Procedures and conservation standards for museum collections in transit and on exhibition

Nathan Stolow

Protection of the cultural heritage

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Technical handbooks
for museums and monuments

3

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Procedures and conservation standards for museum collections in transit and on exhibition
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Preface

Travelling exhibitions of all kinds are increasing at a great rate. The resulting damage may be attributed to poor packing and transportation techniques, which are often out-dated, to climatic variations and even to incompetence on the part of untrained or partially trained museum personnel.

Unesco and ICOM (The International Council of Museums), particularly through its specialized international committees, have over the years sought to reduce the hazards and risks involved in exchanges of cultural objects.

This work is a condensed version of the author's book entitled *Conservation Standards for Works of Art in Transit and on Exhibition,* which has already appeared in Unesco's 'Museums and Monuments' Series.[1] This shorter text is being made available in the 'Technical Handbooks' series, which aims to give practical and technical guidance on the conservation and restoration of cultural property. Intended to contribute to the international spread and exchange of professional knowledge and experience, the series is destined in particular for museums and monuments services whose resources are limited and which must find solutions to their problems of conservation that are more suited to the means available. It is hoped that the information in this handbook will succeed in providing practical guidelines in this sense.

1. Nathan Stolow, *Conservation Standards for Works of Art in Transit and on Exhibition,* Paris, 1979. (Museums and Monuments, XVII.) (English and French.)

The author is responsible for the choice and the presentation of the facts contained in this book and for the opinions expressed therein, which are not necessarily those of Unesco and do not commit the Organization.

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Contents

Introduction

The emphasis in this work is on promoting standards of total care and handling of exhibitions at all levels of activity at all places and at all times. This concept may seem obvious but many readers will know from their own experience how easily damage and deterioration can come about in travelling exhibitions when sufficient attention is not given to even simple conservation and care procedures.

In many instances, exhibition traffic occurs without the advance consultation of experts who could ensure that the objects survive the rigours of travel and changes of climate. All too often the conservator is called in only when the object is already damaged as a result of some unfortunate mishandling in transit or abrupt exposure to a sudden change in humidity and temperature. Obviously, not all works can travel safely, except at great expense. A point is reached where the cost of transporting certain works may be as great as that involved in bringing groups to see them *in situ* at the museum proper.

Conservation science has advanced to a degree where measures can be instituted and hardware designed to resist or at least attenuate the effects of vibration, shock and climate changes—particularly those of relative humidity. Such measures enable paintings, sculptures, photographs, ethnographic and archaeological materials to be transported without risk. At the early planning stages, staff can be trained in appropriate handling, packing and shipping techniques. Loan agreements and contracts can be made to specify the technical and conservation requirements and transit administration for the overall physical safety and security of the collections involved.

The author in an article published in *Museum*[1] referred to the development of a new type of conservator—an 'exhibition conservator' who would be concerned with all the matters of technical and conservation care associated with exhibitions—from examination and environmental monitoring to advice on handling and packing. Finally there would be a period of observation after the return of the collection to establish whether the various travels had caused any delayed action: such as the development of cracks, fissures, or loss of adhesion of structural elements.

Often there appears to be a conflict between the exhibition organizer on the one hand and the conservator on the other. The former is concerned with having the work viewed in a well-designed setting by as many people as possible. Impediments to viewing, e.g. glazing, low levels of lighting and similar conservation measures are often ignored, or paid lip service to. It is a misconception to say that the conservator wishes to 'cocoon' the object in such a way that it can no longer be enjoyed—it is safe but invisible!

Fortunately there is a middle ground to be found between the two opposite philosophies. This depends on establishing com-

1. 'Recent developments in exhibition conservation', *Museum*, Vol. XXIX, No. 4, 1977.

munication between exhibition organizers and designers on one side, and conservators and like-minded curators on the other. Such communication should develop at the conceptual stage of the exhibition and not when all the hardware is installed and ready to go. It is possible, for example, to design cases and vitrines which are pleasing to the eye and yet have controlled environments within, or for lighting to be kept to minimal levels by avoiding adjacent brightly lit areas. It is also fairly easy to install lamps outside cases rather than within where they become dangerous sources of heat—causing profound variations in relative humidity apart from light damage to fadeable materials. Another simple and obvious measure is to lend objects to museums at times of the year when the climates are similar. For travelling exhibitions seasonal disparities and similarities between centres can be readily identified and necessary changes in itinerary be made.

The conservation-care measures in simple or complex exhibitions, in single loans, or those involving many items of national treasure status have certain common denominators. The obvious one is to have the object returned to its lender in the same physical state or extremely close to this. Thus, the structure from the surface downwards should remain unchanged and not exhibit any weakness that might give rise to delayed-action damage. This is no easy task. Objects of wood, textile, paper, leather, horn, and a variety of humidity-sensitive materials are known to change dimensions readily according to variations in relative humidity and temperature. The situation is more serious where objects are composed of both humidity-sensitive and inert materials; severe strain can develop with subsequent cracking or breaking. Large paintings on canvas can be subject to vibration effects which cause eventual weakening of the adhesion between the fabric and the paint-layers proper. Heavy sculptures not properly cushioned have been known to break at points where the stresses and shocks have not been properly dissipated. Decorative arts and ethnographic materials wrapped directly in polyethylene film have grown mouldy or mildewy as a result of condensation and high-humidity environments locked in as 'micro-environments' around the object.

It is sometimes thought that ancient objects somehow survive the shocks and rigours of movement and travel. This is just not so.

Ancient wooden objects, e.g. from the Tutankhamen treasures, respond qualitatively in the same manner as seventeenth-century furniture, or nineteenth-century Indian masks, when the relative humidity undergoes cyclic changes.

The originating museum, or institution, in asking for proper care of its objects on loan should re-examine its own handling and conservation standards. Often these leave much to be desired. A review of the most basic receiving, shipping, storage, handling, and examination procedures should be periodically carried out. No institution should be immune from self-scrutiny and aim for improvement. The care of cultural property starts therefore in the museum itself. How the works are handled at the shipping door, moved, stacked, temporarily stored, examined, environmentally conditioned and exhibited—all influence in an incremental fashion their final condition. To ensure constancy of condition means exercising tender and expert care at all times and places. The first place to practice this is in the museum proper.

The sections that follow attempt to compress an extremely broad subject into a manageable and concise form. The coverage starts with the description of causes of deterioration of collections and suggestions are made for measures to minimize damage; following this are guidelines for the storage and preparation of objects for exhibition; concise descriptions of handling and packaging techniques, and of transportation methods and their evaluation. The last major section lists current guidelines and standards. A list of useful references and data are appended at the end for further study. The illustrations are selected to demonstrate acceptable and safe techniques within the means of both small and large-budget institutions. By extension and modification of the methods shown it is possible to make applications to other fields as well. Thus, the method for packing a three-dimensional wooden sculpture could be readily applied to an anthropological object or an elaborate piece of decorative art. Likewise, the technique of handling flat works, e.g., paintings or drawings, can be extended to photographic items of various dimensions and format.

The overall purpose of this text is to identify the technical and conservation problems in the preparation and organization of exhibitions, and to show through examples how conservation care can be maintained. In this way, it is hoped that the reader directly or indirectly involved in this field may be made aware of the need to maintain collections at all phases and venues. It is only by improving standards at all levels and by their constant implementation and monitoring that the works of today can survive intact for the enjoyment of future generations.

Deterioration of museum objects

Most museum objects are composed entirely, or in part, of materials which respond readily to moisture in the atmosphere, that is to the relative humidity (RH), and exhibit dimensional changes, i.e. expansion when the RH increases, or contraction (shrinkage) when the RH decreases. In this category are cellulosic materials: wood, paper, cotton, jute, linen, as well as protein, animal, bird, fish, and insect materials: silk, wool, parchment, leather, fur, feathers, horn, bone (ivory). Most plastics, e.g., nylon, polyester, polyethylene are humidity-insensitive and absorb very little moisture, but often exhibit surface static which varies with the ambient RH. Metals do not take up moisture, but can form in the presence of carbon dioxide, sulphur dioxide, chlorine, etc., oxides, sulphides, and various corrosion products. The ferrous metals, iron for example, rust at higher levels of RH. Copper and its alloys, bronze and brass, can form carbonates (normal greenish patina), or bronze disease in the presence of additional chloride airborne contaminants. Silver is notorious for forming dark sulphide deposits. Gold and platinum are theoretically inert. But there are examples of early gold contaminated with base metals reacting to atmospheric pollutants. Stone objects are porous and can allow moisture to penetrate. Under indoor museum conditions this presents no danger as the dimensional changes are negligible. However, outdoor exposure at frost-level conditions can be very damaging, causing ex-foliation and cracking at the surface. Ceramics and baked clays are more or less in the same category as stone. Ancient glass objects can respond superficially to RH levels. One such phenomenon is known as 'crizzling', the development of opacity at the surface.

Where museum objects are multi-component, e.g. part wood, part metal or, as in paintings, part pigment (inert), part textile, it is obvious that a choice of RH is very difficult to make for the entire structure. If the object in this category is already dimensionally stabilized at a particular level of RH, it is best to maintain this level at all times. This is often not the case. Paintings are subject to stresses and strains, panel paintings and furniture to warpage and cracks, and ethnographic objects of complex construction to deformation and breakage. Museum files contain much information and documentation which confirm the hazards of environment on the structures and stability of multi-material objects.

The basic aim of the conservator is to maintain the RH level as constant as possible for the simple-construction, moisture-sensitive collections, and arrive at compromise levels for the multi-component ones. A possible solution in the latter category is to apply moisture-barrier coatings to the hygroscopic portions, thereby rendering the total object less susceptible to dimensional changes. This technique is well known to painting conservators who have long experimented with vapour barriers on the backs of wood-panel paintings.

The RH should be kept as constant as possible, so as to avoid dimensional changes in the object. Extensive or erratic changes in RH can ultimately fatigue the structure, causing cracks, flaking, splitting, etc. Too high levels of RH can bring into play mould-growth or corrosion, and too low levels cause embrittlement and danger in handling. At lower levels, too, there is the annoying problem of static electricity and dust accumulation on surfaces.

Recommended levels of RH have been proposed in the past for collections on exhibition, in transit, and in storage. Little research however has been carried out on the detailed behaviour of materials at specific levels of RH. In many European and Asian collections the 'ideal' RH is quoted as being around 55 per cent. In North America generally it is given between 40–60 per cent, in recognition of the very serious problem of condensation in buildings in the winter period.

TABLE 1. Relative humidity levels

Material	Humidity tolerance	
	High	Low
	%	%
Anatomical collections, apart from items embalmed	60	40
Archaeological specimens: hygroscopic items,	60	40
stone and other inert materials	40	20
Arms, armour, metals (wooden components need special protection)	40	20
Ethnographic bark, cloth, basketry, masks	60	40
Botanical specimens	60	40
Ceramics, tiles, stone	60	20
Coins, various	40	20
Costumes, textiles, rugs, tapestries	50	30
Furniture	60	40
Glass	50	40
Insects	60	40
Ivory, bone carvings	60	50
Lacquer	60	50
Leather, parchment	60	50
Paintings, on canvas or wood	55	40
Paper	50	40
Oriental screens	55	50

With regard to museum collection categories the norms for RH are shown in Table 1.

It might be possible to place objects in galleries or store-rooms in climate zones set to different levels. This can be done in buildings with sophisticated heating, ventilating, and air-conditioning systems. However, some objects may require very precise levels of RH control as they may crack or break given appreciable changes in ambient conditions. Specific levels can be maintained by specially designed humidity cases independent of localized variations in the air-conditioning system. Over the year there can be a slow, but steady drift of the RH level in the general areas without greatly affecting the bulk of the collection material concerned. This is particularly of value in galleries which suffer from condensation in the winter-time. Thus, in the northern temperate climate the RH can be programmed from 40 to 60 per cent over a twelve-month period (see Fig. 1), thereby minimizing condensation on the inside of exterior building walls. In drier climates the programming may be from 30 to 50 per cent relative humidity.

With regard to temperature, this is of secondary importance in relation to RH. As long as the RH is constant, at say 50 per cent, the variation in temperature from, say, 15 to 22 °C, is of secondary consequence to the dimensions of the object.

From the point of view of chemical oxidization processes, e.g. action of oxygen, etc. on materials, the higher the room temperature, the higher the rate of chemical change

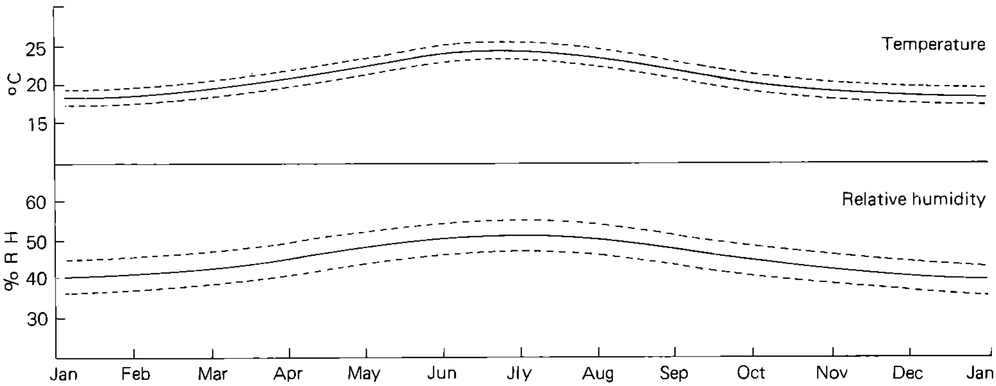


FIG. 1. A scheme for slow variation of relative humidity and temperature during the year to meet conservation requirements for both the collections and the building. This applies in this case to temperate climates characterized by moderately hot summers and cold winters. In other climate regions the curves would be shifted upwards or downwards.

or deterioration. Also, from the point of view of energy conservation, it is better to reduce the temperatures to lower levels—this also permits less expensive mechanical operations at the required RH level. Again referring to the north temperate zone, temperatures programmed from 20 °C in the winter to 23 °C in the summer meet these requirements. In a humid semi-tropical environment the range may be 22 to 27 °C.

In certain cases, the objects require cooler conditions, e.g. for furs, rugs, tapestries, and costumes. The removal of cold-conditioned objects to warm areas should be very carefully done so as to avoid condensation. This is particularly important with such objects brought from store-rooms to gallery areas.

The circulation of air in galleries and store-rooms is very important to prevent localized pockets of variable RH from forming, to inhibit mould growth, and to dissipate atmospheric contaminants. The number of air changes should be sufficient to make it safe for personnel, particularly for lengthy operations (cataloguing, study, or conservation work). Where paradichlorobenzene is used in high quantities for ethnographic or anthropological collections, special attention should be paid to its toxicity for humans and possible effects on objects.

The matter of light, from the point of view of its effect on materials, should be treated as seriously in exhibition areas as in storage. Where the collections are susceptible to light damage, e.g. paper, textiles, costumes, water-colours, prints, drawings, archival records, the levels of ambient light (of any kind) should be low, between 50 and 100 lux (5–10 foot-candles). Daylight and fluorescent light should be additionally filtered with ultraviolet absorbing filters. Lamps also have a heating effect, owing to their infra-red output. Cases, vitrines, cabinets, drawers, etc., should be well removed from light sources to prevent build-up of hot local environments which affect internal RH levels.

The normal atmospheric pollutants of concern are carbon dioxide (above certain levels), sulphur dioxide, airborne alkaline or acidic materials, as well as dust. Stone and marble floors, as well as concrete, powder extensively, possibly affecting works of art. Industrial air not adequately washed or filtered, because of sulfur dioxide or other acidic components or hydrogen sulphide, affects collections in the presence of atmospheric moisture, not only metals but also cellulosic or organic materials. Marine air, rich in chlorides, can provoke bronze disease.

Airborne dust and dirt can be removed at source by efficient filters. For galleries and exhibition areas, it is recommended that dust particles be removed down to the level of 1–2 microns. In storage areas similar levels should be maintained. The air-treatment and circulation problem for store-rooms should be considered most seriously.

Micro-organisms, which give rise to mould growth and mildew formation, are generally active on surfaces at RH levels above 80 per cent and temperatures above 10 °C. Insects can be controlled by preliminary cleaning and subsequent environmental treatment with paradichlorobenzene, or other products. In all instances it should be established by preliminary tests that the fungicide, insecticide, etc., is not harmful to the surface requiring protection.

There are various methods available for establishing different levels of RH within one area, e.g. exhibition gallery or storage area. It has been known for some time that simply enclosing a moisture-sensitive object in a glass case can have the effect of smoothing out the ambient variations in RH, if not temperature. In recent years techniques using chemical solutions, pre-conditioned silica gel, and conditioned clays have been applied to maintain fixed levels of RH, at 30, 40, 50, or 60 per cent for long periods of time. These methods have been designed for small cases or confined volumes for the environmental control of particularly sensitive works of art. By slight modifications larger volumes can be controlled, without the benefit of expensive mechanical and electrical humidity-control systems.

The store-room should ideally be controlled to the levels required in the exhibition galleries for the majority of categories of objects displayed (or stored). The chemically controlled cases referred to above will actually function best within an environment that already has some degree of control. Thus if the store-room is kept within 30–60 per cent RH, the highly sensitive objects can be locally controlled to narrow levels at 50 or 60 per cent, as required.

In museums where considerable quantities of objects are stored in cabinets or drawers the conditions may already exist for establishing suitable micro-climates. Thus, in a consultation visit made by the author to the Field Museum in Chicago in 1972, it was noted that where hygroscopic, ethnographic and other objects were stored compactly in sealed metal cabinets or drawers, the RH levels were relatively stable at about 40 per cent in comparison with wide variations of 30–70 per cent within the room. Here the objects acted as their own 'humidity regulators'. The theory and practice of case design and humidity factors are detailed by the author in one of the references in the selected bibliography. There is therefore an argument for sealed cases, closed cabinets, drawers, and enclosures for objects where ambient conditions are very erratic.

In some curatorial collections, e.g. prints and drawings, it is feasible to combine display with storage. In a recent consultation at the Montreal Museum of Fine Arts, such a system has been developed where the upper part of the display case has a continuous air connection with the lower cabinet which contains on shelves pre-conditioned silica gel as well as solander boxes storing quantities of prints, drawings, and other graphic works.

As a rule of thumb, in a closely packed case, vitrine or drawer containing hygroscopic material, e.g. wood, paper, textiles, for each 1 °C change in temperature, the internal RH will change by 0.33 per cent. Thus if the room conditions change by 5 °C, the RH will change (in the same direction) by 1.66 per cent. On the other hand, if the case or container is very large compared with the object the internal RH responds in an inverse fashion to imposed temperature changes. Thus, if the room temperature goes up, the RH goes down and vice versa.

In any programme developed for micro-climates, the possibility of excessive levels of RH must be excluded to prevent mould growth. It is also assumed that such specialized treatment is designed for long-term storage and in a museum where the personnel responsible for storage systems has suitable technical competence.

Storage of collections[1]

In many museums there is considerable internal movement of collections, from shipping room to storage, to gallery and back, in accordance with various programmes in effect. An active exhibition programme with 3- to 4-week cycles suggest a lot of internal transport with associated risks. There is a tendency to downgrade the conservation and environmental requirements in storage in comparison with those in exhibition areas. This is unacceptable in terms of the concept of total care at all times and places. Where the museum is responsible for a borrowed exhibition it may be necessary to retain it for periods of time in storage, and here both physical environment and security conditions should be of a high standard, at least to the same levels as in the exhibition space. Where the relative humidity and temperature factors differ considerably humidity-responsive objects may be damaged through dimensional changes and strains on transporting from storage to exhibition and vice versa. During movement there are handling hazards and the possibility of vibration and shock transmitted during travel through long, twisting corridors cluttered with cases, bric-à-brac and remains of former exhibitions.

Traditionally, museum storage facilities are in basements, in low-priority areas constructed to minimal standards. The environmental factors causing deterioration are as before: variations in relative humidity and temperature; light; atmospheric pollutants (dust, chemicals, carbon dioxide, sulphur dioxide); micro-organisms (fungi, moulds) and bacteria. Occasionally, very extensive damage may occur in a basement storage as a result of flooding (e.g. the floods in Florence, Italy, and Corning, New York, in recent years). Damage by liquid water is certainly more drastic than that caused by water vapour in the air. Since most storage facilities are made of concrete, there are problems of ammonia exudations and of concrete dust rising in the air and settling on objects.

Storage devices and equipment

The beneficial effects of enclosing objects in confined spaces has already been discussed as at least a positive step in maintaining stable RH levels. The construction and disposition of racks, shelves, drawers, and other hardware can influence the condition or preservation of the stored objects in other ways. The conservation hazards include shock, vibration, rubbing, scraping and damage by human error, and occur in various ways:

Sliding racks for paintings, drawings, photographs. The racks may ride very roughly on the tracks trasmitting shock to fragile surfaces. The hanging devices may be insecure on the screens, risking the fall of an object to the floor.

1. See also E. Verner Johnson and Joanne C. Horgan, *Museum Collection Storage,* Unesco, Paris, 1979. (Technical Handbooks for Museums and Monuments, 2.)

Spring-loaded pole devices for stacking. Too many paintings may be stacked against one pole causing stresses within a stacked section.

Shelves, various. Damage may occur to the objects when they are moved about on the shelves. Excessive handling is often required for placement or for periodic observation.

Drawers. Lack of separators and shock absorbers may cause fragile objects to shift and knock against each other. Some drawer designs do not have smooth stops on pulling out or pushing in.

Compaction storage systems. Such systems save much floor space, and have proved useful in library systems. Special care must be taken to prevent bumping or shock on moving the storage units so that the contents do not become damaged. The constant opening and closing of the mobile storage units may interfere with internally installed humidity control systems.

Materials of construction. Metal is the favoured construction material, usually enamelled steel. Older installations may be of wooden construction. Paint finishes and kinds of wood must be carefully selected to avoid producing vapour harmful to museum objects. Where objects are placed in plastic bins or suspended from plastic devices, preliminary tests are required to make certain that no deleterious action can result through contact. Some plastics, for example, have harmful plasticizers.

Fire control

It goes without saying that sprinkler systems for fire-fighting should not be permitted in galleries or store-rooms housing museum collections. Fire-fighting systems now exist that utilize carbon-dioxide gas, or more effectively, halon (a fluoro-hydrocarbon gas), for quenching fires the moment that heat or smoke detectors are activated. Carbon-dioxide gas systems have a considerable cooling effect upon the room and contents, and can cause moisture condensation on surfaces. Also, personnel in the area, or nearby, may be suffocated owing to the rather low tolerance of the human body for carbon-dioxide gas. On the other hand, halon is less toxic and higher concentrations can be breathed before causing intoxication. Halon systems of advanced design exist in a number of institutions. The author was responsible for the design of one such system in the newly constructed Canadian Conservation Institute for a store-room combining sliding racks for paintings and also for three-dimensional objects housed in halon-protected metal storage cabinets. Such systems are increasingly in use in museums.

Location of store-rooms

As already mentioned, the storage of collections is traditionally relegated to the basement, or other low-priority area in the bowels of the museum. Unfortunately, these areas are often the most difficult to upgrade to the required norms of RH, temperature, and air purity, and are relatively inaccessible. These subterranean locations are also susceptible to flooding, where in one tragic event countless treasures could be destroyed by water action. One recalls again the circumstances of the flooding of the store-rooms of the Florentine museums, archives, and library in the Florence flood, and the great damage caused by the flooding of the Corning Museum. It seems time to reconsider the location of the store-room and place it at a higher level above ground. The attic or top floor should be reconsidered—provided steps are taken to upgrade such space and ensure good physical communication with other functions (elevators, wide doors, high ceilings, etc.).

Storage facilities in the larger institutions are often decentralized into the various curatorial areas. This method of operation certainly leads to better curatorial control and permits ease of movement from storage to contiguous gallery and vice versa. Often, however, such decentralized units are too small and dangerously overcrowded, vying for space with costly and more prestigious exhibitions.

Where exhibition cases are used for display it should be possible to include storage compartments within or alongside them. The recent Egyptian galleries at the Metropolitan Museum of Art in New York are a good example of combined exhibition and storage techniques with environmental controls.

Returning again to the very important activity of museums, that of loan or travelling exhibitions, it is often difficult to find storage space for the temporarily displaced permanent collections. Excessive movement of these objects within the museum, i.e. from gallery to storage and vice versa, with attendant environmental changes, manipulation and handling, presents additional dangers. Not only the temporary loans, but also the displaced works, can be damaged. There does not seem to be an easy solution to this problem as long as exhibition and museum interchanges are on the increase.

Handling and packaging techniques

Damage attributed to human factors

There are essentially two categories of damage here: accidents caused by inexperienced or incompetent personnel; and less frequently, wilful damage by vandals. The first can be dealt with by conscientious staff training in basic handling procedures. Vandalism, however, is difficult to deal with except through vigilant security staff and, in the extreme, by protecting the most vulnerable objects behind glass or in highly secure cases.

Negligent handling and care can be readily remedied by training, and through well organized and maintained storage and work areas. Some typical examples of malpractice are:

1. Handling of objects with dirty hands.
2. Handling heavy or outsize objects without additional assistance and without support underneath, or at centre of gravity.
3. Moving objects, decorative side out, around blind corners or through congested corridors, causing scrapes and surface damages.
4. Overcrowding of storage rooms, shelves and bins, making it difficult to reach particular items.
5. Storage of objects near heat vents, radiators, or locations which experience violent changes of climate.
6. Unauthorized dusting and surface cleaning of works of art and decorative objects utilizing coarse cloths or hazardous cleaning agents.
7. Hanging and placing works of art and objects in the exhibition area while carpentry, painting and spraying activities are in progress. This happens very frequently in the last stages of organization of an exhibition.
8. Not using adequate hanging devices as well as under-supports for heavy objects on display; also putting heavy objects on light-weight pedestals.
9. Placement of humidity-sensitive objects against cold damp exterior walls, or on walls experiencing wide variations in temperature (e.g. walls concealing heating pipes or ducts).
10. Displaying objects in sealed display cases using untested toxic construction materials, e.g. adhesives which contain sulphur, acid-containing fabrics and papers; all of which will have a corrosive affect on the artefacts exhibited within.
11. Improper packing techniques in which objects are crammed together tightly without shock absorbers and separator panels; where packing cases are poorly constructed with air gaps, and lids hammered into position after packing. Labels stapled on lids sometimes penetrate through the case into the art works themselves.
12. Storage of packed cases under extreme conditions of humidity and temperature, even out-of-doors, creating shock conditions at time of re-packing.

To avoid these more obvious examples of neglect, all handling and preparation procedures should be re-examined and rectified where necessary. All staff concerned, senior to junior levels, should participate in 'care recycling'.

In travelling and loan exhibitions the works must be handled most carefully once they are unpacked. The shipper, registrar, preparer, curator, conservator individually and collectively must carry out their tasks in the most fastidious and conservation-conscious way. In smaller institutions handling borrowed materials, one person may embody several functions—those of registrar, preparer and curator—and here the responsibility is even greater. It does not follow that a one-person operation leads to greater frequency of museum damage. Sometimes one well-trained professional can operate more safely than a number of persons collectively having less skills and ill-defined duties.

Preparation for travel and exhibition

The condition report is one of the most important documents in the museum. It records historical and acquisition data, describes the technical and compositional nature of the work, and is the time record of its conservation state. Various kinds of condition report have been used to meet different museum requirements. Thus the registrar's and conservator's condition report, with associated photographs, X-rays and laboratory data is of necessity detailed and technical. However, in travelling and loan exhibitions the condition reports may be abbreviated and designed in such a way that changes or cumulative effects (damages, cracking, etc.) can be recorded, and actions taken at specific times. Examples of typical condition reports are given in Appendices A and B.

The lending institution should always examine its objects prior to loan and on their return. Intermediate examinations and checks on condition should also be made. It is usually possible to attribute a particular damage to an event, e.g. dropping of a case, rupturing of a packing crate by an inexpertly handled lift truck, or water seepage through outdoor exposure (because the case was too large to enter the museum doors for shelter within).

Photographs are very convenient for detecting changes in the surface of objects; e.g. new cracks, warping, abrasions, losses of paint, gilding, jewels, feathers, and so forth. It is not always obvious where the damage or weakened condition started. Shock, vibration and transit movements transmit through packing cases (unless very well protected with internal shock absorbers) and it may be months before the structures have fatigued to the point where damage finally occurs. In travelling exhibitions involving several centres it can be appreciated how difficult it would be to pin-point the origin of damage.

The writing of condition reports is a very imperfect art. In some instances the record is too brief, in others overly detailed. Here there is room for training of personnel in the detection of damage, potential fragility, and the differentiation of old stable damages from newly formed ones. Usually the conservator has this kind of training and can be the final arbiter in difficult situations. In general, it is better to have longer reports and more condition photographs to protect the lending or borrowing museums in the event of insurance claims or litigation.

Not all objects should travel, particularly if, after examination and documentation, it is found that their structure or condition cannot resist the physical hazards of handling, packing, and the mode of transportation. Such objects are usually placed on non-loan lists. In exceptional situations, where an object must travel notwithstanding its condition and against the judgement of the professional staff, the responsibility must rest with the authorities concerned. It then becomes imperative that there be sufficient preparation time (for restoration, or consolidation), and an adequate budget to design the most elaborate and fail-proof packing cases. Such high-budget transits as that of *La Pietà* by Michelangelo, the Irish treasures, the Dresden collections, and the Shakespeare exhibition are cases in point. The handling, packing, case design, environmental controls, curatorial accompaniment and related technical costs, together with insurance represent budgets in the hundreds of thousands, if not millions, of dollars.

For smaller exhibitions and museums with much more limited budgets, the preparations are of necessity less elaborate but must still conform to minimum standards. The risks to objects and works of art in low-budget exhibitions are obviously greater. Often, however, the selection criteria for loan and exhibition are not well established, and works not carefully examined for safety in travel.

Once works are deemed to be in suitable and stable condition for exhibition, then consideration is given to preliminary protection of various forms prior to packing. Thus, paintings are checked to see that they are securely fastened into their frames and that they have protective backs. Prints, drawings and photographs glazed in frames present great risk of breakage of glass. It is normal practice to remove the glass and replace it with acrylic rigid sheet, plexiglass, lucite or similar type of glazing. If the question of light damage (e.g. fading action) is a factor, then an appropriate type of ultraviolet acrylic sheet is specified. Sculptures and three-dimensional objects are usually pre-wrapped in soft tissues in cocoon-like fashion. Bronzes and metallic objects likely to corrode or develop oxides are given protective coatings. Often it is necessary to have double systems of packing for maximum safety, the first layer surrounding the object as the conservation protection barrier, which is preferably applied by the conservator; subsequent layers of padding, cushioning, and double packing then surround the pre-packed object as additional barriers against shock, thermal insulation, and for humidity buffering. These aspects will be elaborated further in the sections on packing and transport.

A word of precaution about the use of polyethylene as a preliminary packing material. It is often used as an immediate wrapping film around a painting, sculpture or work of decorative art. As long as the transport proceeds through constant-temperature zones then the risk of condensation within the polyethylene enclosure is minimal. However, in many exhibition transits changes in temperature do occur with condensation developing on the interior surfaces. There is great risk then of mould growth, development of corrosion on metals and other defects associated with very high levels of localized RH. It is therefore preferable for the immediate wrapping material around an object to be of a cellulosic or humidity-buffering material, such as soft paper tissue or paper quilting. The polyethylene film can then be applied over this layer. The risks of condensation are thereby considerably reduced, as the initial paper layers, if applied sufficiently thickly, act as temperature insulation as well as moisture buffers.

Whatever systems of preparation or pre-packing are used in an exhibition of the loan or circulating type, they should be well described and included in the travelling documentation for re-utilization at each stage of re-packing and unpacking. Ideally, the staff initially involved in applying these measures should travel from centre to centre to ensure that there is continuity in the care and handling. Unfortunately, it is the rare exhibition where this wise precaution is taken.

Over the years, criteria for lending have been established, based on proved conservation principles, the known risks of transportation, climatic variations, and the risks of indifferent or hazardous handling in different institutions. Some museums have very restrictive loan criteria or policies, others are very lenient. The following may be considered to be realistic criteria, established by conservators and curators concerned with the good maintenance of their collections at all times.

Paintings and similar flat works

Conservation records should be checked.
Works should be examined to see that they are properly fitted into their frames.
All works on canvas supports should be fitted with protective backings (cardboard, masonite, etc.) attached to frame or stretcher.
Especially fragile or ornate frames should be replaced with travelling frames.
Frescoes and similar paintings should be securely mounted on rigid shock-absorbing supports.

Non-loan criteria
Paintings on wooden supports very susceptible to R.H. variations, unless placed in climate-controlled travelling cases.
Unprimed canvases, or surfaces which mark very easily, also paintings of very large format, e.g. 3 × 5 metres.
Powdery or flaking paint not easily treated.
Weak canvas support which, for technical or aesthetic reasons, cannot be lined.
Paintings on glass or similar fragile supports.

Works on paper, including rare books and manuscripts

Conservation records should be checked.
Individual works must be mounted on rag or acid-free boards by hinge method (or equivalent) with window or other mats of similar material. Books and manuscripts should be well bound and pages securely attached. Micro-organisms should be eliminated, or at least stabilized.
Flat individual works, where glazing is mandatory, must be taped in criss-cross fashion, otherwise acrylic plastic should preferably be used. For protection against fading, acrylic plastic having ultraviolet absorbing qualities is used. Extra care must be taken to eliminate shock transmission.

Non-loan criteria
Powdery drawings, e.g., pastels, unfixed charcoal, lean gouache. Occasionally, pastels have been transported by personal courier with exceptional packing.
Brittle paper, or mount which cannot be removed.
Works of exceptional light-sensitivity.
Books and manuscripts where the binding is defective, the book block weakened, or there is evidence of micro-organism attack.

Sculptures and three-dimensional objects

Conservation records should be checked.
Heavy mounts or bases should be separated for packing and shipment. Preliminary packing or cocoon wrapping is required.
Metallic objects (e.g. bronzes) should be given protective wax or acrylic coating, followed also by cocoon wrapping.

Non-loan criteria

Very moisture-sensitive wooden objects unless, as with panel paintings, RH controlled travelling cases can be devised.

Plaster, wax, glass.

Bronzes subject to 'bronze disease', unless correctible in time.

Structurally weak objects difficult to reinforce. Many contemporary sculptures are in this category.

Stone and ceramic objects infused with salts which would react under variable humidity conditions. This applies also to archaeological finds.

TEXTILES

Conservation records should be checked.

Works should be rolled on a tube for shipment if too large to ship flat, with acid-free interleaving paper.

Non-loan criteria

Weak or deteriorated fibres.

Extreme sensitivity to light.

HISTORICAL, ETHNOGRAPHIC, SCIENTIFIC OBJECTS

Conservation records should be checked.

Dismantling or other procedures, if applicable, must be carried out. Working drawings may be required for re-assembly.

Protective coatings, if applicable, must be used.

Non-loan criteria

Extreme fragility.

Easily marred or discoloured surfaces.

Deteriorations not readily restored for technical or aesthetic reasons.

Great weight, excessive dimensions, or overly complex construction.

PHOTOGRAPHIC COLLECTIONS, MICROFILMS, TAPE RECORDINGS

Conservation records should be checked.

Degree of fragility and inflammability minimal, if acceptable under controlled loan conditions; absence of micro-organisms.

Acid-free mounting and matting of flat works, with appropriate acrylic glazing of ultraviolet absorbing type.

Non-loan criteria

Works of great fragility and brittleness.

Works with a high degree of inflammability, e.g. nitrate-base films.

Very faded and unusually light-sensitive materials.

Tapes and recording materials highly susceptible to deterioration or loss of message or image.

ARCHAEOLOGICAL SITE OBJECTS

Conservation records should be checked.

Waterlogged objects should be retained in appropriate transportable humidified or liquid environments.

'Dry' objects should be protected in field with appropriate consolidants to permit transport without breakage risk, crumbling, or separation of associated components (e.g., soil, rock materials, etc.)

Non-loan criteria

Objects which because of size and fragility and notwithstanding conservation protection measures applied in the field, cannot be moved without great risk.

Objects which require urgent additional treatment after reaching the museum, or are associated with earth and other significant accretions requiring further examination.

Works having a great tendency to react to light or components in the air.

Further remarks on handling and movement within the museum

Cleanliness is a cardinal rule. It is necessary to wear light-weight clean cotton gloves while handling sensitive surfaces which mark readily or are reactive to perspiration and the oil always present in the fingers. Examples of such surfaces are highly polished, tarnishable or oxidizable metals, e.g. silver, bronze and particularly metals that have transferable deterioration components (e.g. certain bronze patinas); modern 'colour field' or 'hard edge' paintings on unprimed canvas, or those having a matt surface highly susceptible to marking and soiling; easily abraded plastic surfaces; stone and ceramic objects of a porous nature. It is sometimes necessary, however, to make a compromise between cleanliness in handling and security in holding. The object may be heavy and difficult to hold or 'slippery' to handle with gloves and therefore it is advisable to use bare, but clean and dry fingers and hands. If this is the case, surface perspiration and oily matter transferred should be wiped off immediately.

TABLE 2.
Weights of materials (approximate values)

Material	Weight lb/cu.ft	gm/cm³
Leather	37	0.6
Soft wood	30	0.5
Dense wood	50	0.8
Acrylic plastics	75	1.2
Glass (common)	160	2.6
Aluminium	170	2.7
Iron (incl. steels, various)	490	7.8
Zinc	440	7.0
Tin	460	7.3
Copper	560	8.9
Lead	700	11.3
Gold	1,200	19.0
Marble, limestone	170	2.8
Cement	180	3.0

Table 2 gives an idea of weights of various materials for handling purposes.

There are various mobile labour-saving devices used for transportation of objects from one area to another within the museum. These are usually platform carts on smooth-rolling wheels with custom-made dividers for securely holding works of art. Types of manually-operated carts are shown in Figures 2 and 3. These are designed with shock absorbers and cushioning pads as well as anchoring points for tying the works into position. Very small objects can be transported in converted grocery carts or library book-trolleys with provision again for soft padding to avoid shocks. A certain amount of ingenuity is required to apply existing types of mobile furniture, such as library trolleys, or other inexpensive rolling devices.

Very heavy sculptures, weighing several hundred kilograms require special handling equipment, e.g. overhead chain hoists or mobile hoists. There are several such lifting devices on the market rated for different kinds of loading. However, it is important to have the right kind of grappling device to lift the object safely. Here, attention has to be paid to the weight distribution, strength and centre of gravity of the sculpture and not to attach the device to a weak element causing possible breakage. Once lifted, the sculpture should be placed on a padded dolly and then transported to where it is required. There have been instances where sculptures have been decapitated by lifting from an attachment device fastened to the neck! It is also important to apply padding, such as soft quilted paper, in the areas of attachment or encirclement of the grappling devices so as to avoid surface abrasions.

The commercial type of battery-operated fork-lift trucks are really limited to hoisting and moving heavy cases and crates.

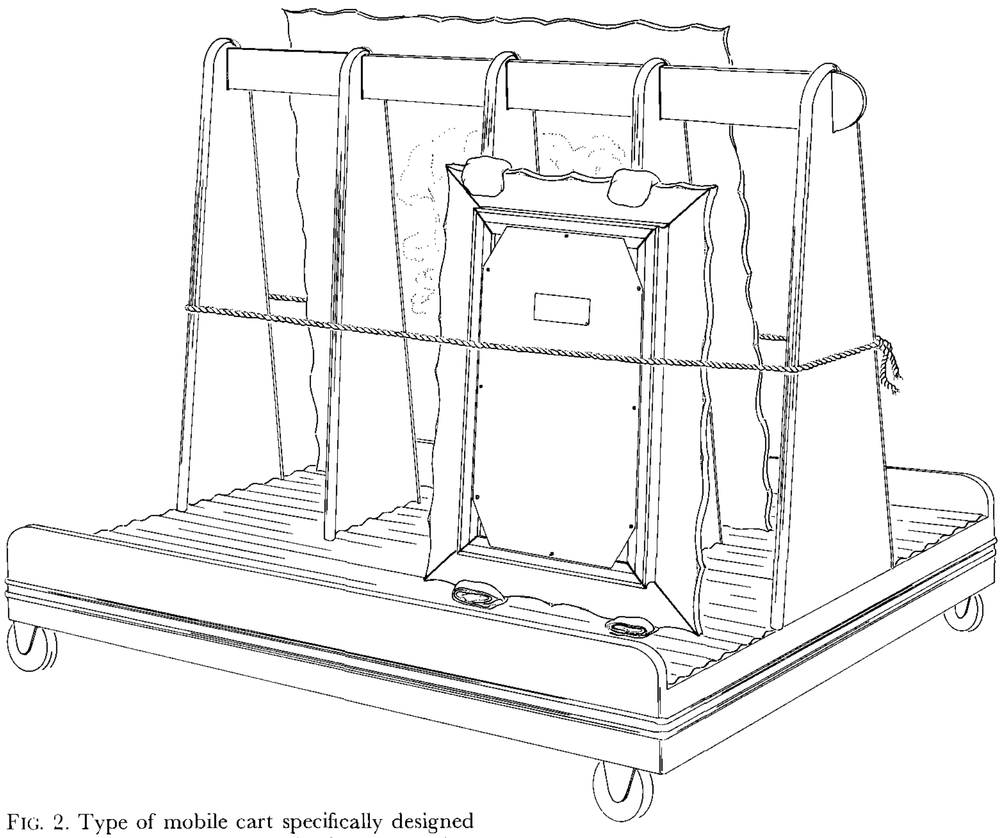


FIG. 2. Type of mobile cart specifically designed for transporting paintings and other flat works within the museum.

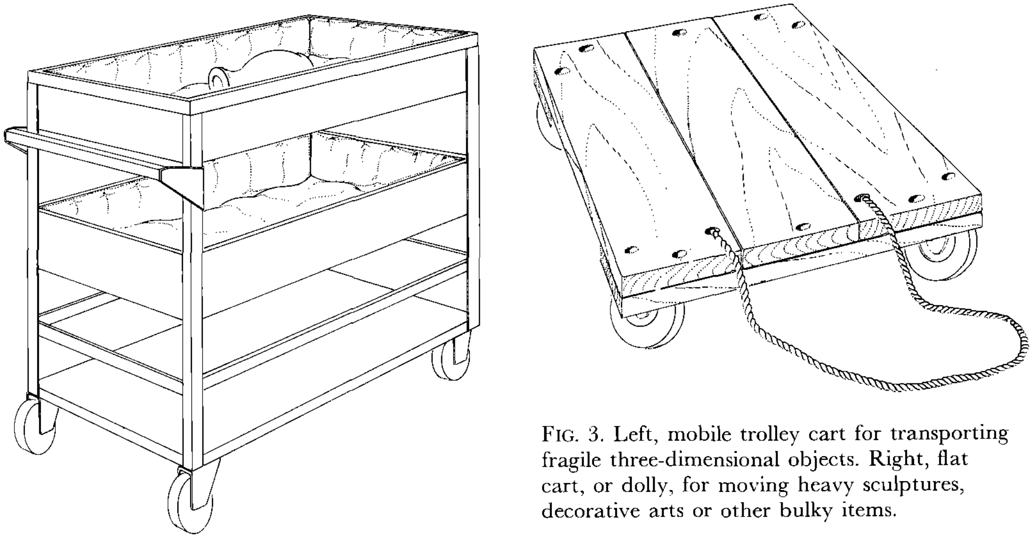


FIG. 3. Left, mobile trolley cart for transporting fragile three-dimensional objects. Right, flat cart, or dolly, for moving heavy sculptures, decorative arts or other bulky items.

These have tines or projection platforms adapted for slipping underneath pallets or cases with battens. In special situations the tines can be raised to a certain height, and by attaching chains and grappling devices, the lift truck can be used as a hoist for lifting a heavy object or piece of decorative art.

Heavily-loaded dollies, carts, and similar mobile platforms require at least two persons for manipulation—one in front and the other at the back. Particular care should be taken on inclines to prevent uncontrolled rolling. The wheels should be equipped with braking devices.

The larger museums have freight elevators for access to the various floors. These usually have a capacity of two or more tonnes and are designed for low speed because of their loading. A smaller number of museums have mechanical loading platforms at the shipping dock. This is a most useful device to raise (or lower) cases to floor level when loading or off-loading trucks. It is then a simple matter to transfer the cases to dollies or mobile carts.

An important consideration in museum internal transportation is to have available a variety of mobile devices of safe design. They should not subject works of art and museum objects to shock or excessive vibration when conveyed through the building.

It is preferable for shipments to be unloaded inside the building proper, i.e. the vehicle enters into a sheltered loading area. Thus the problem of weather affecting cases and their contents is eliminated. Where there are no interior off-loading facilities—and this applies to many institutions—then blankets, tarpaulins, and heavy plastic sheets should be available for throwing round the cases as they are unloaded outside and moved to the shipping dock.

Packing of works of art and museum objects

It is interesting to note that traditional packing and case design still persists in many museums. Some of these methods are quite sound, having stood the test of time, and have had high success rates in terms of protection. With the advent of newer modes of transportation and the decline in care in handling by carrier personnel, traditional case design may prove to be inadequate.

On the industrial side there have been considerable advances over the past twenty-five years in case design, shock absorbers, and handling techniques for very fragile objects, such as television sets, electronic equipment and sensitive instruments. Museums have been slow to adapt newer technology. This may be due in part to the general conservatism of the technical personnel of the shipping room, or simply to a lack of knowledge of what is available outside.

Certainly the time-tested methods of packing and case construction should be retained if they are still valid in protecting the packed objects against vibration and shock, and have a certain degree of temperature insulation and humidity-buffering capacity. The primary purpose of packing and encasement is to protect the object. This is the acid test of any system, whether old or new. The newer technology available in industry should nevertheless be studied and evaluated for possible museum applications. It is however up to the larger museums and research-type institutions to carry out the necessary test and evaluation programmes, particularly where radically new approaches are taken.

The quest for newer packing materials and fastening devices arises from economic and labour considerations. The increased cost of such basic construction materials as

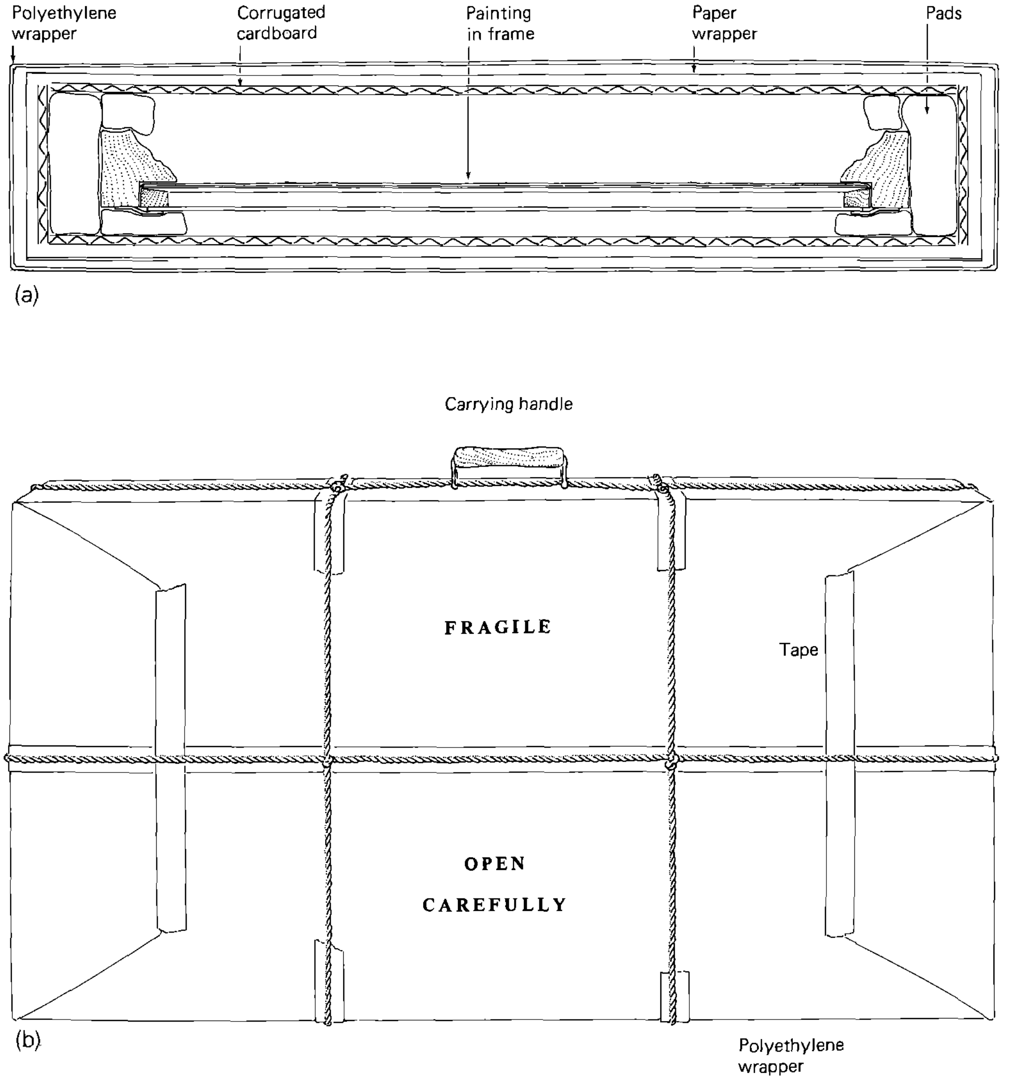


FIG. 4. A corrugated cardboard-and-paper package with polyethylene outer protection may be used for short-distance personal transport: (a) method of packing; (b) package exterior with carrying handle.

wood, plywood, fibreboards, as well as that of skilled manpower, poses serious budgetary problems for museums and institutions as they become more and more committed to exhibition and exchange programmes.

Solutions may be sought in various directions: simplified case construction, modular and re-cycled containers, the use of synthetic materials, and closer planning of effort between curatorial, registration, and conservation personnel. The products of modern industry are not by and large designed to last, or made to museum archival standards. This is the cornerstone of a consumption-oriented society. What is considered durable in industry, of the order of two to three years, is rejected out-of-hand as ephemeral by museum workers. Another factor of commercial practice is the frequent changes in manufacturing specifications. Thus the various synthetic plastics, foam rubbers and the host of products used in the commercial packaging industry undergo abrupt revisions. It is no wonder that certain museum craftsmen prefer wood, as it is a familiar material and practically unchanging in its properties. There is always the possibility that a particular synthetic material may slowly release plasticizers or other deleterious substances when works of art are sealed up in the case. It is fair to say that certain types of wood used in case construction also produce toxic vapours. However well-aged pine and good grades of fir plywood are quite safe.

In the more spectacular international exhibitions of recent years there have been some improvements in case design and packaging, together with a greater focus on conservation and protective measures. Loan contracts and agreements more frequently include precise technical clauses specifying packing, handling, and environmental conditions. Major international exhibitions, e.g. Expo '67 (Montreal) and '70 (Osaka), the Chinese archaeological exhibition, the Irish treasures, and the Shakespeare travelling exhibition all reflect advances in packing and packaging. As mentioned earlier, these displays involved large budgets permitting technical innovations and special conservation vigilance unknown to smaller institutions.

The cases and packing systems described below are generally traditional ones, with certain adaptations. These do not have special provision for built-in devices for humidity and temperature control. Such controlled cases have been described in a more detailed work by the author.[1] Newer materials are of course competing with the standard woods, plywood, and fibreboards. More and more frequently polyurethane, polystyrene and ethafoam (foam plastics in general) are finding their way into museum practice. They have been used first for design and exhibition display purposes, and now are being used for the packing of works of art.

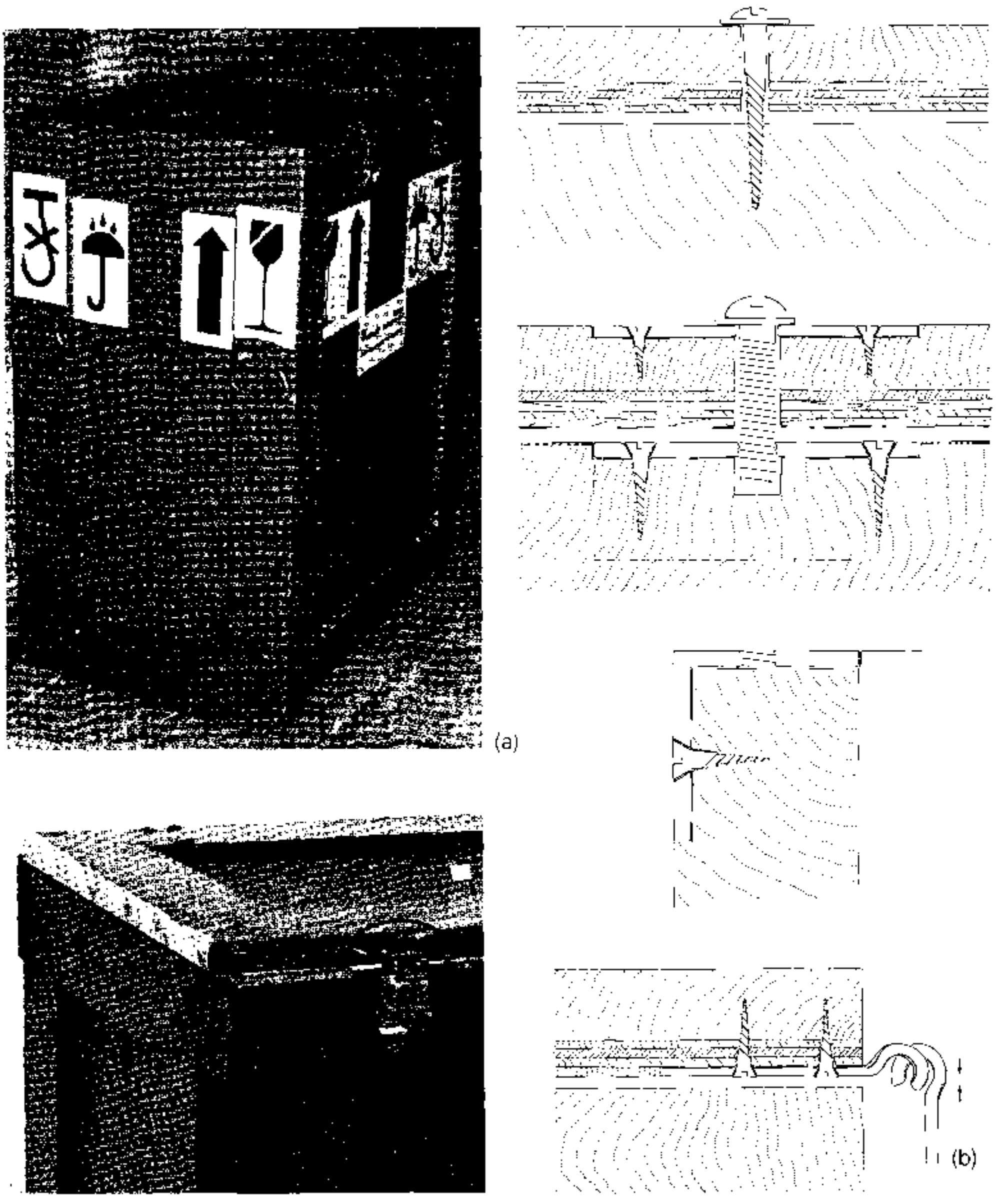
Individual hand-carried packages

In this method an individual-framed painting, drawing, or photograph is pre-wrapped with tissue paper, or kraft paper, and surrounded with additional soft-paper padding material and placed directly in a wood, plywood, or cardboard packing case of slightly larger dimensions. This technique is essentially for short-distance and personalized transport, as the case is not particularly strong, nor is there much cushioning material. If the flat object is unframed it is necessary to attach framing strips along the edges, protruding in such a manner that the wrapping material does not touch or abrade the decorative surface. For weather protection, e.g. against rain or high humidity, the exterior may be wrapped in polyethylene film. Finally, heavy cord is tied round the package together with a handle to facilitate hand-carrying (see Fig. 5).

Pyramid packing for framed works in cases

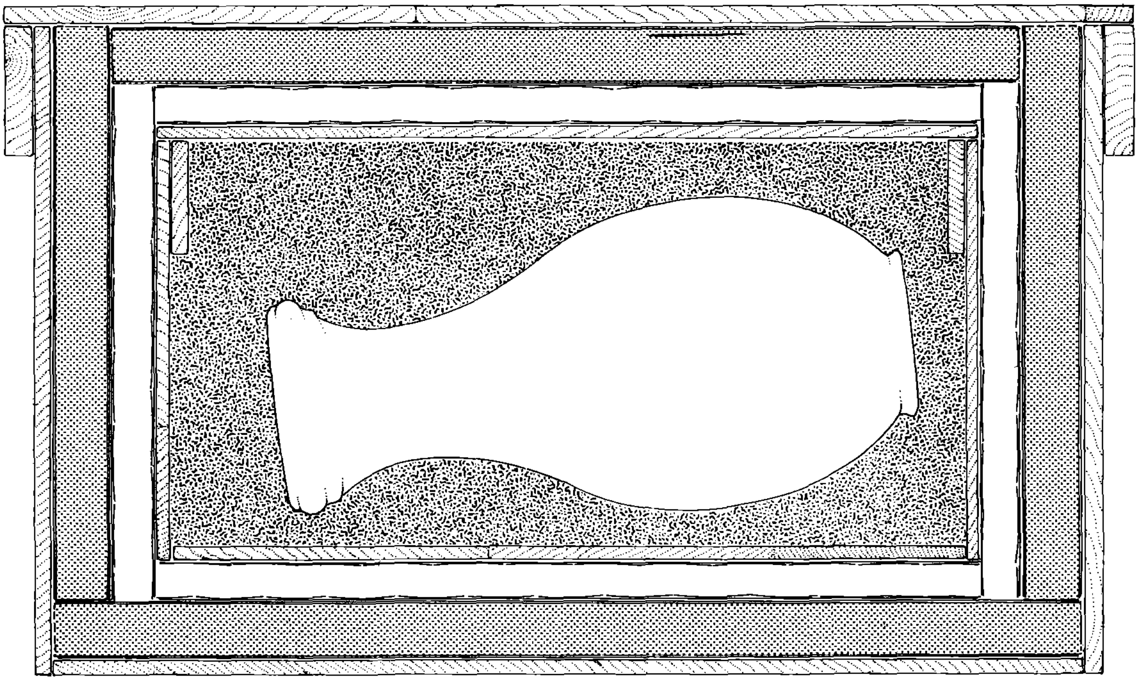
There are two main variants of this system. In one method the paintings, drawings or other flat works in their frames are arranged in tiers upon horizontal 'separating' panels,

1. Nathan Stolow, *Conservation Standards for Works of Art in Transit and on Exhibition.* Paris, Unesco, 1979 (Museums and Monuments, XVII.) (English and French.)



with the free side spaces taken up with various stuffed 'cushions' or shock absorbers. These may be fabric or kraft paper stuffed with soft crumpled tissue, or enclosing foam rubber pieces. A second variation of this system, more hazardous, is the original 'pyramid packing' method, in which framed objects are stacked face downwards with the largest framed item placed at the bottom of the pyramid and the smaller ones progressively to the top. The individual frames are fitted with corner pads and the slack side

FIG. 5. (a) Traditional packing case of plywood and wood. The various warning signs are fixed, e.g. 'Use no hooks', 'Keep away from rain', 'Keep vertical', and 'Fragile'; (b) different closures for cases: (i) wood screw with washer; (ii) bolt and threaded captive plate fixed to case wall; (iii) a newer type of adjustable closure device. Rotating the wing-nut lowers or raises the metal linking attachment.



Plywood

Polystyrene rigid foam

Soft plastic foam

Loose fill packing material, e.g. polystyrene, polyurethane foam

FIG. 6. Packing system for a decorative art object. (Hölm. Copenhagen.)

spaces filled with cushioning material as before. The first packing technique is safer as there is less danger of the framed works shifting position through movement of cushioning material as a result of shock or dropping of the packing case. It is advisable to have sturdy triple-corrugated cardboards or horizontal separators to reduce the possibility of the individual patintings, drawings, or photos damaging one another in the event of extreme shock.

Tray packing in cases

This is another type of group packing for flat works stacked horizontally in a case. The work of art is fitted in a tray framework with shock absorbers positioned at the frame corners. This type of packing system can accommodate five or six such trays. It has been successfully employed in travelling exhibitions having extensive itineraries. Since the trays can be made quite strong and extend fully to the inside surfaces of the packing case, there is little possibility of the works shifting laterally as in the pyramid system. Unpacking and repacking is simple as each painting or object has its own tray. In pyramid packing, there is margin for error in stacking the items the wrong way, or in applying the cushions in the wrong positions, when the exhibition is repacked by different personnel. A distinct advantage in tray packing is that since the overall dimensions of the trays are the same, their sequence in placement in the case is not of great significance. Also the trays can be recycled by simply removing the corner pieces and adapting new ones in different positions for works of art of other shapes or sizes.

Slot and tray systems for cases

Here the interior of the packing case is fitted with slots or slides to accommodate trays as described above or the entire framed work. The slots may be arranged for vertical or horizontal storage. To facilitate sliding action, the trays or frames must be of smooth and uniform finish. A typical system of the vertical type is shown in step-wise sequence in Figure 7. Here the framed paintings are of various sizes requiring filler spaces built into the case wall. In well-designed cases of this type there are shock-absorber pads placed at the bottom and top sections of the slots.

Many circulating exhibitions have been packed in this manner—paintings, drawings, photographs, posters, etc. Repacking in the same manner is assured as the slots are specifically dimensioned for each work.

A variant of the slot system is the positioning of objects on horizontal sliding panels. This has been utilized in the Shakespeare exhibition circulating throughout the United States. The various rare manuscripts and books are held in cushioned corner sections built upon horizontal sliding trays. Additional fastening devices ensure that the books are not jolted out of their cushioned frameworks.

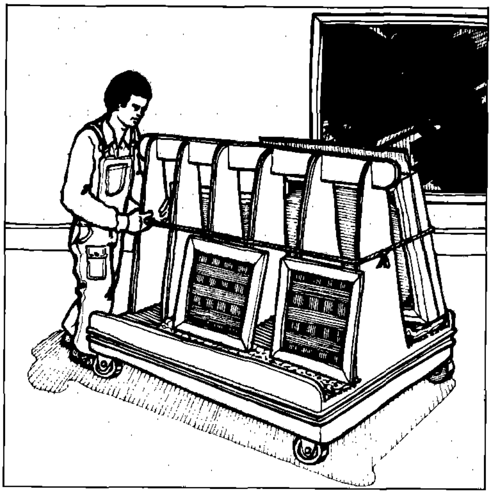
Occasionally, the horizontal or vertical panels are of perforated fibreboard, i.e. with numerous punched or drilled holes. It is possible to secure individual works of art by means of cloth straps or cords.

Large flat works

These pose serious problems in packing and case design. For example, in the packing of a contemporary painting—say three by four metres—the case must be built in such a way that if twisted or torsioned on handling, the forces of deformation are not transmitted directly to the object inside. The cases have to be very sturdily built with extensive cross-bracing to minimize the possibility of twisting on handling and during travel. Occasionally, outsize paintings are removed from their stretcher supports and rolled on large-diameter fibre drums (about 50 cm diameter), decorative side always *outwards*. Obviously, rolling of any kind is damaging to brittle surfaces—cracking and structural weaknesses will eventually develop.

Case systems for three-dimensional objects

A conventional method for packing a bronze sculpture with fairly smooth and regular surfaces is to pre-wrap it with soft tissue and then surround it on all sides with cushioning material. Traditional stuffing materials are crumpled paper, excelsior (wood wool), quilted paper, but in recent years a variety of plastic materials have been used in the form of 'balls', 'peanuts', or 'spaghetti', made by extrusion or similar processes. This type of surround packing is usually called 'float packing' and depends on the object being suspended in the bed of material, so that its weight is distributed and supported in all directions. The sculpture should be so held that in the event of accidental turning of the case, the object does not shift appreciably from its original



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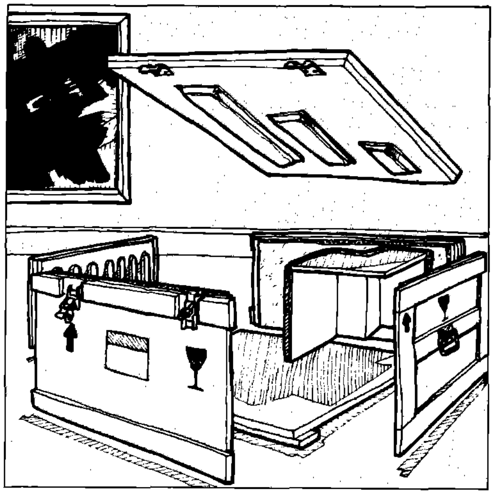

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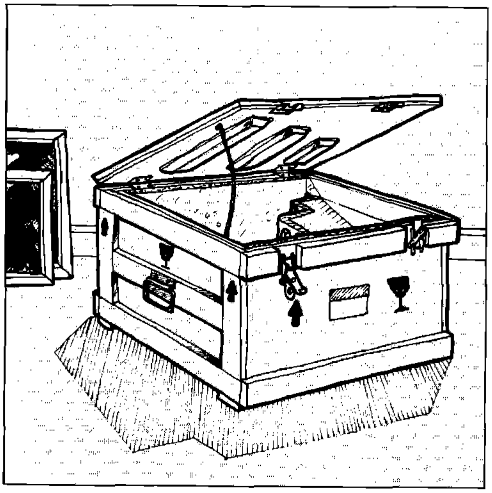

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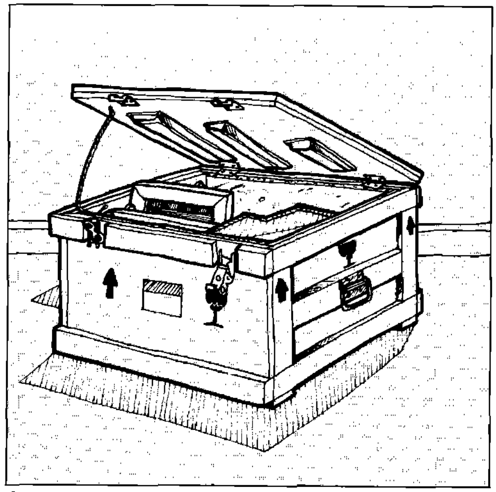

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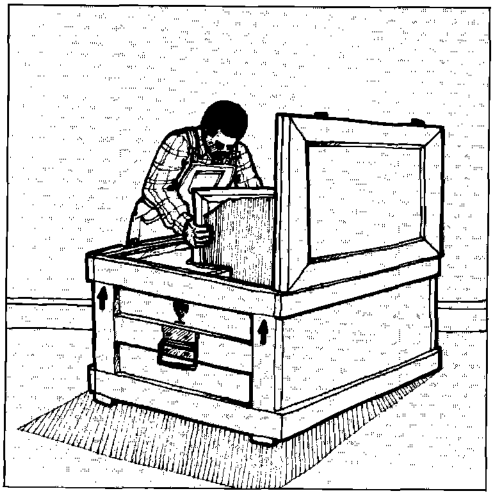

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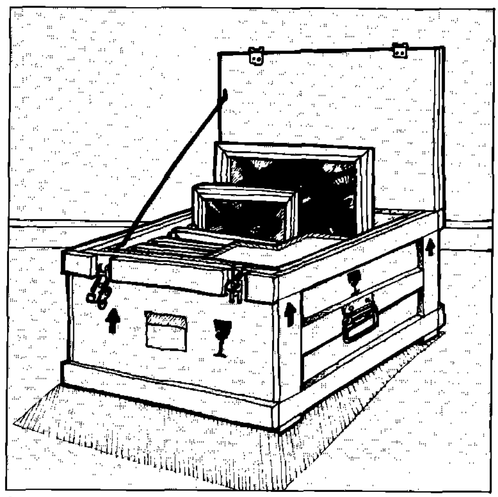

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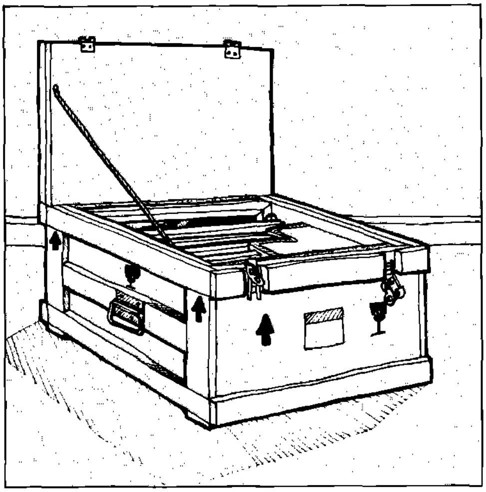

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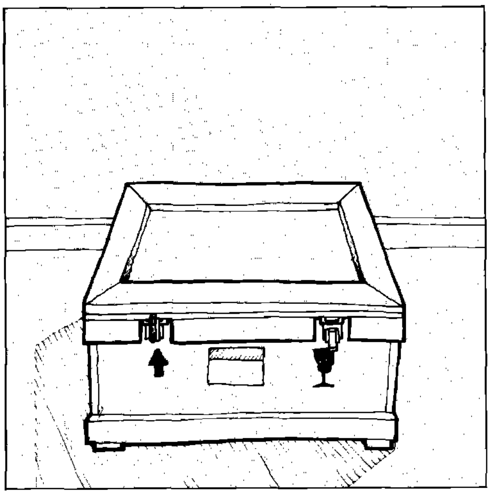

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FIG. 7. Slot system for packing flat works of art.
(a) Paintings or glazed items (pre-protected by applying masking tape over the glass, if glass is mandatory for travel, otherwise acrylic glazing, which does not require taping, is preferable) temporarily stored on mobile padded cart.
(b) Exploded view of plywood and wood elements in construction of case. Padding and fasteners are already installed.
(c) Case constructed and ready for loading.
(d), (e) and (f) Loading of individual works in vertical positions in respective padded slots.
(g) Case ready for closing. Note wood-filler construction in lower right inside of case.
(h) Case is closed by special-purpose re-usable fasteners. Label, and 'fragile' and orientation signs are visible.
(i) Typical screw type of case closure, useful for a few cycles only of opening and closing, as the grip of the screw in the wood is reduced eventually.
(j) 'Captive' screw in threaded metal plate allows repeated opening and closing.
(k) Similar system as in (j), except that the threaded lower plate which is attached to the case is more solidly fastened with wood screws in two different directions. This is a superior method offering greater strength.
(l) One of a number of patented 'Link-lock' fastening devices which offer adjustable closing force. By turning the wing-nut by hand and then by wrench, the 'tongue' pulls down the upper attachment.

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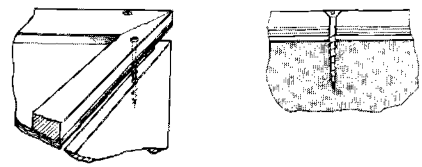

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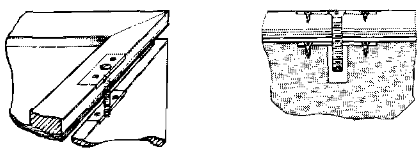

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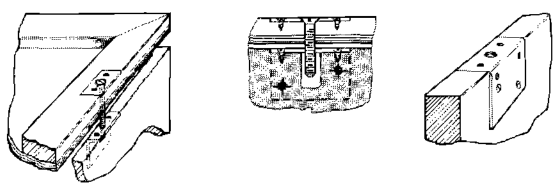

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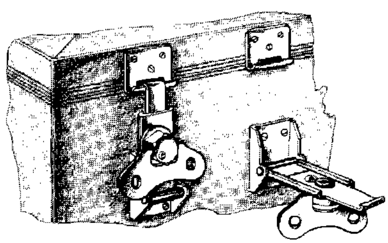

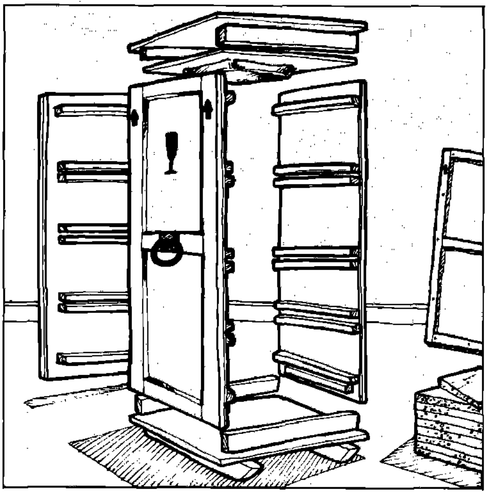
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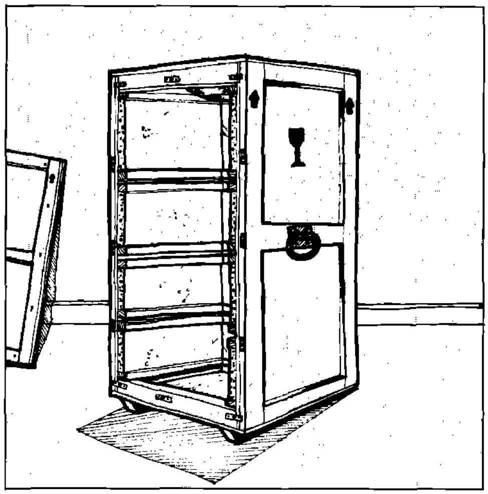
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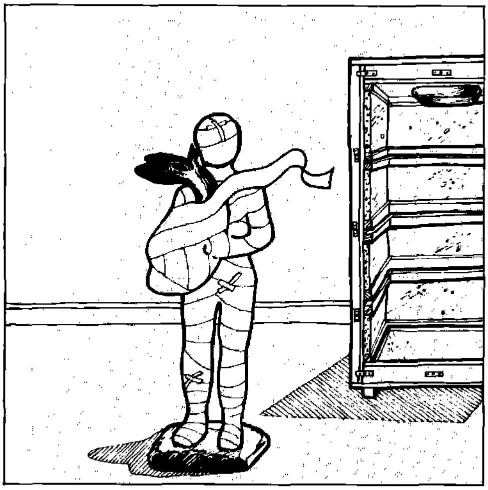
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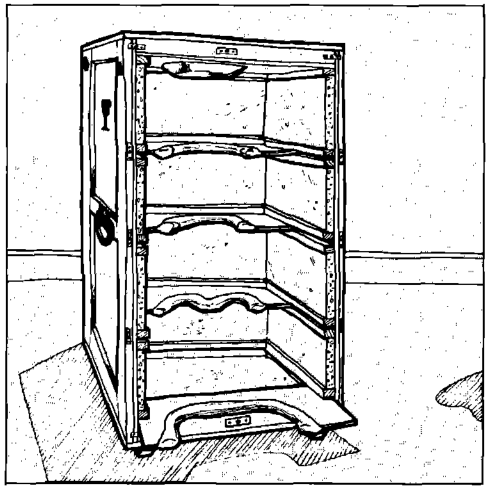
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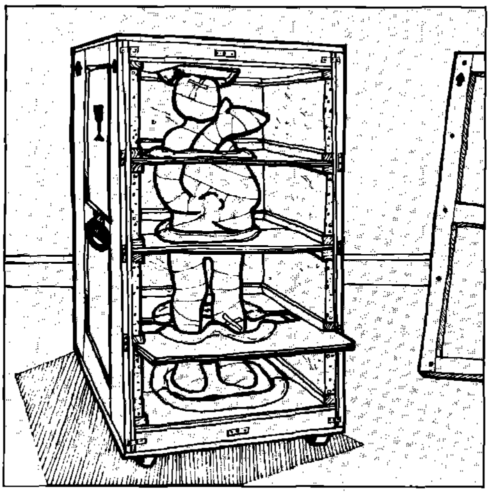
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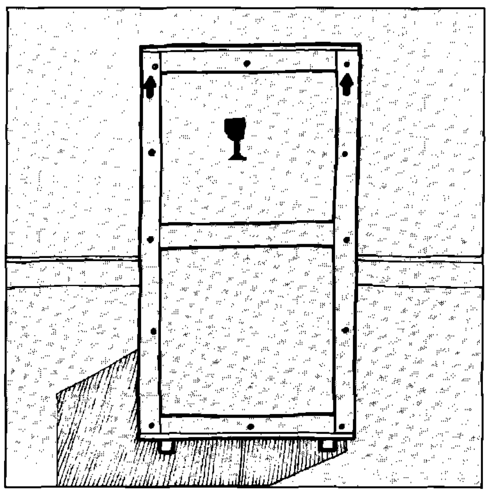
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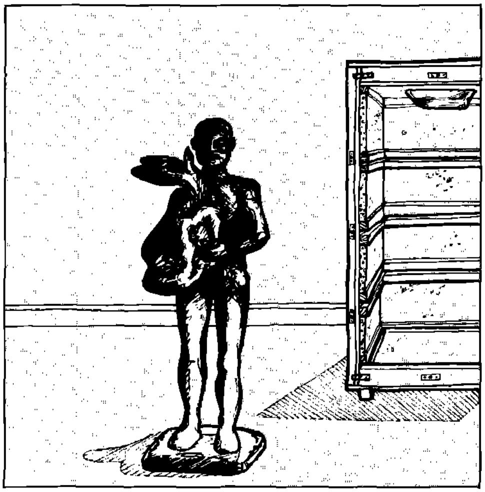
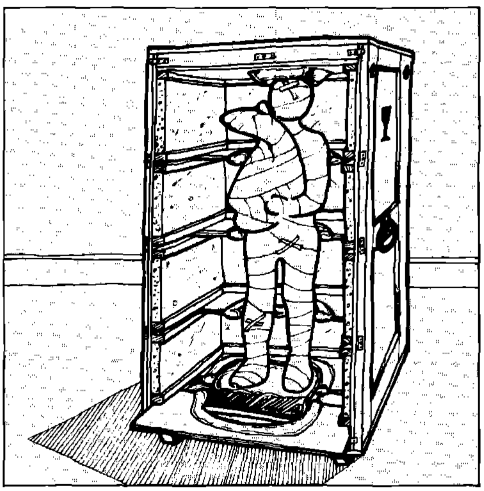


c



f

FIG 8. Template system for packing sculptures or other three-dimensional objects.
(a) Exploded view of case of plywood and wood construction with slots positioned to accommodate templates at appropriate support levels for the three-dimensional object to be packed within.
(b) Assembly of case, including holding devices and padding.
(c) Sculpture to be packed.
(d) Cocooning of sculpture with soft paper quilting or lint-free paper towelling.
(e) Placement of padded template plates in slots of case.
(f) Positioning of sculpture within.
(g) Placement of front sections of padded template plates.
(h) Sealed case, 'fragile' signs and orientation for handling indicated.

'float' position. As has been mentioned in an earlier section, it is important to pre-wrap the sculpture so that the stuffing material does not abrade the surface or patina of the object. The case for the transport of *La Pietà* is essentially an outer steel container lined with asbestos sheet, then lined with twenty-centimetre-thick polystyrene slabs, then an inner box of wood, at the bottom of which is a wooden base which accommodates the sculpture. A further shock-absorbing layer of one-centimetre-thick rubber was placed under the sculpture base. The inside of the inner box was also lined with polystyrene slabs and the space 'over-filled' with polystyrene beads. A considerable amount of research and pre-testing of the packing system was carried out to iron out various problems and to determine the shock resistance of the ensembled double-case packing. It was noteworthy that the *Pietà* sculpture was not pre-wrapped but the polystyrene particles were in direct contact. Perhaps there should have been an initial wrapping of the marble surface in soft tissue before filling the voids in the case with polystyrene beads.

A more conventional method of packing three-dimensional objects, such as sculptures, is the template method. The sequence for packing in this manner is described in Figure 8. In this method the heavy sculpture, e.g. a Rodin or Maillol bronze, is carefully studied to determine its centre of gravity and likely points of support. The case is constructed to accommodate a series of horizontal sliding supports shaped to fit snugly around the selected perimeters (hence the supports are referred to as templates). These are padded wooden forms which conform to the contours of the sculpture and are positioned in the slots at appropriate support levels. The head fitting is of a resilient material and is under compression when in place. The case is of heavy plywood and wood construction to prevent distortion on handling. The front portions of the templates are placed in the slots and when the case is closed the entire surround of the sculpture is snugly retained. The sculpture is initially wrapped in soft material and the form members are faced with soft resilient material at their leading edges to prevent abrasions. The voids in the packing case may be filled with stuffing or plastic foamed beads; this is optional. In this system of bracing it is important to understand the strength properties of the sculpture and its weight distribution (centre of gravity). Inexpert placement of the template form of bracing can result in strain on the sculpture if, by accident, the packing case is tilted or accidentally turned upside down. Note that the templates and other bracing elements are screwed in position rather than nailed, permitting ready and safe dismantling. All the pieces are carefully labelled to facilitate repacking in the same manner at a later date. Smaller sculptures can be grouped together in a compartmented box employing similar template holding devices for each item.

Use of rigid-foam plastic

Rigid-foam plastic (expanded polyurethane or polystyrene) can be trimmed or shaped, grooved or cut, to fit around the contours of a sculpture or other three-dimensional object. This does not have quite the same cushioning action as the loose-fill packing described above. A series of objects, such as pots, implements, bronze heads, ethnographic artefacts, etc., are placed in cut-out recesses of thick slabs of the rigid-foam plastic. Each object rests in its own 'bed'. This method is used fairly frequently because of the ease of retrieval and repacking. There is some difficulty in cutting out the holes to have an exact contour fit. If the three-dimensional object is higher than the individual slab, it is necessary to extend the cut-outs and the contour fitting to additional layers of the plastic. In this case, to avoid confusion, there must be careful labelling of the separate slabs. As before, the objects should be pre-wrapped with neutral material to prevent contact with the plastic-foam material.

Another variation of foam packing is a chemical process where the 'two-phase' foam-making ingredients are poured in place around the object (which is of course initially protected with polyethylene film). There are not many museums employing this essentially industrial technique because of the technical difficulties in obtaining a careful balance of the reactive chemicals. The chemical ingredients are toxic, and the heating effects appreciable. Rigid-foam plastic packing pre-formed, or poured *in situ,* have both been in use in industry since the 1950s, particularly for packing cases to transport fragile electronic components. Because of the dangers involved, this method, as attractive as it is, should not be used.

Double-case packing, and cushioning

It has been known for some time that encasing an object in a box which is then placed in a second box with cushioning material between effectively protects the work from externally transmitted shocks and vibrations. Traditional cushioning materials, such as rubberized animal hair, excelsior (wood wool) and cellulose wadding, have a high degree of shock absorption, but, with the exception of the animal hair, also high moisture absorption. For controlling to some degree case humidity, this moisture-absorption factor is very important. The synthetic foam materials (manufactured in panel or particle forms), especially polyethylene, polystyrene and polyurethane foams, have excellent damping shock absorption but low-level moisture absorption. As a group also, they are as low in dusting, i.e. they create minimal dust inside a packing case. Noteworthy is the slight corrosive action caused by polyvinyl chlorides, moulded rubber, and rubberized hair. There is increasing evidence to suggest that vinyl chloride and vinylidene chloride plastics (e.g. 'saran' products) can cause chloride contaminations on bronze, silver and other susceptible metal objects. Thus, it is again important to pre-wrap objects in neutral materials and not keep them in direct contact with plastics or other materials of doubtful stability.

Table 3 conveniently summarizes the cushioning and degree of stability of various shock absorbers.

A word of caution must be given regarding the stiffness or softness (degree of compressibility) of the rubber or other cushioning layer used in packing. After placement, the compression should be such that the cushion layer operates within its functional elastic range. A totally compressed layer of rubber, for example, is useless, having no 'springiness' left. The cushioning material should be selected therefore with loading in mind.

Spring-suspension packing has also been used in industry for transporting X-ray tubes, delicate equipment and so forth. In the design of such systems it is important that the tension (or compression) of the springs is within their effective elastic limits and that they are correctly placed in the various directions. As with other cushioning

TABLE 3. Cushioning materials, natural and synthetic

Material	Damping shock absorption	Dusting	Corrosive effect	Moisture absorption	Fungus resistance
Rubberized-animal-hair blanketing (anti-fungus treated)	excellent	average	slight	slight	good
Cellulose wadding	excellent	much	none	varies	poor
Cork	good	none	none	some	good
Excelsior	excellent	very high	much	high	poor
Shredded paper	excellent	very high	much	high	poor
Polyethylene foam	excellent	slight	none	low	good
Polypropylene foam	excellent	slight	none	none	good
Polystyrene foam	excellent	slight	none	slight	good
Polyurethane foam	excellent	fairly high	none	low	good
Moulded rubber-foam	good	some	slight	much	poor
Polyvinyl chloride foam	good	none	slight	much	good
Polyethylene cellular film–air in sealed bubbles	excellent	none	none	none	excellent
Polyethylene cellular film–open cells in film	excellent	none	none	none	excellent

devices, if the springs are over-compressed or too stiff, the expected damping and shock-buffering action will not take place. Such systems are best left to qualified experts. Eventually, however, museum applications of these sophisticated devices become more freely available.

Additional notes on synthetic material for packing purposes

In general, synthetic or plastic materials have very low moisture capacity and therefore are not suitable for packing where RH control is critical. the cellulosic materials, paper, wood, etc., are superior to the synthetics in this regard. The use of cellulosic materials for pre-wrapping to create an initial buffering environment and then surrounding with a synthetic cushioning material has proven to be a very effective combination. The practice of eliminating the initial buffer wrapping and using plastic materials throughout is not to be recommended for transportation where large temperature variations can occur. Condensation can occur on a metal object, for example, when there is no humidity-buffering material in the vicinity and the air at the surface of the object reaches 100 per cent saturation (dew point or condensation point) level.

Again, the advantage of pre-wrapping with a paper material is that it isolates the object to a certain extent from any chemical contamination arising from plastic products used as cushioning. Some plastics may contain plasticizers or other substances which slowly transfer or vaporize after a period of time. In a closed case the build-up may be significant. The paper wrapping will absorb these substances and act as a barrier. More research remains to be done on plastics, their contaminants, and how best to neutralize them.

A disadvantage of many of the synthetic packing materials in the particle, sheet or panel forms, is their tendency to develop electrostatic charges. Dust forms inside the cases, and it is necessary to use a vacuum cleaner, which is hazardous to fragile objects. The cellulosic materials are less troublesome in this regard.

The foamed plastics do excel, however, as thermal insulating materials and as shock absorbers. The foamed plastics, polyurethane, polystyrene, and ethafoam, are excellent insulators, and are also very light. Thus, one cubic metre of foamed plastic weighs in the order of twenty kilograms compared with a cellulosic material which is from ten to twenty times heavier. The insulating capacity of the foamed plastics is also about twice that of natural products such as fibreboard, wood shavings, and so forth.

Transportation

Consideration will now be given to the various forms of transport used for exhibitions in transit. From the museum point of view, there must be a balance between costs and conservation. There are exceptions in the transport of national treasures where it is decided that expenses are secondary to the very special equipment and precautions required in moving the objects to destination.

The types of transportation system discussed here are the ones which museums and galleries use at this time—by road, rail, sea, air, or various combinations according to circumstances.

It is not intended to dwell at any length on the special points of documentation, insurance and costs, of concern to registrars and transportation agencies, but rather to evaluate the physical factors of transportation affecting conservation and condition.

By road

Various types of conveyance are used: car, truck, bus, tractor-trailer, container (for wheel-based vehicles), and mobile museum vehicle (artmobile, museobus, museumobile, etc.). In countries where highway systems are well-organized with extensive networks, this method can be very efficient and fast. Since the shipments are made on a door-to-door basis, there is less handling of cases, unlike trans-shipments required in rail, sea, or air transport. The packaging can also be lighter and more economical as there usually is a more direct and personal involvement and control by museums and trucking handlers. The vehicles can also be temperature controlled and occasionally humidity controlled, according to special requirements.

For short transits, as within a city, smaller packages can be hand-carried in passenger cars. A typical packing would be paper, corrugated cardboard, polystyrene foam, making sure that there is no possibility of the material next to the surface of the object being sticky or adhering. For an hour or two, there will be no appreciable change in the microclimate within the package except when the ambient temperature is excessive. This is unlikely if the passenger car is heated (in winter) or cooled (in the hottest days of summer). Personal protection of the package rules out rough handling or shock. Car accidents can occur, and damage can result from a collision or fire. This form of transport should always be in the hands of a responsible museum official.

Most museums, however, ship objects for shorter hauls, intra- or inter-city, by commercial vehicle. Some museums have their own trucks specially designed to carry works of art with a minimum of packing, and in which an attempt is made to control climatic conditions. The interiors are provided with various holding devices, e.g. poles, straps, dividers, which permit easy stacking and access and removal of objects. Many countries use removal companies or firms specializing in fine-art moving. There have been significant advances in commercial handling of art works to meet the increasingly stringent demands of museum personnel. It is difficult to verify that proper care and handling are maintained throughout, though, especially when commercial vehicles group museum shipments with other goods. The exclusive use of a commercial truck can be costly, being justified only when the shipment is a large one, but better handling is assured.

The specifications concerning trucks for museum use, whether owned by the museum or a commercial firm, have to be well thought out. Certainly there must be provision for shock absorption, effective insulation, temperature control (heating and cooling), humidity control, if necessary, a variety of holding and restraining devices, fire-fighting equipment, intrusion alarms, emergency electrical systems. There is considerable technology and expertise in military and commercial fields which can be adapted. Special-purpose vehicles have been built for field use to transport electronic and space-technology gear, medical supplies, flowers, mushrooms, etc., where temperature, humidity, vibration, shock are important factors to maintain in transit.

Where ordinary unheated trucks must be used, again for short trips, the temperature of the packing case may be maintained for a longer time in cold weather by covering with heavy blankets or padding which were initially kept at room temperatures. Keeping the vehicle indoors for some hours, as in an indoor-loading bay, prior to loading, is a simple means of ensuring that the van temperature will be preserved for a reasonable period of time, as opposed to loading into a cold truck. It is, therefore, important for museums to have indoor shipping and receiving facilities so that temperatures can be maintained a little longer during transit. Trucks or trailers with built-in heating systems, or of the type that can be plugged into a power source, are the best solution, as they can keep the cases warm allowing for out-of-doors unloading if interior facilities are not available.

In tropical or sub-tropical zones the vehicles should preferably have cooling systems, or be stored at least initially indoors in a cool environment prior to loading.

By rail

There are generally two categories of shipping by rail: freight and express. The former is seldom used by museums as it is the slower method reserved essentially for heavy industrial and commercial goods, bulk materials and, in general, a host of items which require unsophisticated handling. Freight shipping is usually from city to city, requiring trans-shipment by truck at the rail connections. If works of art were to be shipped by freight they would have to be packed in very sturdy cases, very shock resistant, and capable of withstanding wide climatic variations, and delayed delivery.

Shipping by express train is a safer, more rapid form of transport. Usually this is by passenger train in the baggage car. The railway authorities may have connecting vehicle services to deliver shipments 'from door to door'. Even by express train it is necessary to pack in sturdy well-cushioned cases as rough handling may occur at the various transfer points. In rail travel there are steady vibrations and bumps due to the track, and strong shocks during the shunting of wagons. The baggage car is usually heated in the winter-time or cooled in the summer, but frequent opening and closing of doors at station stops create very erratic indoor conditions. Stowage should be made well away from these doors. In exceptional circumstances, express shipments can be monitored by couriers directly in the baggage car, and supervision in handling and placement carried out by such personnel.

By sea

Nowadays, sending exhibitions or individual cases of works of art by sea transport is relatively rare in comparison with shipping by air or road. Certainly, in intercontinental transits or transatlantic voyages, shipping by air has virtually replaced that by sea. The handling hazards are greater here than by rail, and cases must be very solidly built to withstand rough handling, dropping, and stowage under extremely variable climatic conditions in the hold of an ocean liner. Nevertheless, there are certain circumstances which require this form of transportation—where the lending institution requires it—as for very important irreplaceable national treasures—or in the moving of very heavy and large objects (sculptures), too bulky for air travel.

Usually, the stowage aboard ship is arranged in the strongroom or at an upper location with a better degree of protection against climatic changes and water seepage (i.e. during storms). The cases must, of course, be well secured and lashed into position. The cushioning and packing material within the cases should be well designed so as to prevent shifting or settling of the objects, resulting in their damage.

Safe shipment overseas requires special attention to documentation, advance communications and proper packing procedures. Usually, double-box packing is required with vapour barriers. The customs examination must be arranged, in advance, to take place not on the docks or sheds of the shipping company but in the museum at destination. In general, import and export regulations, in their complexity, tend to inhibit the use of sea transport for museum exchanges. Another deterrent factor is the very long transits involved, lasting sometimes weeks, as there are also long periods of storage before and after the voyage, as well as trans-shipment by surface vehicles. During such long intervals the enclosed objects, if they are humidity and temperature sensitive, can be seriously affected unless very specially designed environmentally controlled containers are employed. Because of rough handling, particular attention must be given to the strength of cases; usually double-case 'construction' is required. The supervision of handling, stowage, and specifications for environmental conditions is advisable to protect the cases. High levels of humidity as well as salt air can penetrate improperly constructed cases and affect the contents. Instances of mould growth inside cases have been reported for long ocean-freighter voyages, where a variety of climatic zones are traversed. Additionally, shipments are kept for long periods of time at ports prior to transfer to trucks, and variable environments are likely to affect the contents of the case.

The author recalls one instance of a packing case which, when off-loaded from a ship, accidentally dropped into the water. The painting within was severely damaged by salt-water penetration.

By air

The most common, and efficient, method of moving cases is by air. Statistically, this is also the safest in terms of accident frequency per kilometre travelled. It should be said though that when an air crash occurs the loss is usually total. There are generally two categories of air transit: air express and air freight. The former is usually faster, more expensive as a result, and involves transfer arrangements at airports, so that deliveries can be made on a door-to-door basis. Air freight usually refers to bulk shipments on special-purpose planes, with varying degrees of temperature and pressurization control. Some air freighters are actually converted wide-body passenger jets, or combined passenger and freight configurations.

It has been known for some time that pressure changes inside aircraft can affect conditions inside the cases normally used for transporting works of art. Most cases are not hermetically sealed and are subject to air leakage according to pressure differentials between the outside environment and the inside of the case. If a non-air-tight case is placed aboard an aircraft and during the course of travel the environmental (cabin) pressure drops appreciably, air will pass out from the interior of the case according to the behaviour of gases under reduced pressure. This in itself is not a greatly disturbing factor to the internal RH. However, when the aircraft descends to ground level, the atmospheric pressure in the cabin or hold rises again to normal and air is drawn into the low-pressure case. This air, if very damp, or dry, relative to the required condition may cause damage to the case contents. Air-pressure differences in this way may upset the RH balance of the work of art.

An additional hazard exists when cases are stored in unheated and unpressurized luggage holds of aircraft. During a long trip at high altitudes, the luggage hold in the belly of the aircraft may reach temperatures as low as −40 °C. On landing, the removal of the cooled cases to normal conditions will result in the drawing in of warm air of higher moisture content and condensation may occur causing damage.

Therefore, when air travel is the mode of transportation, cabin pressurization and temperature control must be specified, and account should be taken of weather conditions at the landing destination. These should be as close as possible to the desired RH and temperature for the shipment.

The RH in jet-aircraft cabins has been measured at maximum flight altitudes and can go as low as 6 per cent. Tests were made by the author in Boeing 747, 735, and 727 aircraft, across Canada and the Pacific and Atlantic Oceans, at altitudes of 5,000–11,300 metres. Table 4 shows the psychrometer measurements taken in the cabin during the various trips.

TABLE 4. RH levels in aircraft on various flights

Flight and date	Aircraft	Portion of flight	RH (%)	Altitude (metres)
Ottawa—Vancouver 21.2.70	737	Ottawa—Toronto	20	5,000
		Toronto—Winnipeg	19	7,000
		Winnipeg—Edmonton	13	10,000
		Edmonton—Vancouver	13	10,000
Vancouver—Tokyo 22.2.70	727	Vancouver—Anchorage	10	10,700
		Anchorage—Tokyo	10	10,700
London—Montreal 7.2.77	727	—	12	9,000[1]
		—	6	11,300[2]

1. One hour in flight.
2. Four hours in flight.

In air journeys it is advisable to select itineraries with as few landings as possible—as each ascent and descent contributes to air exchanges within the case, as described above. There is a tendency to cut costs in air shipments by utilizing light-weight materials and a minimum of packing. If the case lacks, or is deficient in, thermal insulation, dunnage, shock-absorbing materials and leaks air very readily, then the contents are not being properly protected. The shipment may reach its destination quickly and cheaply, but runs the risk of damage.

Remarks on shock and vibration in transport

Most works of art, except those constructed of the most durable materials, need to be protected from the forces of shock and vibration during transit. These matters are of legitimate concern to the museum field, especially with the increased numbers of travelling exhibitions and their transportation by road, rail, sea, and air. The relationship between exposure to shock and vibration and possible damage is not yet clearly established. It may very well be that many instances of weakness in structure of paintings are also attributable to a long history of shock and vibration.

In the packaging industry considerable strides have been made in the design of cases and cushioning materials so that delicate instruments (e.g. electronic devices, computers, X-ray tubes) may be transported with great safety. Here the specifications for industrial shipments call for protection against vibration and against vertical drops as high as one metre. Research and development in case design are usually carried out by packaging engineers who are professionally competent to devise methods for cushioning the static and dynamic forces acting upon cases during shipment. New techniques are tested by instruments which evaluate and record shock and vibration forces during transit movements. Arising from such tests, novel methods and materials for packaging result. For example, in the shipment of very fragile aircraft components, a method employing suspension straps or springs proved highly successful.

All forms of transportation will vibrate objects being transported, but each form has ranges of vibration forces which predominate. The following data summary is based on industrial studies:

Rail. According to the speed of the train and the length of the rails (ten- or twelve-metre sections), in the region of 30 to 145 k.p.h. the vibration frequencies range accordingly from 2 to 7 cycles per second.

Road. For normal highway travel, the vibration range is from 70 to 200 cycles per second.

Air. Different forcing frequencies depend on the type of aircraft, conditions on take-off, flight, and landing. The frequency may vary from 20 to 60 cycles per second.

Sea. The vibrations differ at different sections of the ship and may range from 11 to 100 cycles per second. In addition, there are movements and vibrations during storms or heavy seas.

While it is possible to mitigate the effects of vibration by use of suitable elastic cushions, protection against a drop or sudden shock is more difficult. By increasing the thickness of padding and cushioning in a packing case, a degree of protection can be realized. The term 'G factor' is often used by packaging engineers. It refers to the imposed force-load (as a result of drop, shock, acceleration, deceleration) upon the packed object as a ratio of its static weight. Thus, if as a result of a drop, the force of acceleration on a 150-kilogram object is 1,500 kilograms, the G factor is 1,500/150, or 10. According to the degree of fragility of the object, a certain maximum G factor can be tolerated. Beyond this, breakage or other damage can be expected. The sudden stopping of a train or truck can transmit considerable forces to a packed object unless adequate cushioning is present and acts in the direction of the applied force. In practice, an absorbing material—rubber, quilted or crêpe paper, etc.—need not be so compressed as to absorb all the energy of the impact. A moderate amount of shock absorption is sufficient. It should be borne in mind too that a cushioning material should not be so soft as to be completely compressed.

Standards and guidelines for exhibitions and travel

The following list summarizes the possibility of damage to collections whether on exhibition or in transit.

A competent conservator should be retained for consultations upon any matters concerned with care, physical safety, and environmental control. This person should work closely with the exhibition organizers (director, curator, registrar) from the early planning stages to a period of time after return of the loan.

For lending of works of art, information records should be obtained from the borrowing institution on environmental conditions such as RH, temperature and museum lighting levels on walls and cases. Information is also required on security measures against possible theft, vandalism and fire. A building environmental survey report is very useful. It is highly desirable for loaned works to be kept under the same range of conditions of RH and temperature; and the system of packing and mode of transportation should be selected by the lender to maintain these conditions during transit as well.

Works of art, objects, historical materials, selected for exhibitions should be adequately protected prior to release for packing procedures. In the packing of works of art, all container materials should be preconditioned (seasoned) to the same level of RH and temperature at which the works of art have been normally exhibited or stored. Where humidity-controlled cases are required, conservation specialists should be consulted, and methods for monitoring specified.

Condition reports should be drawn up by the lending institution on point of loan, and reporting continued at all stages of the itinerary. Photographs may be required.

Paintings on canvas (and other framed works, e.g. prints, drawings, photographs) should have protective backs of compressed fibreboard or tempered cardboard prior to packing. Glass fronts should be removed and shipped separately if required; it is preferable to replace with acrylic plastic. If there is the possibility of dust developing within a packing case, the objects should be wrapped in soft paper first, ascertaining that the picture front will not adhere to the paper wrapping. The fitting of paintings into their frames should also be checked to ensure that there will be no slipping or shifting, and that the frame and picture unit is sufficiently strong to resist shock in transit. Also, all screw eyes and hanging wires must be removed. In some instances, it is advisable to cushion the work in the frame with foam-rubber strips (of the self-adhesive type). Thus, any force transmitted to the frame in transit will be partly absorbed by the compression of the foam rubber strips. Panel paintings should be checked to determine that they are free to 'self-adjust' in their frames. There may be special handling and humidity specifications for such works because of their great susceptibility to RH changes. Unfixed pastel paintings are rarely lent because of the danger of pigment loss. Sculptures, decorative arts and ethnographic materials require specialized preparation and packing techniques. Special attention is given to weight distribution, cushioning and dunnage. The objects should be pre-wrapped in inert, non-adhering, soft materials, avoiding polyethylene or plastic films likely to cause condensation or chemical action.

The packing case should be constructed of new materials, e.g. plywood (of the waterproof type) of appropriate thickness, depending on weights and dimensions of objects to be packed. Provision should be made for prior humidity conditioning of the packing and cushioning materials to surround the object. The joining of the plywood should be made by means of pine or similar battens. The case should be strong and stressed, if necessary, with diagonal members to prevent twisting.

Packing-cases can also be made of heavy-duty, water-resistant, rigid cardboard, corrugated fibreboard, plastic or metal. It should be assumed that paintings and graphic works will be transported vertically and that heavy three-dimensional objects will be placed in the case so that the centre of gravity is as low as possible. For efficient thermal protection, the general shape of the case should approach that of a cube, so that, on exposure to extremes of temperature, the interior conditions will change more slowly. There should be sufficient handles for manipulating the case, and skids provided at the base for mechanical lifting and, of course, to keep the case off the ground. Labels and other indications, 'Fragile', 'Ride on edge', 'Keep dry', 'Up', etc., should conform to international practice, and be prominently displayed. Such labels should not be nailed on, but applied with a waterproof adhesive. The external surfaces of the case should also be painted or varnished with a waterproof coating to give a distinctive 'cleanly designed' appearance. Cases should be constructed as air-tight as possible, the lid having positive locking devices which permit tight sealing, and yet be conveniently opened. Nailed-down lids or attaching by wood screws are not recommended. Screws readily lose their holding power in wood after two or three cycles of opening and closing.

Where shipments proceed through tropical or semi-tropical zones or are destined for such climates, the cases and contents should be protected by fungicidal treatment. Specialist conservators should be consulted to ensure that the chemicals are not harmful to the objects.

Shock- and vibration-asborbing cushioning material should be placed about the packed objects to offer protection against shock, drops, or heavy vibrations in transit. These should be of the right 'springiness' so that they are neither fully nor too lightly compressed by the weight of the packed object. When sculptures are packed, the centres of gravity should be ascertained, and the cushions and templates placed where needed. In this way the G forces can be absorbed in all directions.

For fire protection some shipments require external packing-cases of fire-retarding materials. These can be designed to underwriter's and government specifications. Steel construction with mineral wool, asbestos, etc., can give fire ratings of one hour, two hours, etc. The case containing the works is placed inside the 'fire-box' at the point of shipment, and remains there until arrival at destination. In certain exhibitions it may be necessary to keep the packingcases in the boxes until ready for exhibition.

The temperatures in loading docks, cars, vehicles, trains, plane cabins, docks, warehouses, ships, etc., should fall within the range of 15 to 25 °C. All areas should be sheltered and free from rain, snow, wind and water seepage. Neither should cases be stored against radiators, heating vents or exposed to direct sunlight. In exceptional circumstances, e.g. very long journeys, the RH should be specified as well, generally 35–60 per cent. A closer degree of RH control may be required for cases containing highly moisture-sensitive works of art. Again, expert consultation is required in these situations.

Important shipments should be accompanied by trained couriers, knowledgeable in conservation and travel specifications, and able to direct transportation officials and personnel, to ensure that the transit specifications are respected.

For air transport, additional specifications to be fulfilled are: that the cabin or storage area in the aircraft be pressurized and temperatures controlled within the range 15–25 °C. Journeys should be planned for minimum stop-overs. Cases which have been hermetically sealed should have pressure-relief valves so that after delivery to destination the inside pressure can be equilibrated to the outside prior to opening.

As a precautionary measure, upon arrival at destination, the cases should remain unopened for twenty-four hours prior to unpacking. This is particularly important if the shipment was inadvertently exposed to very cold or hot conditions.

The empty cases, packing materials, supporting devices, etc., should be stored under controlled conditions for at least a three-week period before repacking.

RH conditions during exhibition should be specified and proved to be safe to the objects. Generally, these will be between 40 and 60 per cent according to season and location. Highly sensitive objects requiring more precise RH control should be exhibited in specially designed micro-climate-controlled cases, e.g. through the use of pre-conditioned silica gel. Thermohygrographs may be required for monitoring purposes.

Light levels should also be specified, particularly for fadeable or light-sensitive materials. For the most delicate objects, e.g. water colours, fugitive textile dyes, lighting free of ultraviolet content should be between 50 and 100 lux. It may be advisable to rotate such delicate objects every three or four weeks during prolonged showings.

Appendices

CONDITION REPORT
Name of Exhibition: 16th-18th Century Sculptures and Folk Art
Opening Date: 15 May 1978
REPORT NO.: 78/36
PRIORITY RATING: (1) 2 3

Institution: Anonymous National Museum, CITY, COUNTRY.
Collection of: " " "
Catalogue No.: B753

Title: Saint Sebastian
Artist (or School): Unknown, Austrian.
Dated: 16th century No
Type of Object: Polychrome
Size: H 180 W 50 D 45 centimeters
Insurance Value: —

SURFACE COATING OR PATINA: ☐ Unvarnished ☑ Varnished ☐

PAINT FILM OR DECORATION Medium is characteristic of ☐ Combination of:
☑ Oil Painting ☐ Synthetic ☐ Watercolour ☐ Pastel ☐ Print ☐ Pencil ☐ Photograph
☐ Tempera ☐ Encaustic ☐ Gouache ☐ Charcoal ☐ Collage ☐ Ink ☑ Polychrome ☑ gilded

CONDITION:
☐ DISCOLORATION: fading, yellowing, blanching, grime, darkening
☐ BLOOM: loss of transparency. DULLNESS: loss of gloss
☐ PULVERIZATION: powdery surface EFFLORESCENCE: salts or wax
☐ STAINS: finger marks, fly-specks, accretions
☐ PENTIMENTO: visibility of changes in design by artist
☐ MECHANICAL DAMAGES: scratch, abrasion, stretcher-mark, crack, loss
☐ BLISTERS: bubbled appearance. BURNT.
☑ CLEAVAGE: flat cleavage, buckled cleavage, cupped cleavage
☐ Embrittlement, flaking, chipping: paint and/or ground loss
☐ Alligatoring, cracking, creasing, wrinkling
☑ DAMAGES: insect, mould, micro-organisms, water

Description/Comments/Photos
☐ RESTORED: Bleached, inpainted, overpainted
☐ CONDITION SOUND
See attached photographs showing paint cleavage and mould infestations near base of sculpture.

SUPPORT OR BASIC CONSTRUCTION MATERIAL
☐ Fabric ☐ Paper ☐ Cardboard ☑ Wood ☐ Presswood ☐ Metal ☐ Glass ☐

☐ EMBRITTLEMENT: desiccation, corrosion
☐ DISTORTION OF PLANE: dent, bulge, draws, warp, loose, crease
☐ RUPTURE OR PUNCTURE: tear, split, hole, loss, missing part
☐ DISCOLORATION: yellow, brown colour, stain
☑ DAMAGES: insect, mould, micro-organisms, water

Description/Comments/Photos
☐ RESTORED: lined, patched, backed, cradled
☐ CONDITION SOUND

STRETCHER-FRAME OR REINFORCEMENT: ☐ Stretcher-frame ☐ Cardboard ☐ Panel ☐

☐ LOOSE: Keys missing
☐ INADEQUATE STRETCHER: rotten, distortion of plane
☐ CONDITION SOUND

FRAME OR PRESENTATION: ☐ Unframed ☐ Framed ☐ Unmounted ☐ Mounted ☑ Base (pedestal)

☐ INSECURELY FRAMED: weak rabbet edge, glazed, nailed in, rotted
☐ LOOSE: ornaments, miters, scratched
☐ DISTORTION OF PLANE:
☐ CONDITION SOUND
☑ Pedestal base needs re-inforcement prior to being put on exhibition

RECOMMENDED TREATMENT:

☐ Re-Line	☐ New Stretcher	☐ Bloom Treatment	☐ Bleach	☐ Varnish	Reframe
☐ Marouflage	☐ Restretch, Flatten	☐ Partial-Varnish Removal	☐ Deacidify	☐ Reshape	☐ Backing
☐ Cradle	☐ Size, Laminate	☐ Dry Clean, Wash	☑ Fungicide	☐ Book Restore	☐ Install Plexiglas
☐ Transfer	☑ Impregnate	☑ Accretion Removal	☑ Insecticide	☐ Rebind	☐ Isolate Painting
☐ Patch	☑ Mend, Fill	☐ Stain Removal	☐ Legibility	☐ Mounting	☐ Use Mending Plates
☐ Strip Line	☐ Back Removal	☐ Overpaint Removal	☐ Inpaint	☐ Matting	☐ Modify Rabbet Edge
☐ Reinforce	☐ Coating Removal	☐ Addition Removal	☐ Tone Match	☐ Inlay	☐ Repair and Retouch
		☑ Attach loose paint			

ESTIMATE: $250–350

EXAMINED IN: ☐ Lab ☑ Store Room ☐ Gallery ☐ Private Residence ☐

EXAMINED BY: J.B. Morgan
Title: Conservator
Date: 10 January 1978

1. Conservator's condition report; examination prior to exhibition or loan

THE MUNICIPAL MUSEUM OF DECORATIVE ARTS
CITY OF PANTIPOL, TERRA NOVA

NATIONAL EXHIBITION OF FINE CRAFTS 1977-1978

Cumulative condition report

Cat. No.: 34 Title: Textile Rhapsody Artist: Jodi Tchekhov

3 metres high x 2.60 metres wide
Dyed wool with metallic Threads

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1. Exhibition centre: Municipal Museum Decorative Arts City Pantipol

Condition Arrival: Sig. Date:

Departure: satisfactory Sig. [illegible] Date: 25/1/77

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2. Exhibition centre: University Art Gallery, Bainbridge

Condition Arrival: Satisfactory Sig. J.M. Smythe Date: 25/1/77

Departure: Satisfactory Sig. J.M. Smythe Date: 25/1/77

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3. Exhibition centre: Fine Crafts Centre, Smithville

Condition Arrival: Paint stain lower left corner Sig. G. Georgen Date: 25.2.77

Departure: Stain removed (see attached report and correspondence 28-2-77) Otherwise Satisfactory Sig. G. Georgen Date: 24/3/77

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4. Exhibition centre: St. Lawrence Cultural Centre, St. Lawrence

Condition Arrival: Metallic threads pulled upper right corner Sig. M.M. Milne Date: 24/3/77

Departure: condition unchanged Sig. M.M. Milne Date: 26/4/77

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5. Exhibition Centre: Municipal Museum Decorative Arts, Pantipol

Condition Arrival: condition unchanged, as above Sig. [illegible] Date: 26/4/77

Departure: Sig. Date:

Additional Remarks: Minor restoration work carried out on frayed metallic threads upper right corner before returning to artist (J. Tchekhov) see correspondence attach. P. Petrov 3/4/77

2. Typical cumulative condition report for a single object at various points in the exhibition itinerary

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