wooden Objects conservator removing damaged veneer from the clock case; close-up of veneer; adjustment of the repaired clock works by a conservator from the Archaeology and Ethnology Division; and the newly backed manufacturer's label being toned with watercolour medium by a Paper conservator. Bytown Museum collection, Ottawa.*



object. Then we carefully removed several layers of darkened shellac and oil polish with solvents. Next, areas of delaminated mahogany veneer were relaid; restored veneer areas were stained to the correct colour, and the entire case prepared for refinishing and waxing. Finally, all the clock's components were reassembled, including the works which proved able to keep accurate time.

Two other pieces recently treated in the furniture laboratory illustrate the wide range of furniture styles encountered as well as the many kinds of materials used. One, a fine late 18th-century *Sheraton* satinwood inlaid workbox, of English provenance, had been exposed over a long period of time to the adverse environmental conditions typically found in Canada, particularly extreme variations in relative humidity which caused glue lines and joints to fail and veneered panels to warp. This box is exquisitely constructed, various exotic woods having been inlaid over a pine carcass. In the process of falling to pieces when received, it was carefully reassembled and minor restorations were done as well. It is presently in the collection of the Montreal Museum of Fine Arts.

A second object, a late 19th-century teapoy belonging to the Hastings County Historical Society (Ontario), is made of native Canadian hardwoods, including bird's-eye maple. This, too, is a well constructed and interesting piece, damaged when steam radiator pipes near it burst. This was the same Christmas Day disaster in 1975 which damaged numerous paintings and books. Veneer on two legs was destroyed, mouldings on the sides and drawer front were lost, and the finish overall was severely damaged. The teapoy was cleaned, delaminated veneer relaid and replaced where necessary, and an extensive amount of the lost moulding restored. After staining the new parts to match the old, it was refinished where needed and restored to a satisfactory condition.

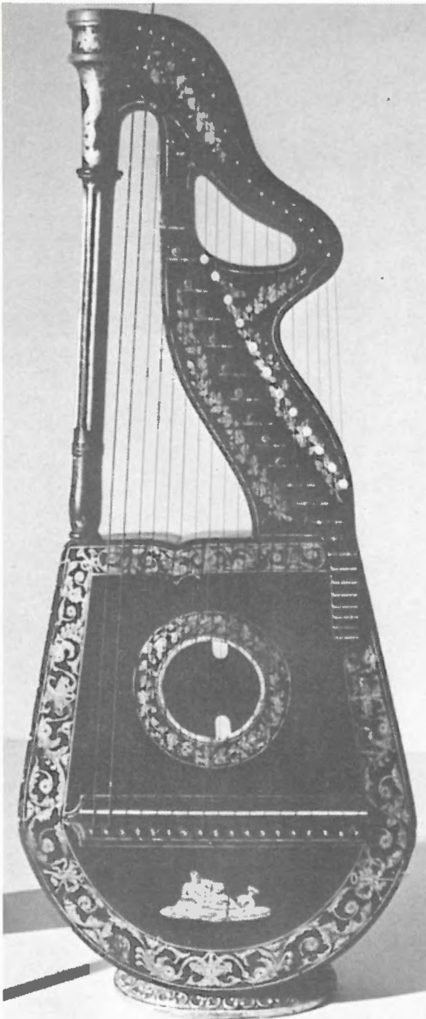


Sheraton *satinwood workbox, 18th century, before conservation treatment. Montreal Museum of Fine Arts collection.*

A pipe organ requires long-term treatment. Built by the firm of Hutter and Kittredge *in the mid 19th century, this one has a foot-operated bellows which supplies air to three ranks of wooden pipes. The front panel above the keyboard conceals a system of shutters which can be used to increase the volume by means of a foot pedal. This case is pine veneered with mahogany; in this photograph it has been partially cleaned.*

Besides a thorough cleaning, thick layers of varnish on the case were removed, and missing veneer and decorative woodwork were replaced. Pipes had to be realigned, and leather in the bellows mechanism was stained and hardened with age. Bellows linkage and pedals needed repair, as well as the keyboard. The early Canadian needlepoint in the front panel was placed in the care of a textile conservator.

From the collection of the Bytown Museum, Ottawa.



Light's *dital harp, circa 1816, after conservation treatment. Collection of the National Museum of Man, Ottawa.*

The conservation and restoration of musical instruments is a specialized field all-too-often ignored. Considering the extent of Canadian holdings of such objects, it is important that the Furniture and Wooden Objects Division be able to offer assistance in the overall preservation of many different types of musical instruments. Two have been treated to date: a *Light's* dital harp of English origin, made about 1816, which belongs to the National Museum of Man; and a large mid 19th-century pipe organ from the Bytown Museum in Ottawa.

The dital harp is an early 19th-century invention which is more decorative than musical. Black lacquer covers the entire surface of this example, to which an elaborate design in transfer gilt has been applied. Its fittings are made of wood, ivory and lacquered brass.

It was decided that, wherever possible, the appearance of the instrument in terms of its finish should be left as it is, and that no attempt would be made to restore it to look as it did when it left the maker's workshop. This treatment, therefore, would be more inclined toward preservation, with less emphasis on actual restoration.

The most urgent treatment needed was consolidation of the lacquer, which had become brittle and was flaking badly, especially at the back of the instrument. In fact, it was necessary to consolidate the surface even before it was cleaned. All areas of damage were brushed with a solution of polyvinyl butyral, which readhered the flakes and prevented further deterioration. Gentle brushing with a weak detergent solution removed most accumulations of dirt and grease, and where this was ineffective, a mild solution such as hexane was used. Some of the brass tuning pegs were bent, and these were carefully straightened by clamping them between padded blocks of wood. One of the brass ditals, through which the strings pass, was broken and so a copy was made and finished to match the appearance of the originals. Reproductions of two missing ivory guide pegs also were needed. Three of the six remaining strings on the harp appeared to be originals, being made of gut or silk overspun with extremely fine copper, and these were retained. Missing strings were replaced with black Dacron, which looks sufficiently different from the original material to avoid confusion and yet harmonizes well in appearance and is unobtrusive.

Final completion of this division's extensive laboratory and workshop facilities will enable us to more efficiently treat larger pieces of furniture and greater numbers of wooden decorative art objects. In addition, we shall be able to research new techniques and methods of conservation where as yet imperfect or no previous guidelines exist.

Thom Gentle
Robert Barclay

Textiles

An Aubusson *tapestry in brilliant reds, yellows and oranges after repair and cleaning gets a final ironing to give the heavy fabric a sheen. Covering the iron with cheesecloth causes the steam to spread evenly as a fine mist. The tapestry, by Fernand Leduc [1972], had been damaged in transit from Amsterdam, Netherlands, to Canada. It belongs to the Department of External Affairs, Ottawa.*

Many different kinds of textiles can be found in museums throughout Canada. There are items made by native peoples; historic costumes, uniforms and manufactured goods; and many types of banners, flags, tapestries, carpets and furniture fabrics from the time of earliest Canadian settlement to the present day. Peoples of numerous cultures and national origins have contributed to these diverse collections — Inuit, Athabaskan, French, British, Scottish, American, Ukrainian and Oriental, to name but a few. Moreover, the varieties of cloth are many, as are decorative techniques, such as dying, lace work, needlepoint or beadwork. Thus, the textile conservator's work is complex, and there is much to be done.

While the CCI has been able to undertake a number of small textile projects, we are still in the formative stages of setting up a Textile Division. The appointment of a Chief Conservator for this division is expected to be made within the next few months, perhaps by the time this publication appears. We can then devote our attention to equipping the new laboratory, which we hope will be functioning by the spring of 1977.

THE REGIONS

Each of the various regions of Canada — Atlantic Canada, Quebec, Ontario, the Prairies, British Columbia, the North — has a distinctive geographic identity, economic base, ethnic mix, pattern of life and, to some extent, even attitude of mind. Not surprisingly, the museums, galleries and historical collections throughout the country reflect these regional identities. In British Columbia, for example, there are museums devoted to the mining, fishing or lumber industries. As well, a number of museums and galleries display examples of Chinese and Japanese artifacts and fine art. And, what British Columbia museum would consider its collection complete without some examples of Northwest Coast native art and artifacts?

One could sketch similar characteristics for the other regions as well, and expect them to be reflected in local collections. Agriculture, oil, large transportation networks and ethnic diversity are commonly associated with the Prairies. Urbanization and early industrial development — mining and manufacturing — against a background of British immigration come to mind in thinking about Ontario. Quebec's history is steeped in the early fur trade and the settlement of New France; furthermore, the province was a centre of railway development, of manufacturing, and of lumbering. Fishing is perhaps most readily associated with the way of life of Acadian and Scottish Atlantic Canada, although mining and lumbering also have been important industries. Arctic Canada embraces the culture of the Inuit, as well as an era of exploration by Europeans and North Americans which began in the 16th century and has continued to the present day.

These regional characteristics of collections are important considerations in the formulation of a national museums policy. The Canadian Conservation Institute, as established by the National Museums of Canada, was designed to be a nationwide facility, with a headquarters laboratory in Ottawa and five regional laboratories. It was recognized that the services of the CCI should be easily accessible, and that it should develop expertise in the various regions which would meet their particular needs. Two of the regional centres have been established to date: the Atlantic Conservation Centre in Moncton and the Pacific Conservation Centre in Vancouver.

As the Canadian Conservation Institute grows and gains experience in serving the more than 1,600 museums, galleries and archives across the country, it will become more accessible, more regionally specialized and, ultimately, more useful to the museum community.

The Atlantic Conservation Centre

In 1973, a survey was conducted by the CCI in the Atlantic Provinces. It produced some rather startling results. Sixteen carefully selected museums and archives were visited in order to evaluate the regional need for conservation work. A sampling of objects, which could be classified as national treasures, were examined at each institution. Those needing the attention of conservators were totalled, giving the following figures:

	Quantity	*Man-years required*
Paintings	846	38
Graphic art	1,620	22
Polychrome sculptures	—	23
Artifacts	3,251	56
Archival documents	148,644	268
Rare books	25,010	704

Thus, the 16 institutions had 179,371 items requiring 1,111 man-years of work. The items examined accounted for less than 10 per cent of each collection surveyed, and the 16 institutions selected were less than 10 per cent

Steadying her hand on a vertical rod, a conservator inpaints areas of missing pigment on Bark Mokanna in a Gale. *Canadian painter William Yorke meant the work to depict an actual day - 14 October 1866 - in the North Atlantic, roughly 700 miles from the coast near the latitude of Cape Cod, Massachusetts. Collection of Beaverbrook Art Gallery, Fredericton, New Brunswick.*

of the total number of museums, archives and similar institutions in the four provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland. Therefore, it is not an exaggeration to consider that the total work load is in the range of tens of thousands of man-years! It should also be noted that the survey did not include the conservation of textiles, furniture, historic farming implements, boats and marine artifacts, architecture (such as log cabins, historic houses and settlements) or underwater archaeology, all of which are important parts of the Atlantic region's cultural heritage.

In June 1974, the Atlantic Conservation Centre began its operations in temporary quarters at 236 St. George Street in Moncton, New Brunswick. The challenge of coping with the region's pressing conservation needs had been accepted. By 1978, larger and permanent laboratory facilities are to be erected on the campus of l'Université de Moncton. The building has been designed in conjunction with the requirements of conservators, and will accommodate 20 or more specialists in various fields. There will be ample space for conservation laboratories in the fine arts, paper, textiles, artifacts and furniture, as well as administrative offices, conference rooms, a library, an audio-visual room, and an exhibition gallery. Scientific documentation and other services will include a microscopy section, a photographic studio and darkroom, and x-ray analysis equipment. A variety of storage areas, including a vault for works of art, will be provided.

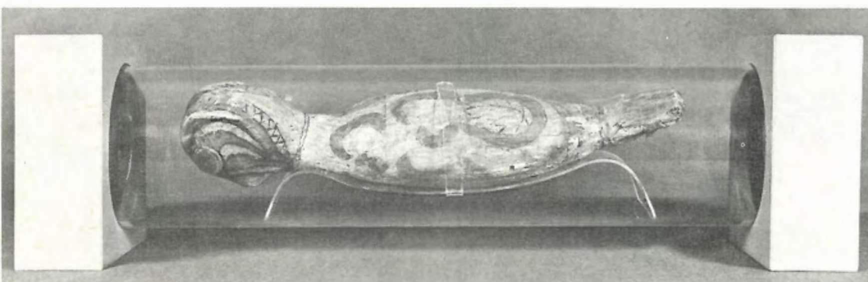
In the present quarters, the ACC offers conservation services according to a list of priorities recommended by the Regional Director and approved by an Advisory Committee representing the four provinces. The ACC also provides assistance to large museums that wish to set up their own restoration facilities, so that they can apply basic treatments to their collections. By doing this, the Centre can provide conservation services to a greater number of small institutions and devote more attention to objects requiring complex and time-consuming treatments. Sessions at which museum technicians can work closely with conservators, thereby gaining valuable practical experience, are encouraged. Moreover, seminars and lectures are held for museum personnel and the general public.

One of the major projects now underway at the ACC concerns the procedures that should be followed in emergencies, wherever they might occur. Frequently, only prompt action will save an object in a dangerous situation. A list of what to do and what not to do at these times, along with sources of various materials and persons who may be contacted for professional advice, will be distributed to all regional museums. A standard emergency field unit containing equipment and supplies is being prepared so that aid can be delivered quickly by road or air.

For a fragile Easter Island bird effigy [bottom], a special display and storage case of Plexiglas was made at the Centre in Moncton. When received, nearly half of the effigy's outer layer of painted tapa cloth was in shreds, and the rest was severely embrittled. Pressurized nitrogen in the case provides an inert atmosphere to retard such deterioration of this valuable ethnographic object in the future. Collection of the New Brunswick Museum, Saint John.

The three conservators of the ACC each specialize in one of three fields: fine arts, paper conservation, or artifacts (historical, ethnological and archaeological). The work of each division reflects to some degree our Atlantic coastal setting and history, and contrasts with other regions, even if only by way of the great numbers of objects involved. The specific problems facing ACC conservators stem from various causes, some of a local nature and some which plague conservators everywhere. For example, the generally damp maritime climate of the four provinces, as in British Columbia, creates special difficulties which must be overcome. On the other hand, a large percentage of the objects which come to the ACC, especially the Fine Arts Division, illustrate a common and more widespread woe: they have been treated previously, and too much time must be spent merely correcting earlier errors and faulty repairs.

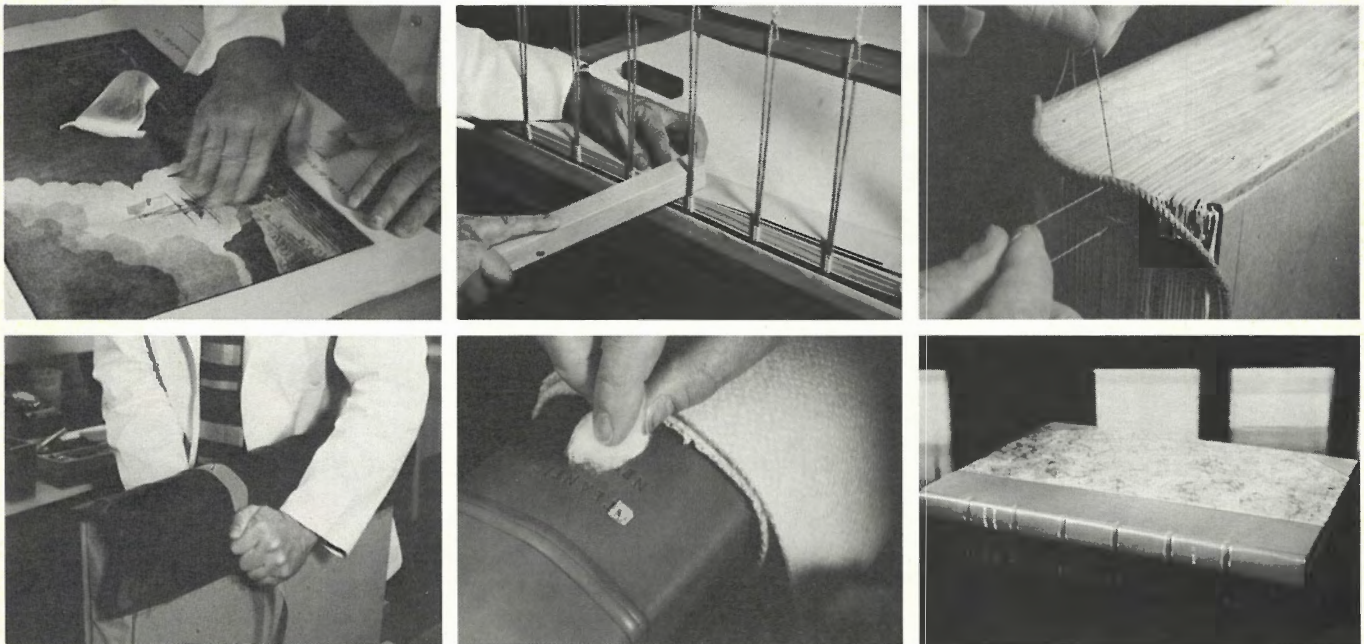
A few recent projects of the Fine Arts Division, related to these problems, also emphasize the role of improvisation and experimentation in finding new techniques and materials. In looking for a new non-shrinkable fabric for lining paintings, we tried polyester monofilament. A paper stressing its advantages



under certain conditions was presented at a seminar this past summer at the National Gallery of Canada in Ottawa. This substance can be used for a variety of techniques, both hot and cold, utilizing adhesives such as wax resin, beva, animal glue, emulsion and pasta. It is especially useful, because of its transparency, in cases where the visibility of an inscription on the original canvas is important, or for later identification and localization of previous accidents and repairs.

Sometimes an existing technique needs to be modified to cope with specific regional conditions. One such case concerned the need for flexible supports for paintings on wooden panels. These can warp severely from continual humidity and temperature changes. After correcting the distortion of such paintings, strips of hardwood can be fixed to the back of the wood panel, against the grain, for strength. The adhesive, a thick layer of synthetic resin, is designed to remain flexible to allow movement of the wood.

Another development came about following a query from an institution faced with transporting two valuable paintings by the 19th-century artist Cornelius David Krieghoff. The frames, original to both paintings, were in fragile condition and had suffered from much handling. After these were repaired, a plexiglass display case was made for each painting, providing protection without interfering with the aesthetic appearance of the works. Handles and heavy supports, attached to the back of the cases, allowed easy and safe handling. Two wooden shipping boxes, lined with felt, also were built. This sort of procedure involves nominal expense and can be done by museum personnel; it is recommended to all museums that include travelling exhibits as part of their programmes.



Stages in the restoration of Atlantic Neptune. *From the upper left: dry cleaning the aqua-tint drawings; compressing stitches during binding; attaching the primary headband; attaching the leather; gold-leafing the title; the completed book. Collection of the Public Archives of Nova Scotia, Halifax.*

The ACC's Paper Division is attempting to cope with the vast accumulation of books, documents, maps, graphic art and historic photographs in the libraries, archives, museums and historic settlements throughout the Atlantic Provinces. Curators and archivists are gradually becoming aware of the enormous scope of this material, and some have taken measures to stabilize the environments in which these objects are kept. Those which have passed through the ACC's laboratory include large vellum scrolls, important archival letters, and books such as the three-volume set of *Atlantic Neptune*, with its magnificently detailed navigation charts and aqua-tint drawings of harbours and coastlines. This set, dated 1780-81, was prepared by Joseph F.W. Les Barres, a military engineer who surveyed the coast of Nova Scotia in the 1770s for the British Admiralty.

Unquestionably, the most urgent need facing the vast repositories of papers and books is to stabilize these objects, to buffer them against future acidic formation, and otherwise protect them against further deterioration. Secondary to this is cleaning, bleaching and restoration. In the case of the *Atlantic Neptune*, a great deal had to be done, for pages were brittle and stained, and acid hydrolysis had caused printing to transfer to other pages. The leather and marbled paper bindings also had deteriorated considerably.

Example of typical wood decay in a log house. Acadian village of Caraquet, northern New Brunswick.

Many different techniques are utilized in the Paper laboratory. For example, several de-acidification processes are used, depending on the material being treated. New techniques in paper conservation include use of a new type of leaf-casting machine for mending documents in a fraction of the time that it can be done by hand. Also being developed is a vacuum table which, with cold air, will dry documents quickly and efficiently.

To the Artifacts Division comes a seemingly endless variety of objects from many cultures of the remote and more recent past in Canada and throughout the world. There are historic tools, mechanical gadgets and other items of wood and metal; ceramics and glassware; costumes and beadwork from ethnological collections; and furniture. They might come from the hayloft of a barn, a museum storeroom, the wet ground of an archaeological site, or one of the many sunken shipwrecks in these coastal waters.

Besides technical skills, the artifact conservator must have an extensive knowledge of the decorative arts, ethnological and archaeological materials, and industrial technology, plus an understanding of social, craft and trade conditions of related time periods. A reference library is available at the ACC so that objects may be examined in light of their appropriate historical and technological contexts. Because of this aspect of the conservator's expertise, he frequently can contribute insights into the work of the craftsman (and his culture) who produced the object, thereby aiding the historian and curator.

A field related to the conservation of artifacts is that of architecture. But, while many of the principles which apply to artifacts are also relevant to buildings and other large structures, in the restoration and preservation of the latter the conservator finds himself working with lawyers, architects, archaeologists, historians, concerned citizens, and others. Cooperation between all these interested parties is necessary to ensure that these parts of our heritage are protected.

Roger Roche
Joan Rathbone
Charles A.E. Brandt
Richard O. Byrne

The Pacific Conservation Centre

The geography and history of British Columbia has favoured settlement and development in the southern part of the province, particularly around the city of Vancouver, the lower Fraser Valley, and southern Vancouver Island. It is in this area, therefore, that one finds the oldest and largest of the more than 100 museums and archives in the province. Of these, only two have their own conservation departments; indeed, the chief conservator of the British Columbia Provincial Museums has long acted as advisor for many of the province's museums, and has been involved in problems concerning cultural sites of native peoples in the region. Still, the conservation needs of the province's museum collections are great and urgent. The picture revealed by the 1973 CCI survey of 32 public collections and totem pole sites probably did not surprise anyone seriously involved in the field: roughly 500 man-years of work are required to treat the objects most in need of attention! And, compared to survey results from the Atlantic Provinces, this figure is moderate (it reflects the relatively short history of museums in the West).

Formally established in April 1973, the Pacific Conservation Centre moved into accommodations on the 4th floor of the Federal Building at Hastings and Granville Streets in downtown Vancouver. One large room was subdivided into separate work areas for paintings, works of art on paper, ethnology, administrative offices, and a photographic section. Another room, occupied since 1974, serves as a laboratory for the treatment of archaeological and historical materials and as a wood workshop. The space at the PCC is adequate at the present for the small staff, which consists of a director, a

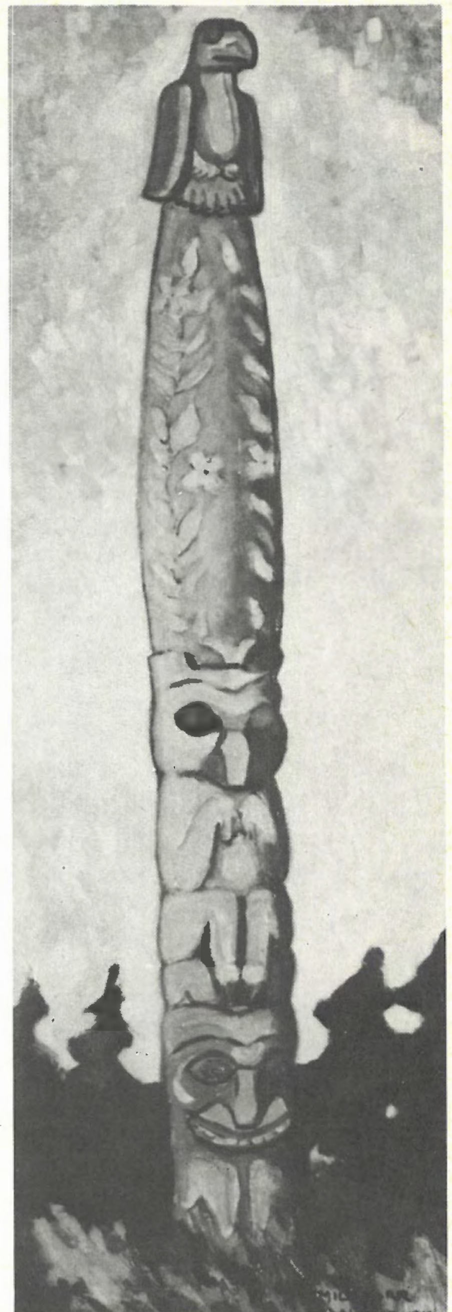
secretary, and three conservators, specializing in archaeology/ethnology, works of art on paper, and paintings. At times, this nuclear staff has been augmented by students from conservator training programmes.

As with the Atlantic Conservation Centre, the activities of the PCC are coordinated by a Regional Advisory Committee, composed of local museum authorities and others connected with the arts, who are familiar with the needs of collections. Close liaison is maintained with client museums, who frequently consult the Centre's staff in matters relating to conservation, storage and display. When necessary, queries are referred to specialists in various fields at CCI Headquarters in Ottawa. The Headquarters' scientific staff also is called upon to solve specific problems and to perform necessary analyses. In administrative matters, too, the Centre relies on Ottawa for help and guidance.

Since an important function of the Canadian Conservation Institute is the dissemination of knowledge among museum professionals, seminars dealing with various aspects of conservation have been held at the Pacific Centre. Museum workers from British Columbia, Alberta and Saskatchewan have attended these sessions. Objects treated here have been exhibited to draw the attention of the public to the role of conservation in museums. A few interesting examples are described in the following.

Deterioration of paintings sometimes can be blamed on poor-grade materials and faulty construction. Such was the case with a work — *Yan, Queen Charlotte Islands* — by the well known British Columbia painter, Emily Carr. At the Provincial Archives in Victoria, it was noted that the painting's cardboard support had badly warped. Furthermore, "traction crackle" had occurred in several places where a quick-drying layer of green paint had been applied over a soft, slow-drying layer of violet. When the quick-drying layer shrank, it slid over the soft paint beneath, rupturing in the process. In other areas, the ground was friable and paint layers were flaking away from the support. Also, the picture had never been protected with varnish, and it was coated with dirt directly on the painted surface.

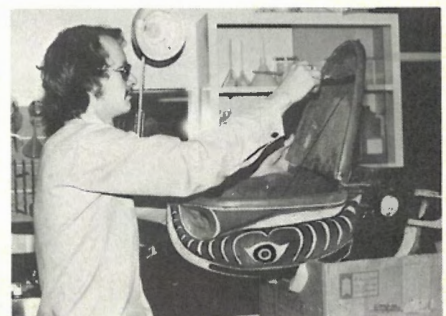
The surface dirt was removed with moisture where it was safe to do so. Then, the friable paint had to be consolidated. Unlike paintings on canvas, which can be both consolidated and flattened when they are lined, paintings on solid supports must be consolidated from the front and flattened in a separate step. Four consolidants were tried: wax resin and three synthetic resin solutions. A solution of polyvinyl butyral readhered the paint/ground layers most strongly and changed their gloss, texture and colour the least. Next, a solid support of *Masonite* and *Fome-Cor* was built, and the cardboard support cold-mounted onto it with a polyvinyl acetate emulsion under vacuum pressure. This operation flattened the painting and strengthened it mechanically. Then, spots which were missing paint were filled with gesso putty and inpainted with powder pigments ground in a synthetic resin solution. Finally, the painting was sprayed with a synthetic resin varnish. These treatment procedures resulted in a markedly improved appearance of the painting. But, more important, the structural consolidation it received will greatly retard further physical deterioration.



Emily Carr: Yan, Queen Charlotte Islands, *oil on cardboard, after conservation treatment. From the Provincial Archives of British Columbia, Victoria.*

Ethnological objects treated at the PCC have been made from a variety of materials and have come from many different countries. They include Indian artifacts from the West Coast of Canada, masks from New Ireland in the southwest Pacific, and headdresses from Africa. Some of the most difficult to treat are those made from organic materials, especially if several different kinds were used in the same item. Difficult, too, are those made for a mainly utilitarian rather than decorative purpose; no special value was attached to these, and they were not intended to last long. They were simply used until they wore out and then were replaced. Many artifacts are with us today only because they were intentionally "rescued" at some point in time and sheltered from further use. Unfortunately, such artifacts often are stored under extremely unfavourable conditions, where daily fluctuations of temperature and humidity compound stresses and hasten decay. Although organic materials may be surprisingly durable, they can deteriorate through improper storage to a point where no amount of conservation effort can save them.

Surface cleaning of a Northwest Coast mask by dry-brushing. Kwakiutl killer whale mask, circa *1900, from Sullivan Bay, Vancouver Island. Collection of the University of British Columbia, Museum of Anthropology.*



Documents and works of art on paper are especially vulnerable. Of these, maps are perhaps most exposed to elements which cause deterioration, for they are meant to be used and are subject to much abuse. They are folded and unfolded (or rolled and unrolled), smudged with dirt, and written on with everything from pencils to marking pens. However, as with other works on

Map of Vancouver, 1886, published by the Canadian Pacific Railway, before and after treatment. Owner: University of British Columbia.

paper, the ravages of time and wear on maps are nothing compared to what past owners have done to try to preserve or restore them. Correction of these former remedies comprises about 80 per cent of the modern paper conservator's labours.

A large 1886 map of Vancouver, treated at the PCC, is an example in the extreme. Published by the Canadian Pacific Railway, only a few other copies of this map exist. All are in even worse condition.

To strengthen it against hundreds of rollings and unrollings, the map had been glued to linen, probably when it was new. To protect it from the pokes and rubs of thousands of fingers, it had been varnished. Several insets had been glued to the original to show changes in boundaries or property divisions. Add years of use, countless flexing of the support, exposure to water (vapour and liquid), and many blows and scrapes, and the result is a conservator's nightmare — or dream, if one hungers for challenges.

As the PCC had no working surface large enough for the map (5 feet by 7 feet), a special folding-leg table first had to be built. Then, after extensive experiments with various solvents, the varnish was removed with a combination of acetone and methanol. This was done in a wooden and card-board tray lined with mylar, large enough to bathe one vertical quarter of the map at a time. Dozens of loose fragments of the varnished top paper layer then had to be fixed down in preparation for several aqueous treatments which would remove the yellowed and brownish stains. These treatments included a gentle wash with water, overall bleaching, local bleaching of more tenacious stains, and rinsing by spraying and blotting repeatedly. During this time, the insets were removed to be treated separately.

Next, a facing was prepared by impregnating a sheet of terylene with acrylic resin dissolved in xylene, and was heat-set to the map on the vacuum hot table. This held the map together while the old linen backing and glue were removed, the major losses filled, and two layers of strong Japanese paper applied. The facing was then removed, and losses on the front of the map were carefully inpainted. Finally, the support poles were refinished and reattached, and a storage tube of large diameter was made.

From start to finish, these treatment steps involved a long and tedious process. The map, now owned by the University of British Columbia, dominated the work of the PCC Paper laboratory for several months. Many other objects treated at the PCC during the past three years were as time-consuming, although some required only brief attention. A greater output from the PCC can be expected in the future, since our initial period of setting up workshops and establishing our operations is over. In spite of a few temporary setbacks, the future of artifact conservation in British Columbia appears far brighter than it did three years ago.

Ursus Dix
Barry Byers
Barbara Keyser
Eric Lawson

CONSERVATION RESEARCH SERVICES

In the broad field of conservation today, the role of modern science is crucial. Without it, even the great skills of conservators would be hard-pressed to resolve a multitude of diverse problems and difficulties which arise in conservation everyday. Artifacts and works of art are of materials of many different kinds, and treatment of them demands the use of a similar variety of scientific aids and techniques. New testing procedures must be continually developed and alternative methods of conserving artifacts explored if the Canadian heritage is to be better preserved. Conservation Research Services was established to meet these goals.

Thus, scientific research at the CCI is not research carried on merely for its own sake. Rather, it is meant to bring modern technology to bear on the important questions in conservation. Typical recent projects have dealt with the need to develop preservation techniques for Indian rock art sites, methods for treating water-logged wood from archaeological sites, and a better varnish for paintings. Answers to these sorts of questions are derived from numerous disciplines, including chemistry, physics, biology, engineering and metallurgy. However, the context in which the questions are posed requires that those involved in this work be more than just good scientists. If meaningful results are to be accomplished, a scientist must have an understanding of what conservation is all about and a feeling for the real needs of conservators. This attribute of the researcher can only be acquired by experience, by working closely with conservators.

The CCI research programme consists of three divisions — Analytical Research Services, Conservation Processes Research, and Environment and Deterioration Research — each with distinct aims and areas of responsibility. The main work of Analytical Research Services is to determine, by the use of highly precise and versatile techniques and equipment, the chemical composition of an artifact or work of art. The study of existing methods of conserving artifacts, for the purpose of improving them or developing entirely new methods, is done by Conservation Processes Research. Environment and Deterioration Research examines the causes of artifact deterioration in order to draw up specifications for environments in which such destruction will be minimized. While the scientists in these divisions primarily engage in research, they also assist in training seminars and answer requests for a variety of other services.

The preservation of water-logged artifacts from archaeological wet sites presents a new and challenging area of study for conservation scientists. [see text, page 30] A small stream crosses a portion of the Lachane Site [below], one of several wet sites in the Prince Rupert Harbour area of the northern British Columbia coast. Fragile artifacts found here, excavated gently with jets of water from hoses, include basketry [above] and a small carved wooden post [top].

Conservation Processes Research

An object from the past which we wish to preserve ordinarily has undergone two principal stages of existence since its production and use, stages which represent drastic and often sudden alterations in the object's immediate surroundings. First is the period of abandonment after the object is discarded or otherwise neglected; the second is the period of man's renewed interest when it is placed in our care. During the former, which might mean land or underwater burial, several sorts of physical and chemical changes can take place in the object. If it survives at all, however, it usually reaches a state of equilibrium with its environment during this period. This equilibrium is destroyed when man takes the object into his care. Once again it is subjected to an alien environment of fluctuating humidity and temperature, microbiological or insect attack, or just plain mishandling.

It is the job of the conservator to arrest and prevent such dangers to the object. How to best accomplish this task is the prime concern of the Conservation Processes Research division. This necessitates an especially close working relationship between this division and the conservators, for actual conservation projects in progress dictate the nature of the research. In the restoration of an artifact, the type of treatment employed can have serious implications for its well-being in years to come. Both the treatment and the requirements for its future care must be determined precisely, based on the nature of the materials from which the object is made. Before this can be done, a detailed study of the various destructive processes which can act on the object is necessary.

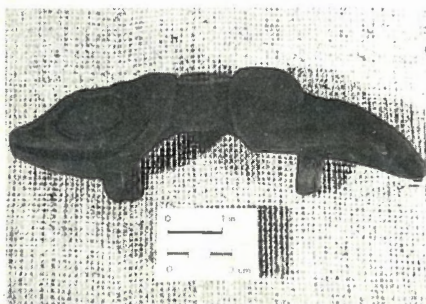
Wood and iron, two of the most frequently encountered materials, will serve to illustrate the sorts of problems faced in Conservation Processes Research. Wood, like paper, leather and other organic materials, can suffer badly from the effects of decay. Everyone is familiar with the tendency of wood to undergo dimensional changes, such as warping, splitting and shrinkage, due to changes in humidity and temperature. In a conservator's terms, the wood is adjusting to its environment and reaching an equilibrium state. It is the magnitude of the environmental changes which determines the degree of dimensional change. Present research concentrates on identifying more precisely what happens to wood structure and chemistry when badly degraded, and how this effects any future treatment. In this work, optical microscopy, scanning electron microscopy, and histochemical (cellular) examination plays a large part.

One recent major concern of conservators is that of water-logged wood from archaeological sites, such as those in the British Columbia coastal region. Water-logged wood is in a relatively stable state when found, and it would continue to be so if kept in a water-logged condition. This, of course, is not practical if the object is to be displayed. The problem, then, is to bring the wood to a suitable moisture content without causing severe dimensional changes. There are two basic approaches. One can remove the water and replace it with a bulking and consolidating agent, or one can remove the water entirely without replacement. The latter involves several techniques now under study.

The treatment methods currently employed for water-logged wood are, in some cases, not suitable for all applications, and in others are as yet of unproven value. Our intention is to re-examine the effectiveness of such treatments and to develop new and more suitable methods, both for small objects and large timbers. Some of the areas we will be considering are freeze-drying, *in situ* polymerization and chemical alteration techniques, together with a continuing assessment of new polymeric materials.

Iron was used extensively from early times to manufacture a wide variety of items. It appears in both wrought and cast forms, and is extremely susceptible to corrosion. As a consequence, most recovered iron objects are in need of treatment of some kind. Corrosion is essentially an electrochemical phenomena, and occurs in the presence of water, oxygen and dissolved salts. In the case of material excavated from soils or recovered from marine environments, the salts are largely chlorides. After recovery these salts and all moisture must be removed completely to prevent continued corrosion. If this is not done successfully, the object will begin to corrode again after a short period of time.

Carved red cedar handle from the Lachane Site, a former winter village of the Coast Tsimshian, northern British Columbia coast. [SEE COVER] The zoomorphic designs are duplicated on the reverse side. Peat surrounding the carving has been dated to circa *A.D. 320. Over 400 perishable artifacts have been found at this wet site, including wooden wedges, handles, box parts, bowls and labrets [lip plugs], and pieces of basketry and cordage. Momentarily placed on a table for this lab photograph, the cedar handle, like all other water-logged objects, has been stored in a water and weak fungicide solution. Archaeological Survey of Canada, National Museum of Man.*



Many methods are used to remove chlorides from iron, although some are of uncertain value. One method used extensively is the electrolytic desalination of iron; the chlorides are removed and, at the same time, the iron corrosion products are reduced to metallic form. Many competing reactions occur during this process, and our aim is to show to what extent each proceeds and thereby optimize treatment conditions.

The electrolytic process is slow, especially for large objects such as cannons, and so work is planned for finding alternative methods of treatment. After stabilization, by whatever means, the iron must still be protected from further corrosion. This is achieved by the use of passivaters or protective coatings, and in these cases testing of the relative effectiveness of such materials will be undertaken.

Expansion of the activities of this newly established division will include, as part of the on-going study of materials and their behaviour, many other areas of conservation, such as paintings, paper and textiles.

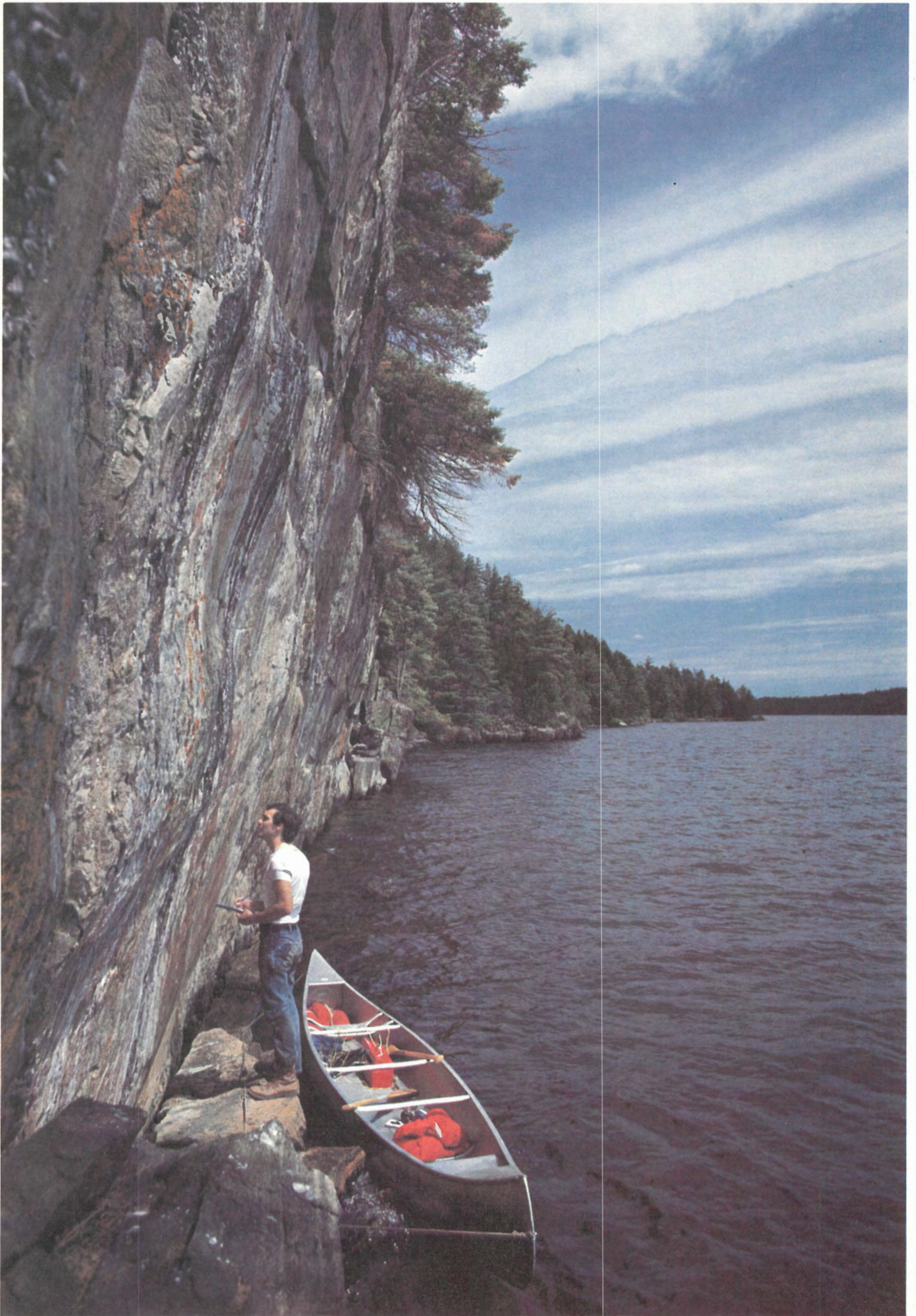
Cliff McCawley

Analytical Research Services

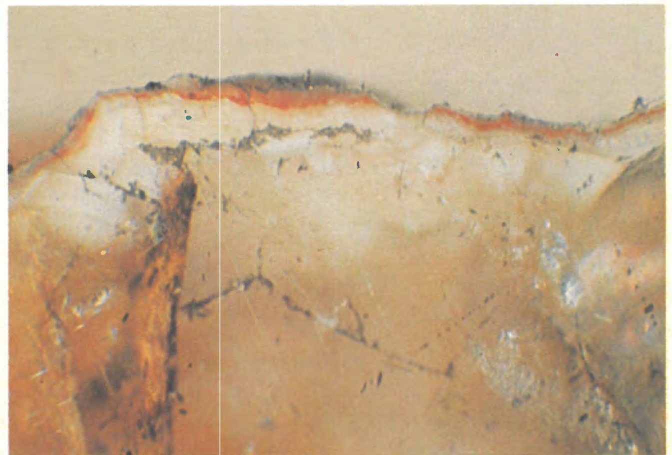
Scientific analysis of the materials present in an object provides valuable information for conservators, curators, archaeologists and art historians. For the conservator, for example, identification of the type of varnish on a painting helps him select the correct solvent to use for cleaning the painting. Similarly, analysis of the corrosion products or patina on a metal artifact not only provides an archaeological conservator with information about how the object has deteriorated, but helps him to select the appropriate conservation treatment. For the curator, analysis of materials such as pigments frequently aids in establishing the authenticity of a particular object. If the style of the object does not appear to be quite right, and if scientific analysis shows that the materials are not consistent with those known to have been used when the object supposedly was made, the object probably is not authentic. Conversely, the analyses of a group of objects from a specific location and specific period provide documentation of the materials used at that time, and helps the historian determine the techniques and technology used to make the objects. The archaeologist attempting to trace trade routes and other indications of contacts between prehistoric peoples is aided by the elemental characterization or *fingerprinting* of archaeological material, such as obsidian from various sites and from potential sources.

Such projects are typical of the everyday activities of the Analytical Research Services laboratory, and normally several may be in progress at the same time. Yet, each problem is unique, and each is approached on the basis of this fact. Each presents its own particular sorts of difficulties. One serious restriction often placed on Analytical Research specialists is that the sample of material taken for analysis must be minute, so as not to damage the artifact. Sometimes, as in the case of an especially valuable object, no sample at all can be taken, and alternative methods of analysis must be used.

The laboratory operations may be appreciated by noting a few recent projects in detail. In 1974, in preparation for a major exhibit of French Canadian and French silver at the National Gallery, the analysis of silver currently in the National Gallery collection was undertaken. Because of the nature of the objects and the fact that sample removal was not feasible, an energy-dispersive x-ray analyser (EDX) was chosen for use in the study. In practice, the area to be analysed on the object is held in front of the x-ray source/detector assembly, and within one to five minutes the instrument qualitatively and quantitatively analyses for all but the lightest elements present in the object's surface. By studying the composition of the silver used by craftsmen in early Canada over a period of about 100 years (principally silver work of F. Ranvoyzé, L. Amiot and F. Sasseville from the mid-1700s to the mid-1800s), it was possible to detect a general downward trend in the quality of silver used during that period of time and also to discover pieces which had been repaired or mismatched.



While investigating the causes of deterioration of Indian rock painting sites in Canada, CCI scientists observed that an effective conservation treatment is often provided by nature. The paintings are typically located on vertical cliffs, such as at Crowrock Inlet in the Lake of the Woods district of northwestern Ontario [opposite page]. After rainfall or during the spring thaw, groundwater seeps down the rock faces. From dissolved mineral ions in the water, a tough "skin" of mineral deposit gradually forms on the rock over the paintings. This natural protective coating holds the pigment in place and reduces erosion by wind and rain. It gradually obscures the art at sites exposed to heavy seepage, as at Cuttle Lake near Lake of the Woods [above]. The photomicrograph [below] shows a cross-section of a tiny sample removed from a painting. Note from bottom to top: base rock; thick white layer formed before paintings were made; iron pigment layer; thin white layer covering the pigment. At Agawa Bay on Lake Superior's eastern end, an act of nature prevented excessive deposition on rock art [left]: after a small layer formed, a large section of rock fell away, diverting the seepage flow. Scientists are studying ways to artificially control the formation of rock surface deposits.



Often requests are received in the laboratory to examine paintings or native West Coast masks in order to establish their authenticity. In these cases, more analytical information is required than can be obtained by a simple surface elemental analysis from an EDX examination. The pigments, binding medium and, in the case of masks, the wood, must be examined in detail. For this, minute samples usually about the size of the period at the end of this sentence are removed from the object. These are then analysed by a variety of non-destructive techniques.

For example, a particle of pigment from a painting would first be examined with an optical microscope to determine whether it is a mixture of two pigments, such as red and blue to give a violet colour, or a single pure violet pigment. Next, the pigment is analysed by use of an x-ray macroprobe wave length-dispersive spectrometer to determine the inorganic elements in the sample. This procedure facilitates interpretation of the results of infrared spectroscopy and diffraction analyses. Infrared spectroscopy yields information on the organic content (binding medium and dyes) and on the inorganic pigments. The particle is subsequently analysed by x-ray diffraction using a single particle *Gandolfi-Debye-Scherrer* camera. The exact type of inorganic pigment is determined with this technique. Finally, the particle can be examined at high magnification in the scanning electron microscope (SEM). Research utilizing the SEM is currently in progress in an effort to distinguish natural from synthetic pigments of the same type by examining particle size and impurity content. Thus, by using all these types of analyses, a maximum amount of information is obtained from each particle.

Analytical Research Services also has been examining the pigments and media from groups of authenticated objects of various kinds. From this work, considerable reference information is being amassed, to which may be compared objects suspected of being fakes, replicas, or anything else other than what they seem at first glance. Currently, we are analysing the pigments and binding media on West Coast masks of known origin for this purpose.

In the restoration of a painting or perhaps a large polychrome, a conservator often will request a cross-section analysis of the object so that the paint layers built up by the artist can be seen. On objects which have been repainted a number of times, one can readily see what the original paint layers were. This type of analysis involves removing intact small samples of the cross-section (from surface layer to canvas or wood support) from the object. The samples are embedded in plastic and polished to a flat surface for examination with both optical and scanning electron microscopes. Using the optical microscope, the colours of individual layers are observed. With the SEM, individual layers

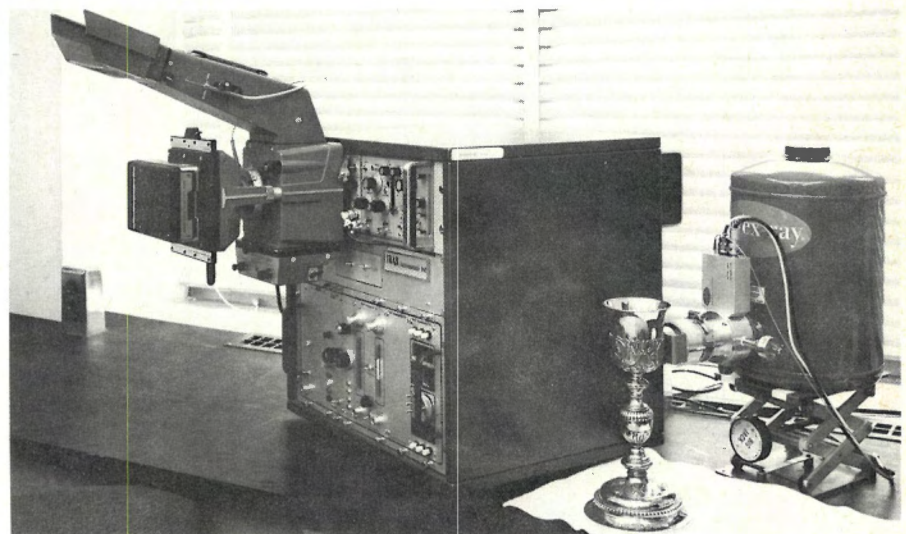
Stains on paper that resist washing may be removed by bleaching, a treatment which can lead to other problems. Two scanning electron micrographs show the surface of a single ply of mat board before treatment [left], and after bleaching and washing [right]. Analyses showed that the rose-shaped crystals are byproducts of the treatment which washing failed to remove. This residue will cause the paper to become brittle. Approximate magnification: x 500.

can be analysed using the energy-dispersive microprobe attached to the instrument. Thus, both the colour and the type of pigment used in each layer can be determined.

Another project, a quantitative trace element analysis undertaken for the National Museum of Man, has provided important information about the archaeological distribution of obsidian in Alaska. This volcanic glass was a highly prized raw material used by prehistoric native peoples for making arrow and spear points, scrapers and knives. It is found in quantity only in few localities in North America. An analysis for each of five trace elements was done by atomic absorption spectroscopy on small samples from archaeological sites and a known geological source. The results showed that three distinct types of obsidian were represented in the archaeological flakes, but only one of these groups matched the geological samples — thus, two sources remain to be discovered. With this sort of information, the archaeologist can direct his field research into aboriginal trading patterns.

John M. Taylor

The energy dispersive x-ray spectrometer for use in analysing a surface area on a silver chalice.



Environment and Deterioration Research

The Environment and Deterioration Research division, as the name indicates, studies the causes of deterioration of artifacts and works of art under different environmental conditions. By understanding these destructive processes, it is possible to specify for museums the proper conditions under which to keep their collections of various objects. Knowledge of the deterioration properties of materials is also needed by conservators, who must select the method of conservation that will best stand up to specific environments. This division provides a direct service to Canadian museums, galleries and archives in being able to carry out environmental surveys at their request and to advise them on matters of environmental control and transportation of artifacts.

Work in progress involves short term service requests for determining the ageing characteristics of certain materials used by conservators and, in conjunction with Conservation Processes Research, longer term projects designed to make significant advances in conservation. The work involves both the physical and the biological sciences.

Much of the materials that one finds in museums, galleries or archives is of organic origin, and, of course, much deterioration is caused by organisms. Thus, there is a great deal of work for our biologist. Samples of artifact materials are examined microscopically and the species of origin identified. It may be the particular wood that has been used in a Northwest Coast Indian mask or in the framework of an Inuit kayak, the bark used in an early basket,

or the type of canvas of a painting. This knowledge permits the conservator to restore an artifact in a logical way. It also provides information about authenticity — an aboriginal mask falls under immediate suspicion if the wood it is made from is not native to the locality from which the mask came. And, if there had been no trade with people of a region from which the wood could have come, then the case against authenticity is further strengthened.

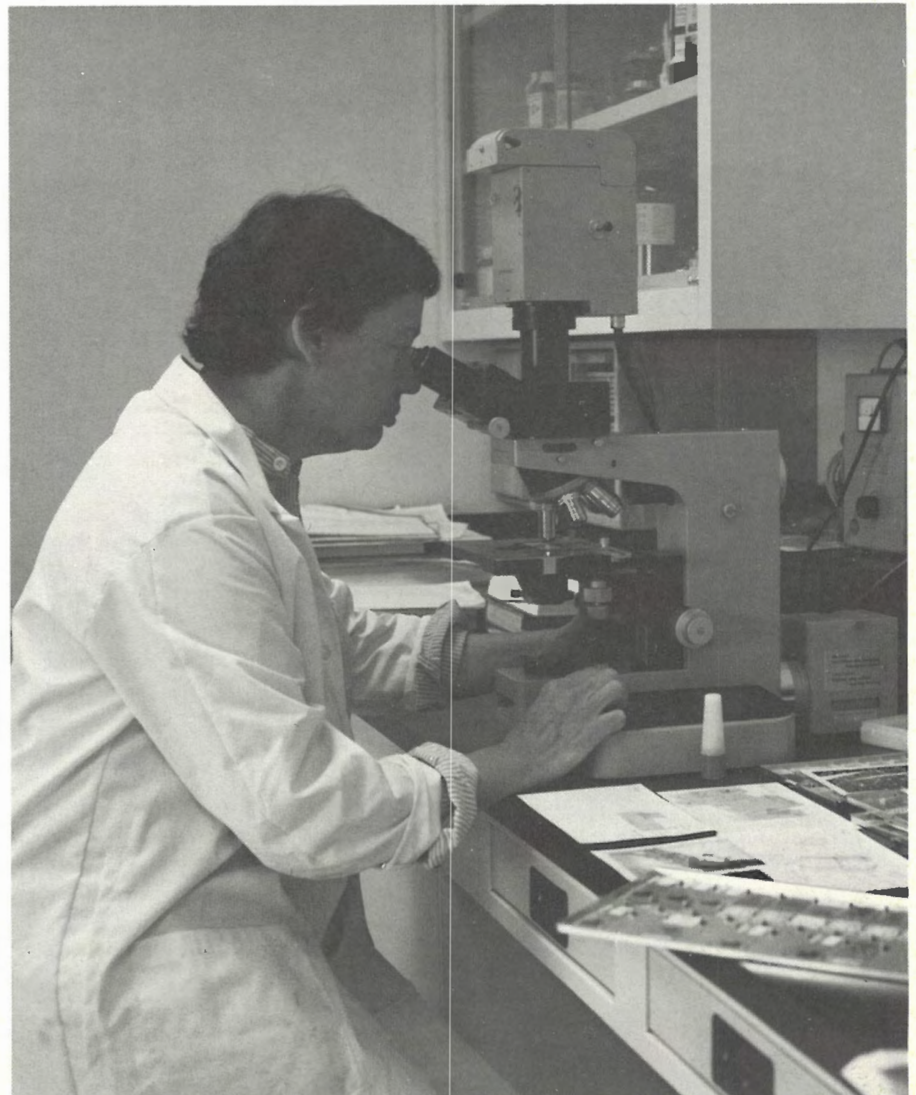
Much damage is caused to artifacts of organic materials by airborne bacteria and fungi. Mildew is an example. Research aimed at eradicating fungi has been carried out, and we have shown that there is a fungicidal action associated with many of the reagents which conservators use to treat paper. As a result, a separate fumigation or treatment with a non-persistent fungicide is often unnecessary. Emergency measures have been developed to handle outbreaks of mildew and insects in museums. In carrying out this work, the scientist uses standard biological techniques and is equipped with microscopes, microtomes, thin layer chromatographic equipment, and other apparatus.

Other types of materials which come to the Environment and Deterioration Research division frequently are commercial products used by conservators in their work. The questions raised are, for example: Will this new material be as durable as the one presently being used? or Does this material contain reagents which will cause deterioration of an artifact treated with it? To answer these kinds of questions, the division is equipped with environmental chambers for carrying out accelerated ageing of the sample. An *Atlas* "*Fade*ometer", for simulating the effects of sunlight and artificial light, permits irradiation of the material using a 2500-watt lamp while maintaining constant temperature and relative humidity. The "*Weather*ometer" is equipped with a 6000-watt xenon arc lamp, and there is provision for adding three contaminant gases (sulphur dioxide, nitrogen oxides and ozone), as well as for controlling the temperature and humidity. In addition, it has a sprinkling system which provides simulation of a rain cycle.

Biologist at work. Environment and Deterioration Research Division.

In microscopic studies of wood deterioration, small samples are stained with dyes that selectively colour different structural parts of the wood. A cross-section of the wood and bark of western red cedar, Thuja plicata *[left, top], shows alternating layers of both thick-walled fibres and thin-walled cells in the bark. This allows it to be easily split in thin sheets for weaving into baskets and other artifacts.*

Severe deterioration can be seen in a histological thin section through a sample of brown suede leather, stained with toluidine blue for contrast [left, bottom]. Both the brown sueded surface and the blue papillary region with circular hair follicles show cleavage due to acid damage.



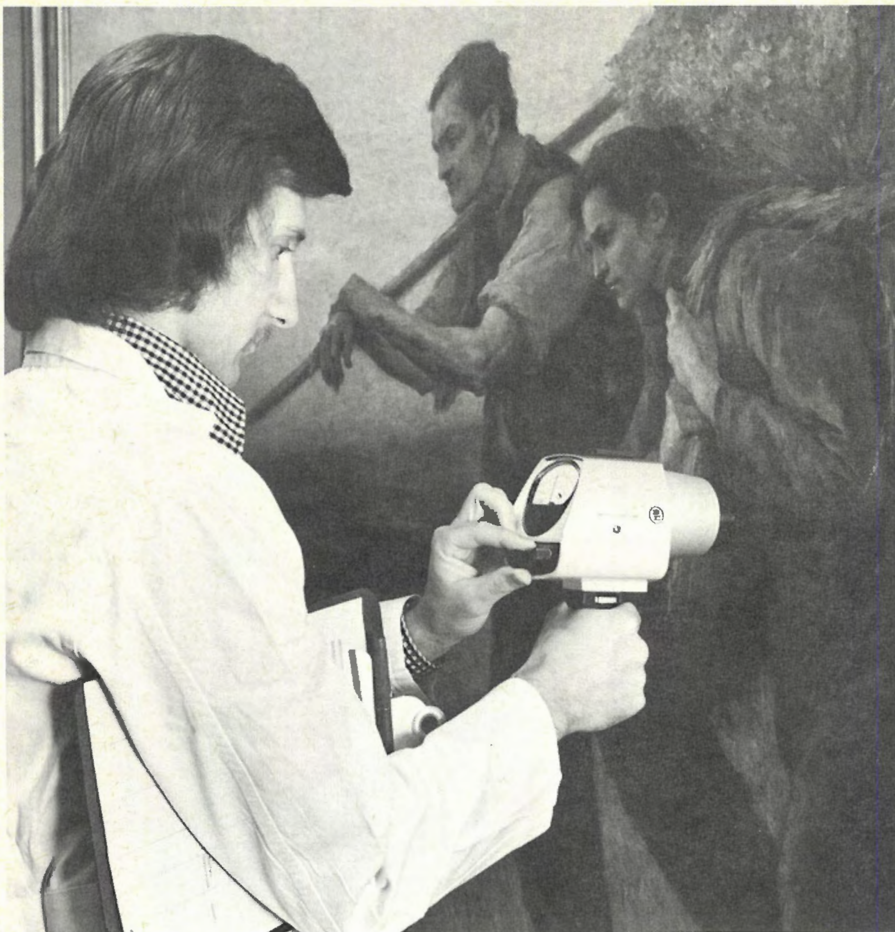
Using the spectroradiometer, a researcher examines the ultraviolet and visible spectrum of a lamp to determine the amount of damaging ultraviolet radiation being emitted.

In a small environmental chamber, paintings and artifacts undergo tests of their reactions to humidity changes. Their dimensions are measured continuously by strain gauges. Layers of pigment on canvas stretch as relative humidity is increased and compress as it is decreased; repetition frequently causes paint to crack and flake off.

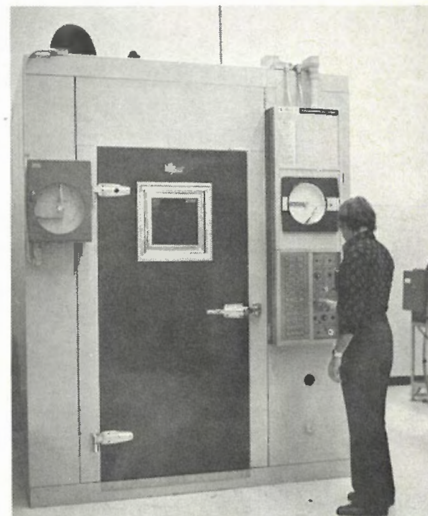
Physical testing is carried out before and after the accelerated ageing, and the amount of deterioration is compared to that from comparable testing of a standard material. We are equipped with an *Instron* tensile tester, an *Elmendorf* tear resistance tester, and an *M.I.T.* fold endurance tester. The latter measures the number of folds that a sample of paper will withstand before breaking; thus it simulates the treatment that book paper undergoes when the book is opened and closed repeatedly. Colour changes in materials are measured with a *Hunterlab* colorimeter. Acidity in paper increases as it deteriorates, therefore the pH usually is measured before and after ageing, as well as any physical parameter that may be of interest.

Longer term projects include a study of the deterioration of caribou sinew, a study of chloride leaching in corroded bronze, and a search for ways to prolong the life of picture varnishes. The work on the picture varnishes is an excellent example of how research projects are chosen for their relevance and importance to conservation. Traditionally, natural resin varnishes such as dammar, mastic or copal have been used on paintings. These age, yellowing and becoming more insoluble. About every 50 years the varnish must be removed and the painting revarnished, and there is always the danger in doing this that some of the paint layers will be removed as well. For this reason, conservators have been switching from traditional natural varnishes to modern synthetics. Unfortunately, however, in the opinion of many art historians and curators, the modern varnishes lack certain aesthetic qualities present in the older varnishes.

We have been examining the effects of adding ultraviolet-absorbing compounds and anti-oxidants to a natural varnish (dammar). The treated varnish is applied to a glass slide. When the varnish is dry it is examined in a spectrophotometer, which measures the relative intensities of the various portions of the spectrum transmitted by the specimen. The sample is then aged for a period of time and re-examined in the spectrophotometer. As the varnish ages, yellowing shows up as a loss of the blue portion of the transmitted spectrum. We have been able to show that the addition of suitable compounds results in a marked increase in the life of the natural varnish, perhaps up to 10 times as long. We therefore expect to be able to advise conservators and artists that they can use a natural resin varnish with its aesthetic superiority, but without having to worry about its relatively rapid deterioration.



Excessive lighting can cause the temperature of an object to rise above that of its surroundings, thereby accelerating processes of deterioration. The instrument being used by a CCI scientist measures the surface temperature of a painting without actually touching it.



Temperatures in the large walk-in environmental chambers can be adjusted to simulate those of Arctic winter or tropical summer. These chambers are used to test new designs for shipping cases, as well as to monitor the stresses on artifacts and works of art caused by temperature and humidity fluctuations.

The Environment and Deterioration Research division has provided environmental norms that museums, galleries and archives should meet. Advice on the environmental control aspects of exhibition case design has been supplied. We also can provide monitoring services. Although we do not have the manpower to do much of this, we have monitored environments in various institutions where crucial problems have existed and where opportunities for collecting information important to our own work have been available. We are equipped to monitor relative humidity, temperature, pollutant gases such as ozone, nitrogen oxides and sulphur dioxide, and lighting conditions. Longer term research in this area includes studies of the dimensional changes in artifacts due to changes in relative humidity, evaluations of the mechanical shock a packing case may be subjected to in transporting it across the country, and studies of the rate of relative humidity change within exhibition cases containing conditioned silica gel.

A number of institutions have approached us with questions in these areas, and we are most pleased to help. It is this direct contact with the museum community that permits us to keep our scientific research practical and relevant to the real needs of conservation in Canada.

Ken Macleod
Mary-Lou Florian

The intensity of light incident on a painting is easily determined with a luxmeter, a recommended procedure whenever new exhibitions are installed. Luxmeters may be purchased at most well stocked photography stores.

A Statistical Survey of Lighting Conditions and the Use of Ultraviolet Filters in Canadian Museums, Archives and Galleries.

R.H. Lafontaine and K.J. Macleod

A questionnaire concerning lighting conditions was sent to 105 Canadian museums, galleries and archives, along with the request that the institutions submit samples of ultraviolet filters in use. Sixty institutions replied to the questionnaire and 26 sent filter samples, which were tested as to their efficiency in removing ultraviolet radiation.

It was found that only 25% of the institutions know what their lighting levels are, and that only 12% of them keep their lighting at acceptable levels. An increasing number of institutions apparently use ultraviolet filters on fluorescent tubes, although no responding institution reported the use of filters for daylight. A number of ultraviolet filters currently manufactured appear to be excellent, and testing of such filters indicates that they can be used for at least 10 years.

Electromagnetic radiation of wavelengths within the visible spectrum is needed before the human eye can see anything.[1] Unfortunately, although light is a necessity, it is also a potential hazard to artifacts and works of art. It may induce photochemical reactions which are manifested as deterioration — pigments fade, paper discolours, fabrics become embrittled, etc. To prevent undue deterioration, norms have been established for lighting of fine art and museum collections. Thus, for extremely sensitive materials, such as watercolours or fugitive dyes, objects should not receive illumination greater than 50 lux.[2] More insensitive artifacts, such as those of bone and leather, or oil paintings, should be illuminated with not more than 150 lux. Metals can tolerate much higher levels, but under no circumstances should lighting intensities in a museum exceed 300 lux.

It is felt instinctively by some that 50 lux does not provide sufficient light to see, but this is not the case. The human eye is very adaptable and, providing that one is led gradually from a bright location to a more dimly lit one and that a satisfactory colour balance is maintained, one normally should have no problem in viewing. In fact, the eye can adequately discriminate colours at 10 to 30 lux.

In addition to keeping overall light levels low, it is necessary to exclude ultraviolet radiation. The lower the wavelength, the more energetic is the radiation; thus the more likely it is to initiate damaging reactions. The ultraviolet, being of shorter wavelength than the visible, can be considerably more destructive. Undetectable by the human eye, it contributes nothing to seeing. Radiation shorter than 300 nanometers is removed by glass, so that it is ordinarily not encountered in a museum or gallery setting. It is only that portion of the ultraviolet between 300 and 400 nanometers that we need worry about. Different sources of light emit different amounts of ultraviolet: incandescent lamps emit a negligible amount; fluorescent tubes may emit as much as 3% to 7%, and the sun's radiation may be 25% ultraviolet.

1. Wavelengths visible to the human eye are between 400 to 700 nanometers. The nanometer is a unit of length equal to a billionth of a meter.
2. The direct illumination on a surface that is everywhere one meter from a uniform source of one standard candle intensity is one lux.

To remove ultraviolet radiation, commercially available materials can be placed over windows and fluorescent tubes. For fluorescent tubes, the most convenient type of filter is a plastic sleeve which slips over the tube. This filters out the ultraviolet without appreciably altering the quality of visible light.

There is nothing new in the above. It has been printed and reprinted in publications distributed free of charge or at modest price to museum personnel. It has been repeated *ad nauseam* at seminars and training sessions for museum workers. **Nevertheless, one still visits exhibitions where lighting levels are far in excess of safe levels, and where fluorescent light and even sunlight is unfiltered.**

This paper has two purposes. First, it provides preliminary statistics on lighting conditions in Canadian archives, galleries and museums: Are light levels acceptable? Are the light levels even known? Is an attempt made to remove the ultraviolet? Second, it offers some data on the length of time ultraviolet filters are effective, based on tests of used filters: Should they be replaced every few years? Are some brands preferable to others?

Procedure and Results

A cross-section of Canadian museums, galleries and archives were asked to reply to a set of questions concerning lighting used in their institutions and, if they used ultraviolet filters, to send samples of new and used ones for testing in our laboratory. A total of 105 institutions were canvassed; those that responded are listed in Appendix 1. It was intended that they represent a cross-section in terms of geographical location, size, and type of institution. A sample of the questionnaire is Appendix 2.

The samples of ultraviolet filters received were examined for their transmission with a *Beckman Acta M VI* UV-visible spectrophotometer. From spectral transmission, it is a simple task to compute the percentage of the incident ultraviolet radiation absorbed by the filter. By comparing new material with material that has been in service for some time, a measure of a filter's resistance to deterioration is obtained. Details of the calculation are given in Appendix 3.

Of the 105 questionnaires sent out, 60 were returned or, in other words, a response of 57.1%.

Lighting Type

If one can conceive of the "average" Canadian museum, the survey indicates that its lighting is 12% daylight, 37% fluorescent and 51% incandescent. It is more meaningful, however, to look in detail. (See Table 1.)

Of the institutions which responded, 75% reported using very little daylight (less than 10% of their lighting). Only one institution (less than 2% of the respondents) reported lighting of more than 50% daylight. By and large, Canadian museums have learned to avoid the extreme dangers of sunlight. The distribution of daylight usage in Canadian museums is shown in Figure 1.

A surprisingly large number of institutions reported using fluorescent lighting. Some 40% get less than 10% of their lighting from fluorescent tubes, but 15% obtain more than 90% of their lighting from this source. The usage distribution of this type of lighting is given in Figure 1.

Figure 1 also gives the frequency distribution for incandescent lighting in Canadian museums. Lighting in most Canadian institutions appears to be between 40% and 80% incandescent. Some 25% of the institutions use less than 10% incandescent in their lighting mix, while in 17% over 90% incandescent is found.

Table 1. Summary of Lighting Use in Canadian Museums, Archives and Galleries.

	Type of lighting		
	Daylight	Fluorescent	Incandescent
Percentage of institutions using more than 90%	0	15	17
Percentage of institutions using less than 10%	75	40	25
Use of source as a percentage of total light in an "average" institution	12	37	51

Lighting Levels

Only 25% of the responding institutions knew what their lighting levels are, and only 12% actually keep the level below 150 lux. This situation indicates that Canadian museums still do not concern themselves with this aspect of deterioration. It may well be that those which responded to the questionnaire are, in fact, more concerned about lighting than those who did not. If so, the poor situation described above would be optimistic in terms of the total museum community in Canada.

Ultraviolet Filters

We found that 68%, or roughly two-thirds, of the galleries and museums that use fluorescent lighting employ filters. However, this practice appears to be a rather recent development, since 63% of those who use filters have only done so for less than two years. For daylight, which is potentially much more dangerous than fluorescent light, not one institution uses ultraviolet filters.

This is quite paradoxical — increasing concern being shown for fluorescent lighting hazards, but none apparently for more damaging daylight. It may be that museum staff have learned that fluorescent tubes may present a danger and that filter tubes are available to remove the danger, yet do not understand the mechanism by which damage may occur. They do not understand that it is the ultraviolet that is dangerous and must be removed, no matter what type of lighting it comes from. On the other hand, it may be that only the very smallest museums and galleries use daylight at all and that these places do not filter lighting of any kind. No attempt has been made here to relate sophistication in lighting methods to size of institution.

Twenty-six institutions sent samples of their filters or reported the brand. These are given in Table 2. *Solar Screen* was the most frequently used.

Table 2. Ultraviolet Filters Used in Canadian Museums, Archives and Galleries.

Brand of filter	Number of institutions using filter
Solar Screen	7
Arm-A-Lite Filter Ray	6
Filter Light	3
Comco Rayshield 403	1
Universal Plastics	2
Commercial Plastics	1
Canadian Westinghouse	1
unknown	5

Efficiency of Ultraviolet Filters

The percentages of incident ultraviolet radiation removed by various filter materials are listed in Table 3. Of all samples tested, the *Filter Light* appears best, although for practical purposes those filtering greatering than 97% have essentially the same efficiency; they are all good. The *Arm-A-Lite Filter Ray* was extremely variable; separate samples ranged from 79% to 99% removal with an average of 90%. This variability was not found in any other product. If institutions choose to buy this make, they probably should send a sample to the CCI to be checked.

We have designated commercial products by the name used by the museum which submitted the sample. It would have been arbitrary for us to change the designation. However, it is highly possible that a few institutions may have called their filters by the name of the supply house from which it was purchased rather than by the manufacturer's trade name. (Thus, the product designated *Commercial Plastics* actually may be *Arm-A-Lite Filter Ray.*) In any case, we have determined that a number of products whose trade names are accurately known are of excellent quality, and museums are advised to specify one of these when ordering.

In regard to the lifetime of filters, there does not appear to be much deterioration over time. The longest used sample submitted was *Comco Rayshield 403* which was 12 years old and still 99% effective. A sample of *Solar Screen* was 95% effective at an estimated age of seven or eight years. There is apparently no reason why any of the excellent products cannot be kept in use for at least 10 years, although testing them every three to five years seems sensible as a precaution.

Table 3. Percentage Removal of Ultraviolet Radiation by Filters.

Brand of filter	Number of samples	Percentage removal of ultraviolet (average)
Solar Screen	6	97
Arm-A-Lite Filter Ray	5	90
Filter Light	3	100
Comco Rayshield 403	1	99
Universal Plastics	1	99
Commercial Plastics	1	81
Canadian Westinghouse	1	99

Conclusions

The survey indicates that Canadian museums and galleries, for the most part, are still insufficiently concerned about the effects of lighting on their collections. Over three-quarters of these institutions do not know what lighting levels they use, and the number that actually control their lighting at acceptable levels is only half of this. As mentioned earlier, these results may well be more optimistic than is actually the case for the Canadian museum community as a whole.

CCI TECHNICAL BULLETINS:

1. *Relative Humidity: Its Importance, Measurement and Control in Museums* by K.J. Macleod.

2. *Museum Lighting* by K.J. Macleod.

3. *Recommended Environmental Monitors for Museums, Archives and Art Galleries* by R.H. Lafontaine.

Technical Bulletins are available free of charge from the Canadian Conservation Institute, National Museums of Canada, 1030 Innes Road, Ottawa, Ontario, K1A 0M8.

Les bulletins techniques sont disponibles, sans frais, de l'Institut canadien de conservation, Musées nationaux du Canada, 1030 chemin Innes, Ottawa, Ontario, K1A 0M8.

PICTURE CREDITS:

6,27,28, Pacific Conservation Centre; 9, Maurice Haycock; 24, 25,26, Atlantic Conservation Centre; 29,30, Archaeological Survey of Canada, National Museum of Man; 32,33 (top), Brian Molyneaux, Trent University; 35,39 (top), 40, John Evans Photography, Ottawa; all others, Canadian Conservation Institute.