Renovation Survey for the Security, Collection Storage, & Climate Control Systems for the Congress Street Wharf

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prepared by

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Contents

B. General Planning and Systems Development

Introduction

Based upon the developed artifact conservation cri-
teria and existing building and artifact information
described in the previous section, this section
records the study process and the resulting design
principles and options investigated for the program
development of the Wharf building. The components of
the study include program and architectural develop-
ment, collection storage analysis, fire detection and
suppression, building and space security strategies
and environmental systems for the mechanical ser-
vices. In describing the study process, we will only
address topics which have a major influence upon the
objectives of providing an optimal environment for
artifact conservation. Therefore, in some cases al-
ternative options will be developed and summarized
with a recommended option; while, in other situa-
tions, where there is no apparent series of options,
a design principle will be stated. Recommended op-
tions and/or principles for the various topics will
then be documented in the following section.

B1.1 SHELL DEVELOPMENT

A. Overall Building and Program Development

Because of the nature of the building's existing
structure (load bearing walls and heavy timber floor
construction), the Wharf is naturally zoned into six
definable spaces or bays per floor for a total of 36
spaces over its six story height. By using these
spaces as discrete planning units and thereby rein-
forcing their inherent zoning characteristics, pro-
gram functions can be easily separated when they are
incompatible in nature, require different levels of
security and access, or have different requirements
for air treatment and for fire detection and suppres-
sion.

This natural zoning characteristic of the existing
building also carries with it liabilities in terms of
developing contiguous activities between spaces. For
example, visual supervision by a staff member of more
than one space or bay at a time is difficult.

The adaptability of these preset building bay areas
to the museums' program demands must be carefully
planned. In order to achieve full utilization of this
high, narrow building, careful understanding and han-
dling of public, staff and service access will be re-
quired. Because of this, major activity groupings
have been developed horizontally on a floor by floor
basis. This allows easy horizontal movement through
compatible activityies, while still maintaining a
clear separation and effective security on different
floors. Therefore, activities requiring greater pub-
lic exposure with high service demands have been lo-
cated in the lower floors to minimize the need for
mechanical means of vertical circulation. Those ac-
tivities requiring greater security and less public
access are located on upper floors.
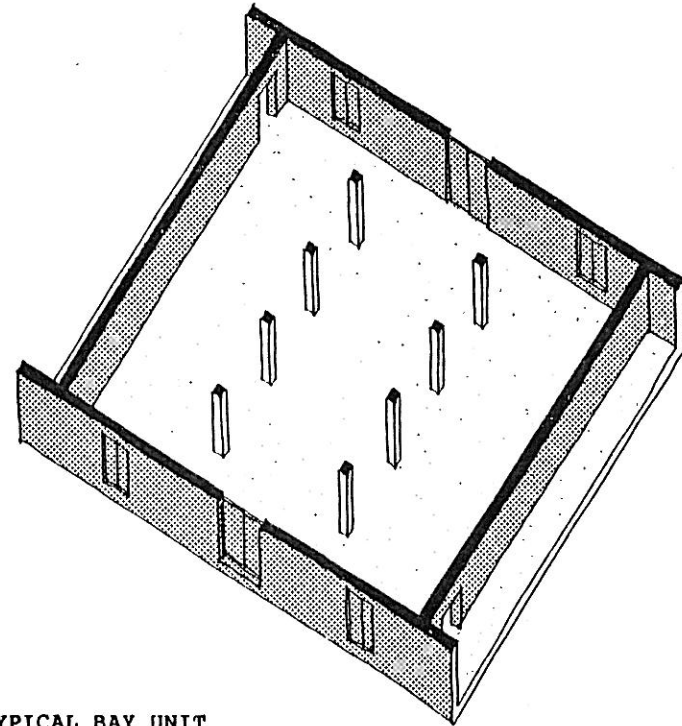
TYPICAL BAY UNIT
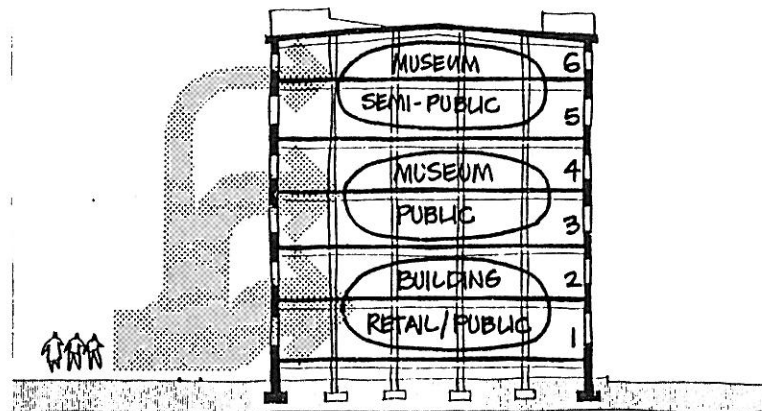

PUBLIC ACCESS/ACTIVITY LEVELS

B. General Building Zoning

Although the museums may adopt a phased construction strategy, the report assumes the full development of the building to the program criteria established by the museums. The building would be basically separated into three major zones of two floors each. The lower two floors would be used for retail shops and public arcade with the first floor accommodating the service functions for the museums. Public access would be along the apron edge of the building facing the channel and at a central point of the second floor. The intermediate two floors will serve as the primary public exhibit and program areas and lobby spaces for the museums with access to the common orientation space directly from the building lobby at the second floor. The two upper floors will house less heavily trafficed and support functions of the museum. These functions would include the library and Resource Center, classrooms, the collections, administrative offices, staff and work spaces.

BUILDING ZONING
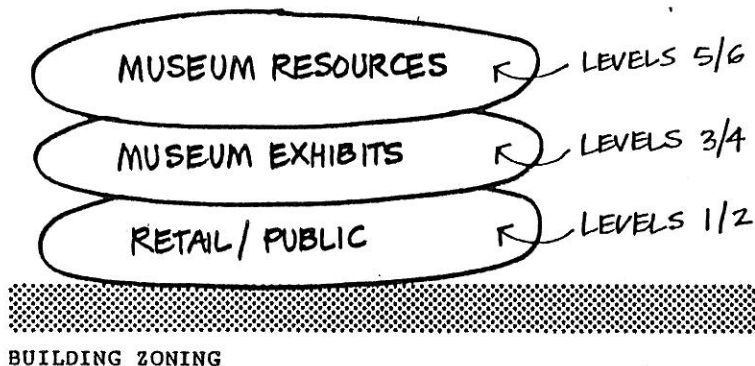
C. Retail Uses in the Building

In conjunction with the operation of the two independent museums within a common building shell, there is a substantial commitment by the museums to develop and lease sufficient commercial space in order to provide complementary public amenities and to partially cover building operating costs. A condition for retail development in the building is that it must be accomplished without compromise of the identities of, ease of access to, or security of the museums' spaces. This has been achieved by defining common building entry points, leading to an interior public arcade, which serves as a circulation and gathering or lobby space common to both museums' lobby and the retail area. By allowing retail activities, the public arcade and lobby to occur at the lower two floor levels within the building, and museum functions on the upper levels, they can function independently but still maintain visual and physical access from one use to the other.

RETAIL LEVELS
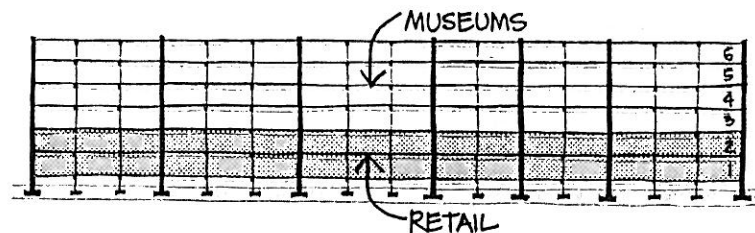
D. Public Access and Circulation

The physical organization of both museums within the building also provides a single path of public entry from grade to the exhibit areas. This path passes through a common museum entry point which is basically housed three floors above grade.

This single point museum entry to exhibit spaces is maintained both for its clarity to the public and for museum security during the after hours retail operations. The entry to the exhibit areas of each museum occurs from an orientation area that is separately defined from the general building lobby and retail arcade. This orientation area is adequate for ticket sales, waiting, group preparation for the museum visit, and controlling the entry to each museum.
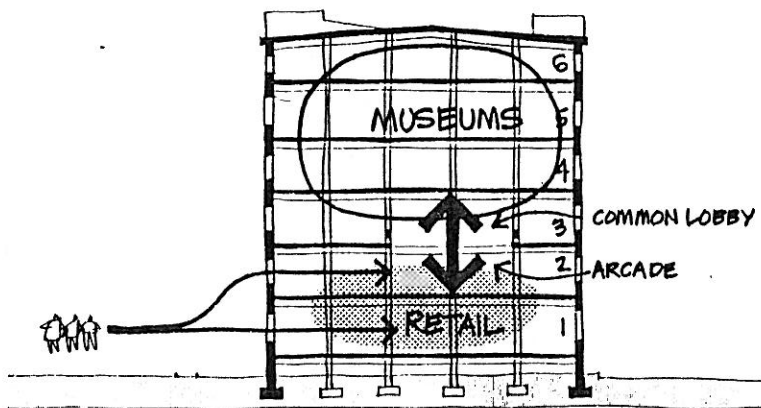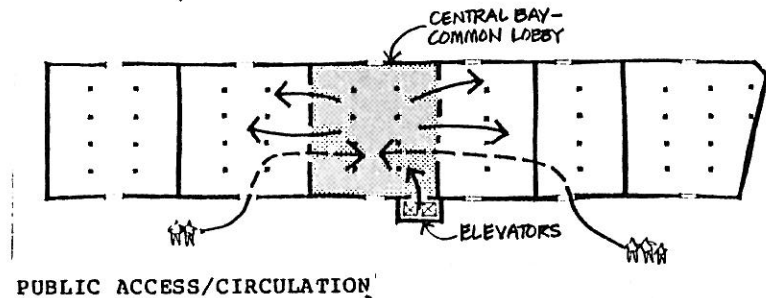
MUSEUM ACCESS/RETAIL CIRCULATION

PUBLIC ACCESS/CIRCULATION
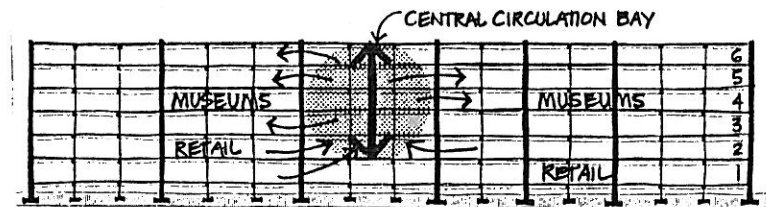

CENTRAL CIRCULATION CORE

With the requirement of museum uses occurring on the upper four floors, passenger and freight elevator service will need to be provided. To minimize demands upon elevator service, high public uses are developed on the middle two floors which have a stronger direct access from the common lobby space.

The main stairway and elevator service is located within one central vertical bay in order to provide common points of entry to individual floors and thus extend the lobby functions vertically to the less frequented areas of the upper floors. The public use of the elevators for access to non-exhibit areas is controlled by key operation when these areas are closed to the public. In addition, reception and control stations are provided at the elevator and stairways on the upper floors, thus providing staff supervision of public usage of these spaces.

Local stairs will be used for local inter-floor access within public exhibit areas and within semi-public and staff spaces. Emergency stair towers will provide safe exiting from all floors to grade and will allow controlled staff usage for inter-communications between floors. For security purposes public access to these stairs will only permit exiting at grade.

E. Building Service

Service access to the retail spaces is to be separate from that to the museums to insure adequate control over the museums' servicing operations and to provide ample storage and handling space for shipping and receiving museum materials. The loading and receiving docks will either be contiguous or located in separate areas of the building ground floor.

The passenger and service elevators are to be located to allow for direct delivery of museum materials from the receiving area to a control point within the museum at an upper floor. This will require a secure storage space at the receiving dock and a system of transporting the artifacts from this storage area to the upper floors.

Due to the size and weight of the Museum of Transportation's artifacts and the need for moving exhibit furnishings from floor to floor, an exterior oversized freight elevator is proposed. This elevator would provide service to every floor of the building and thus a safe means of moving large objects. Where required, large openings will be provided through the masonry walls between bays to allow for the horizontal movement of large objects.

F. Expanding Museums' Public Impact Within the Wharf

In their present facilities, the museums are unable
to expose the public to large portions of their col-
lections due to inadequate space within public areas.
Their relocation to the Wharf will, in part, diminish
this problem with the increase in the area set aside
for exhibits and public use. It is a goal of both
museums to increase public awareness and interest in
museum programs through exhibits, and correspondingly
encourage more in-depth exploration by the public
into specific topics through the use of their
resource facilities, i.e. artifacts collections.

One method of reinforcing this goal is to increase
the awareness of the museums' resources by expanding
them to several levels of the building. A primary
concern resulting from expanding collections loca-
tions is the security of the artifacts from damage
and theft. Therefore, the increase in public exposure
will be primarily visual; direct access to collec-
tions areas will be accorded only to those who have a
legitimate need for physical access to the artifacts
and are under direct supervision by museum staff.

Within the retail areas of the Wharf, the public can
be exposed to the museums by planning satellite exhi-
bit components in the retail arcade. Museum exhibit
space can be located adjacent to retail uses and/or
incorporated into both the retail arcade and the
building lobby. Within the museums proper, satellite
collections and resource spaces can be developed
within different exhibit areas. These areas can be
fitted with either permanent collections display un-
its or flexible storage units, depending upon dif-
ferent exhibit needs. However, the primary public
interface with the museum's non-exhibit activities
will occur at the Resource Center which will function
as a general reading room of a library. Here, a
broad cross section of the museums' resources, in-
cluding collections storage, will be available to the
public for reference use.
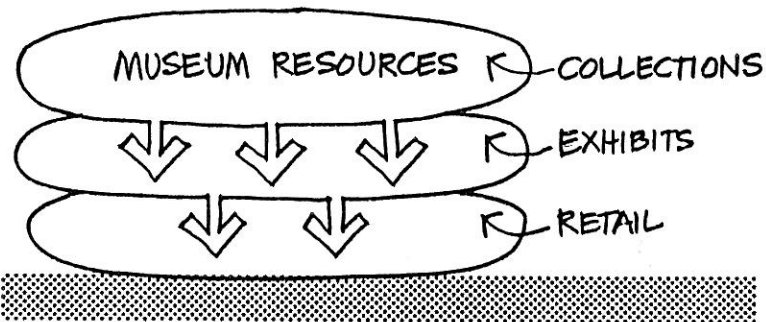
EXPAND AWARENESS OF MUSEUMS' RESOURCES

EXHIBITS / RESOURCES
RESOURCE CENTER
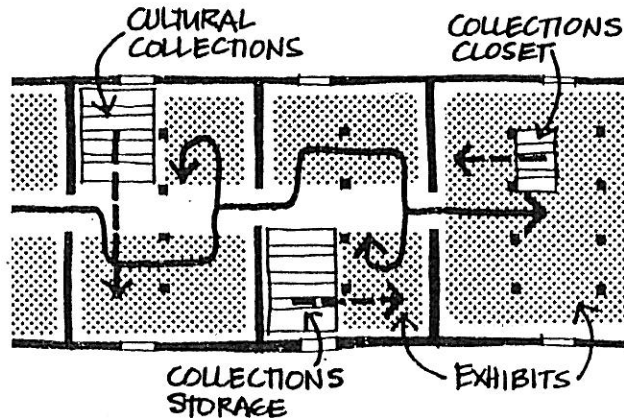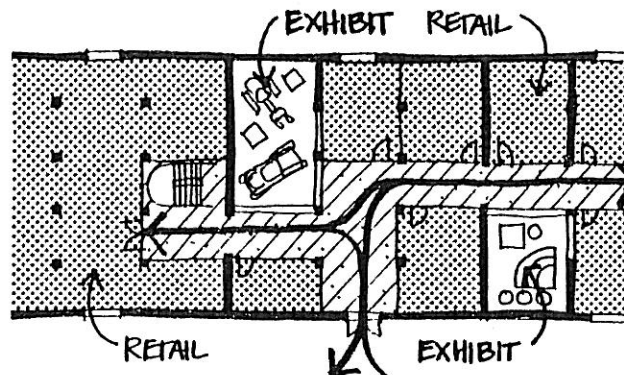CLASSES/WORKSHOPS
STAFF/WORK SPACE
COLLECTIONS
DESIGN/PRODUCTION SUPPORT

MUSEUM RESOURCE FACILITIES

CULTURAL COLLECTIONS
COLLECTIONS CLOSET
COLLECTIONS STORAGE
EXHIBITS

SATELLITE COLLECTIONS ON EXHIBIT LEVELS

EXHIBIT RETAIL
RETAIL
EXHIBIT

SATELLITE EXHIBITS ON RETAIL LEVELS

B1.2 DEVELOPMENT OF MUSEUM RESOURCE FACILITIES

The two uppermost floors which house the non-exhibit functions of the museum become the resource facilities for both the exhibit areas of the museums and for in-depth exploration and research of particular subjects by the public, staff and specialists. These facilities consist of the following components:

1. the Resource Center;
2. the workshops and classrooms;
3. the museum and administrative staff;
4. the exhibit design and production shop;
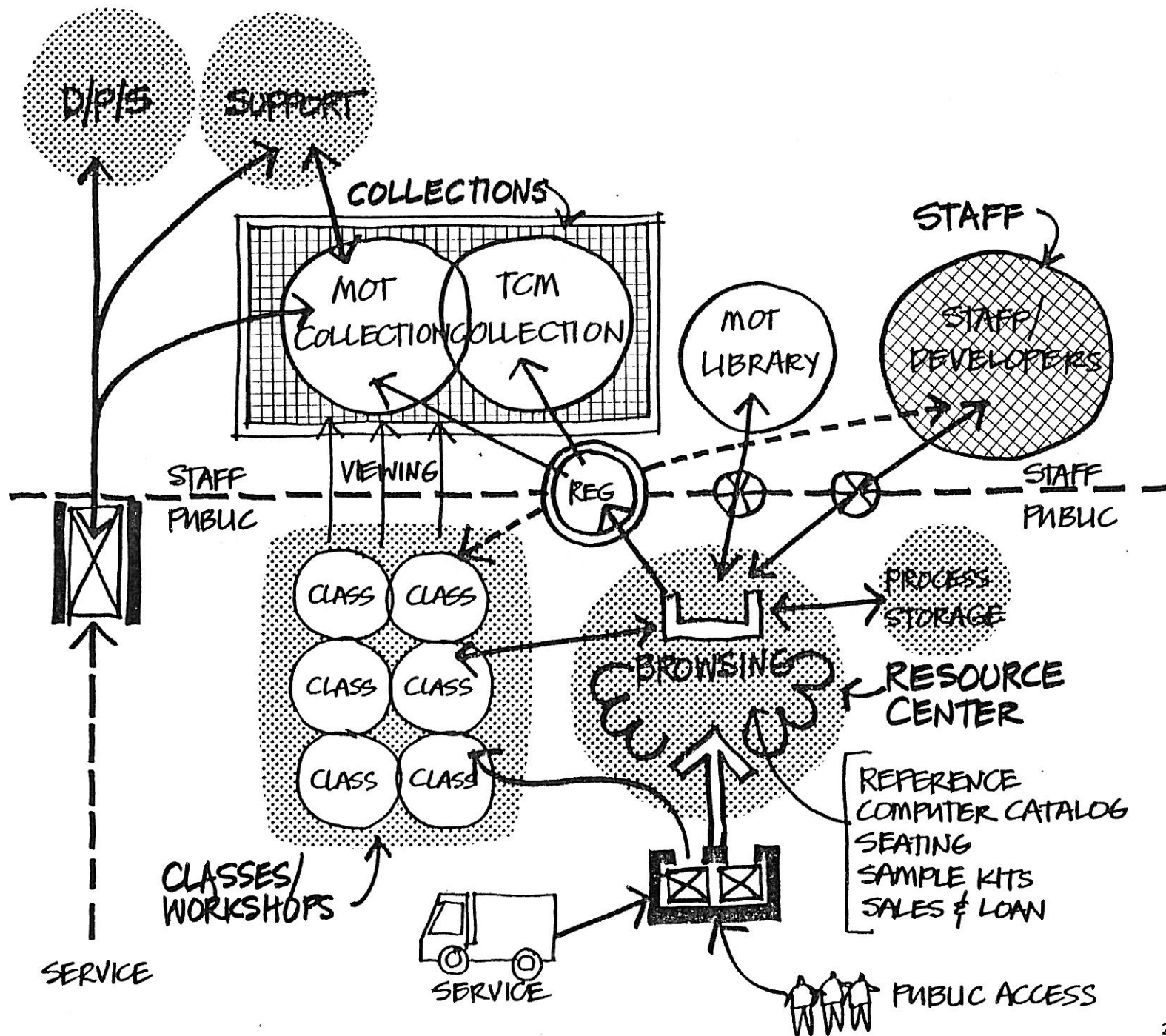5. the collections and artifact conservation spaces.

Each needs different levels of security, requires specific functional adjacencies to other resource uses and must accommodate various levels of staff and public access.

A. The Resource Center

The most public and accessible uses occur in the Resource Center and the museums' workshops and classrooms. The Resource Center provides the control point for access to other less public areas of the museum and supervision of the classroom and workshop activities. The Resource Center also houses materials for general reference and use. These include samples of educational loan kit packages, recycle materials for use as part of educational programs, reference books and slides, a teacher's saleshop and the cataloging index to the museums' artifact collection.

The Resource Center circulation desk provides supervision and assistance for the foregoing activities and the initial screening and reference to appropriate staff members for further in-depth study of the artifacts collection. Whether more than one control point is necessary will be dependent upon the museums staffing capability and the level of service demands placed upon the central circulation desk. A building program development with multiple control points would require additional staffing but also may be capable of better handling future expansion of the museums' resource facilities.

The classrooms and workshops provide for group study and educational programs. Public access and control is provided from the Resource Center. Secure storage facilities will need to be provided within the classrooms/workshops, for collections used in these programs.

D/P/S

SUPPORT

COLLECTIONS

MOT COLLECTION

TCM COLLECTION

STAFF

MOT LIBRARY

STAFF/ DEVELOPERS

STAFF
PUBLIC

STAFF
PUBLIC

REG

VIEWING

PROCESS STORAGE

CLASS CLASS

CLASS CLASS

CLASS CLASS

BROWSING

RESOURCE CENTER

REFERENCE
COMPUTER CATALOG
SEATING
SAMPLE KITS
SALES & LOAN

CLASSES/ WORKSHOPS
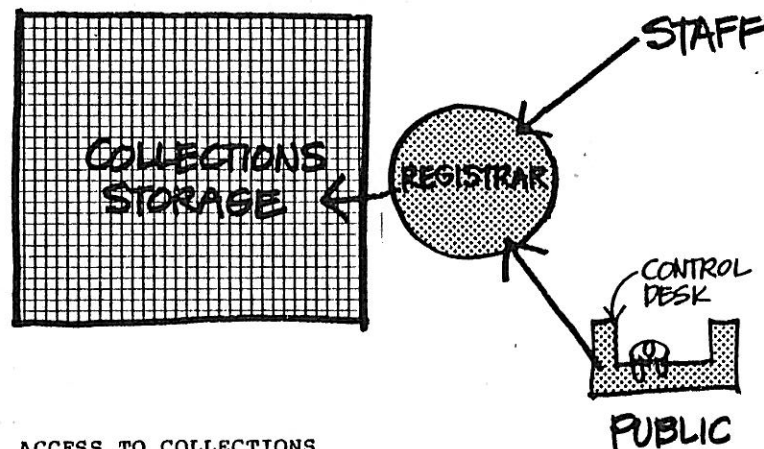
SERVICE

SERVICE

PUBLIC ACCESS

25
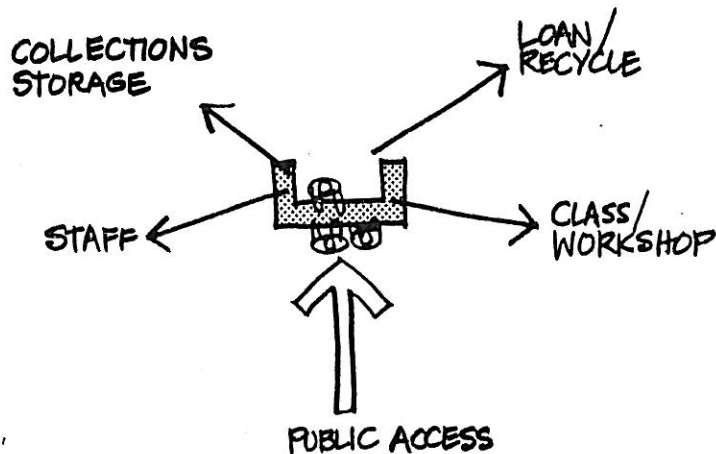
RESOURCE CENTER CONTROL DESK
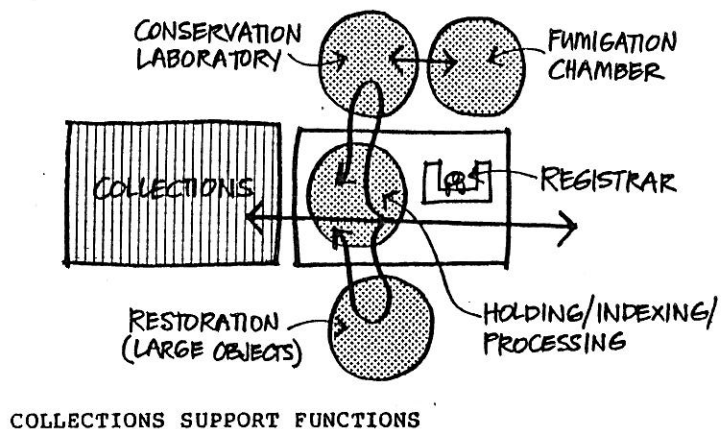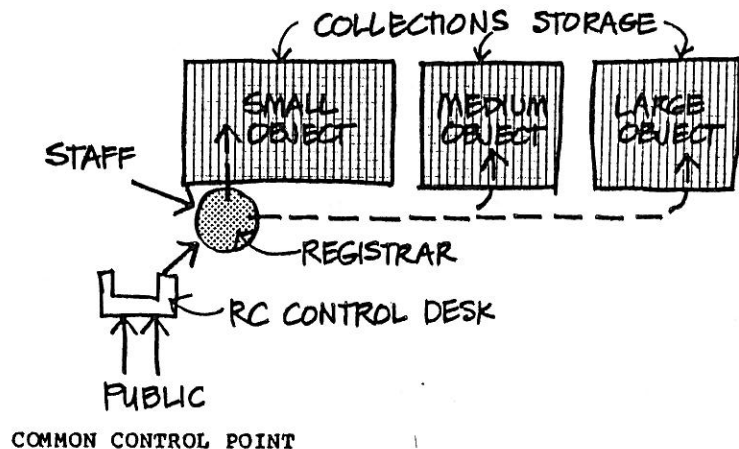
Artifact Collections

Central to the functioning of the museums are the artifact collection storage areas. Here, artifacts are stored for use as references for on-going research and program development, as a resource for educational programs and museum exhibits. Those artifacts that are not actively being used will be stored in the Collections Storage areas. Collections storage will not be physically contiguous but will function from one common access point: the Registrar's Office.

The Registrar's Office area will function as this control point for access to Collections Storage, process returned or new artifacts that are entering storage and monitor the status of each artifact. All access to Collections Storage will be recorded at the Registrar's Office. People wanting access to collections will be referred from the Resource Center to the Registrar where they will be screened to determine the appropriateness of the request, the level of staff supervision required and the type of access that should be granted. Also, staff members with authorization to use the collections will be required to check in with the Registrar for access to the collections.

In addition to access control, the supervision of object conservation will be a responsibility of the Registrar. Storage areas will be monitored for general environmental quality. As new or returned artifacts enter Collections Storage, the Registrar will inspect for damage and either fumigate the artifact and return it to storage or refer the object for conservation work. Some conservatin work will be performed in-house in an adjacent conservation lab. Large collection items (i.e. autos, doll houses, etc.), will be processed in a separate restoration shop. If conservation or restoration of the artifact is beyond the capability of the conservation staff, the conservation space would be used as either a holding space until the artifact can be shipped to a specialist or as a work space for a visiting specialist.


ACCESS TO COLLECTIONS

COLLECTIONS STORAGE

SMALL OBJECT MEDIUM OBJECT LARGE OBJECT

STAFF

REGISTRAR

RC CONTROL DESK

PUBLIC

COMMON CONTROL POINT

CONSERVATION LABORATORY

FUMIGATION CHAMBER

COLLECTIONS

REGISTRAR

RESTORATION (LARGE OBJECTS)

HOLDING/INDEXING/PROCESSING

COLLECTIONS SUPPORT FUNCTIONS

B. Optional Collection Arrangements

Two general building development options studied for Collections Storage space were 1) a horizontal plan arrangement; and 2) a vertical stacked plan arrangement.

The horizontal option would locate the Collections Storage in a horizontal block utilizing one or two floors of the building, probably within portions or all of the three bays south of the central core on floors five and six.

COLLECTIONS STORAGE

RC
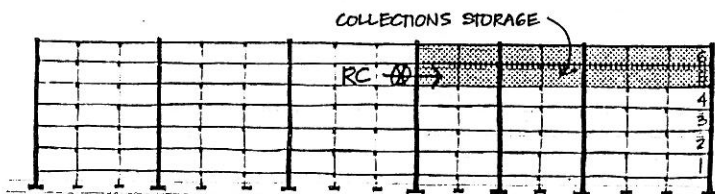
HORIZONTAL SCHEME

By using the existing building floors, the collections space development cost will be less than that required by providing new floors under the vertical solution. However, the density of artifacts may be less efficient since storage would be prohibited in the space between about eight feet (five-foot high stacks plus over-stack storage) and the existing structure of the floor above.

In contrast, the vertical option would occupy space vertically in one or two of the existing building bays by removal of the existing floors in order to provide three collections levels for every two existing building floors, thus possibly increasing the storage capacity within a particular volume.

In this case, the floor levels in the Collections Storage would be independent of the building floors.

COLLECTIONS STORAGE

RC

VERTICAL SCHEME

27

LIBRARY STACK
FLOOR SYSTEM

ACCESS		STAFF	6
		CLASS	5
👁		PROGRAM	4
		EXHIBIT	3
		RETAIL	2
		RETAIL	1
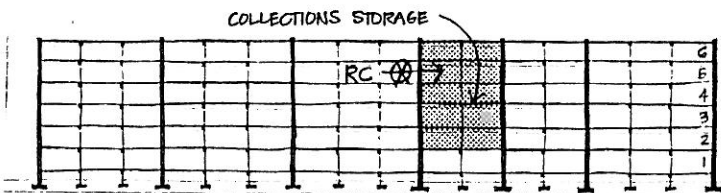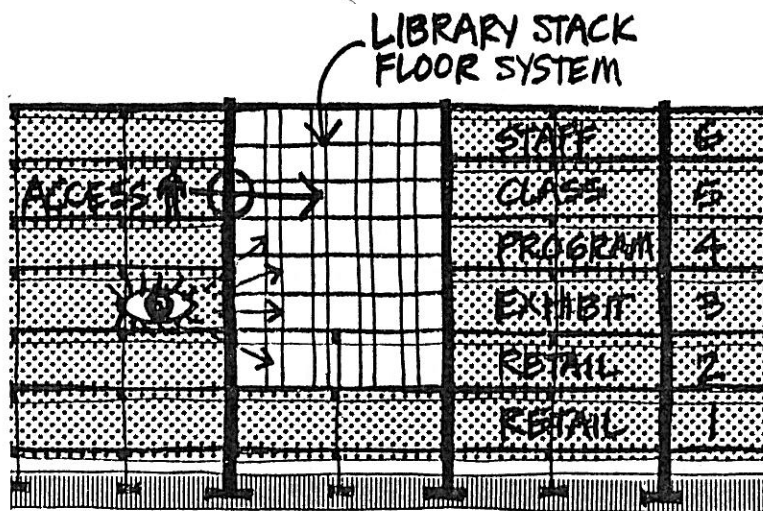
DETAIL OF VERTICAL SCHEME

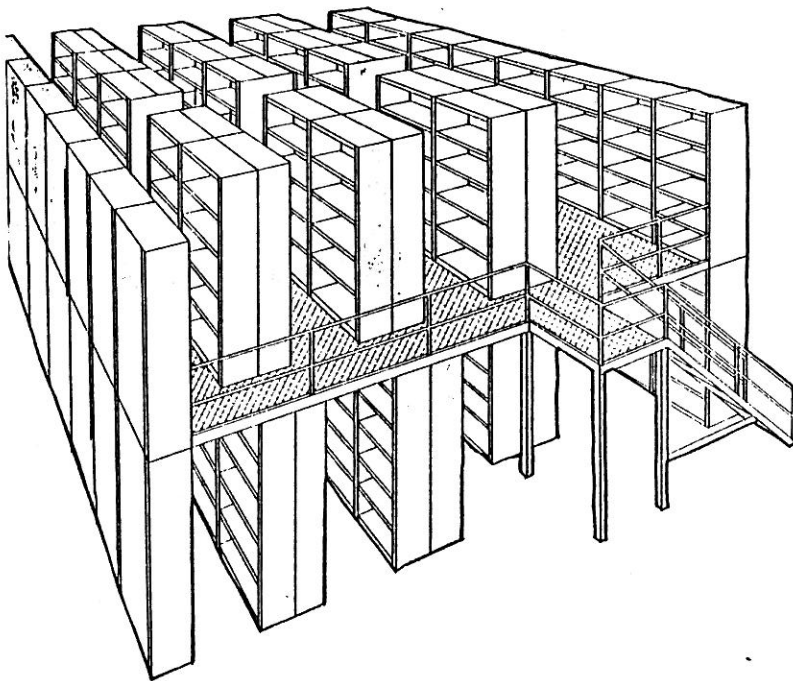The basic advantage of the vertical scheme is that it could project into lower exhibit and program areas within the building, thus providing the visitor visual access to the collections. The horizontal system, on the other hand, would be located on only non-exhibit floors.

The vertical system probably would require a higher initial building construction cost because of major structural changes. Also, considerable storage volume appears to be lost in vertical circulation among the stack levels.

The analysis of other differences between these two schemes reveals the following advantages of each as well as certain special features required by each scheme.

1. Internal Vertical Circulation for People and Artifacts

Stairs only: Circulation by stairs interior to Collections Storage would require carrying artifacts between levels, for either scheme. It was found that a horizontal scheme, exclusively occupying one level, caused severe compromises to other adjacent museum functions.

2. Large Elevators: A large elevator for staff and artifacts could be used in the horizontal scheme by providing a second access control point separate from the registrar. Because floor levels in the vertical scheme don't match that of the existing building, use of the elevator would be prohibited for artifact movement.

3. Dumbwaiter Elevator: Trays and/or carts could be transported vertically on a dumbwaiter, while staff circulation carts would be limited to stairways. This would mean that all small artifacts housed in the Collections Storage within either scheme could be serviced by a dumbwaiter, internal to collections space; and that larger objects must be limited to levels corresonding to existing building floors. The latter results in access problems and loss of flexibility for the vertical scheme.

4. Dust Protection: The collections being stored in a
library stack arrangement of the vertical scheme may
require special floor sealing to prevent dust gen-
erated by foot traffic on upper levels. In the hor-
izontal scheme, a suspended ceiling would be in-
stalled to prevent dust accumulation from upper and
lower floors.

5. Fire And Environmental Protection: Special layouts
for fire and environmental protection systems would
be required for the vertical scheme in contrast to
the horizontal scheme which would use that similar to
other building bays.

C. Collections Storage

Under the general function of the Collections
Storage, objects will be housed in a variety of ways.
The alternate means of artifact storage is dependent
upon their physical characteristics, required level
of environmental and security protection, and the
type and frequency of access to the objects. The fol-
lowing subsection outlines the physical conservation
criteria developed to date for storage and handling
of various objects and its resulting impact upon the
museums' program and building development.

B2. HOUSING OF COLLECTIONS

The design and/or selection of alternative housing
systems will derive from collections-related museum
operational, philosophical, and conservation goals;
from economic considerations; and from the charac-
teristics of the collections.

In some cases "off-the-shelf" catalog items may be
appropriate housing solutions. In other cases, spe-
cial design solutions which may incorporate "off-
the-shelf" items will be required.

For purposes of this study, "collection housing"
shall mean; the specific housing units (cabinets,
shelves, trays, etc.) which support and contain the
artifacts and "collections space" shall mean; the
space, or "envelope", in which the specific housing
units occur.

B2.1 IMPACT OF COLLECTION CHARACTERISTICS ON THEIR HOUSING

The characteristics of the museum collections will
dictate the selection and design of housing systems.
The physical characteristics of the artifacts (dimen-
sions, weight, shape, texture, materials, etc.) will
most significantly impact the storage unit design.
The distribution by physical characteristic and quan-
tity will significantly affect the housing layout and
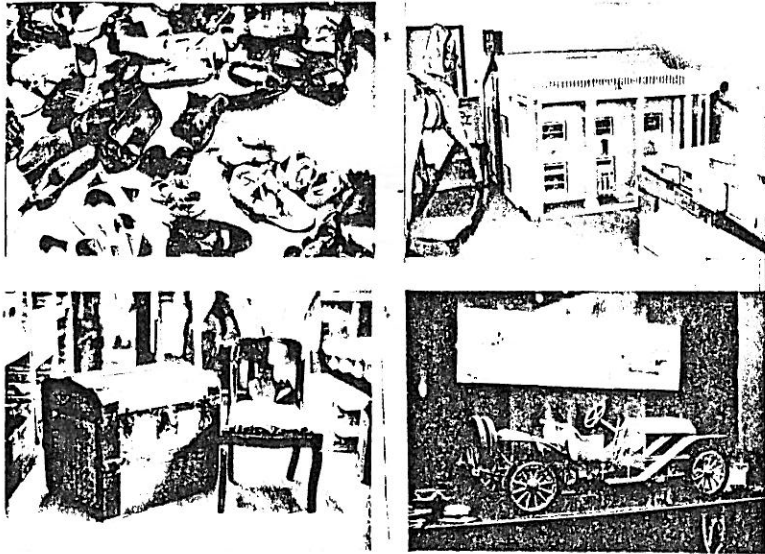floor area required.

The overall dimensions of the artifacts and distribu-
tion by size are initial factors in determining a
particular housing system. Artifacts from both TCM
and MOT group themselves into four categories sharing
common dimensional characteristics:

- small objects (1CF max.)

- medium objects (1-27CF)

- large objects (over 27CF)

- special objects (items with unusual shape or
  characteristics)

These artifact characteristics and dimensional ca-
tegories were derived from general observation of the
whole collections and from general museum collection
descriptions (a description of the museum collections
occurs in Section A). Therefore, the dimensional ca-
tegories are approximate.

The majority of artifacts within TCM collections fit

into the small and medium categories. The majority of objects in the MOT collections fit into the medium and large categories. In viewing both collections as a whole, the small object category is the largest grouping and is, therefore, the object grouping determining their major housing system.

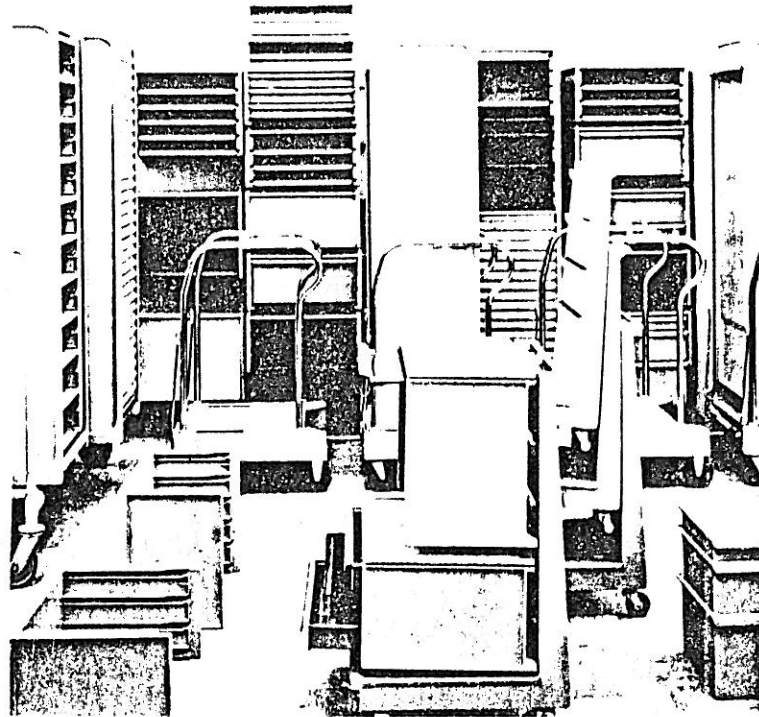CATALOG MODULAR HOUSING SYSTEM (HERMAN MILLER)

A. Small Objects

A system for housing small artifacts will include a modular framework into which will fit components to accommodate various housing conditions.

A few such total systems are currently on the market; they have been reviewed during the course of this study. However, they have the following limitations:

1. Inability to accommodate the specific needs of TCM/MOT collections (for example, most catalog systems are designed for hospital or office usage).

2. High initial purchase cost and potential increased cost for future needs (which may not directly reflect cost of materials and manufacture).

3. Potential inability to modify or replace system parts in the future as storage needs grow and change.

4. Many possess a strong design statement which visually competes with collections objects.

A specifically designed system on the other hand has the potential for meeting all needs of TCM/MOT collections, as well as other related museum goals. Such a system will assemble standard available manufactured items and materials and/or may require some specially manufactured elements; however, the control of this process can be by the museums initially and in the future.
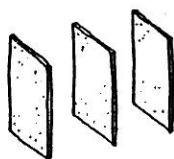
The present collection storage system employed by TCM is an example of a specially designed system for particular storage conditions. It consists of an ABS plastic tray (about 20" x 30" x 3"), and a modular framework of unistrut columns and texture 1.11 (grooved) plywood panels. The trays slide on stapled wood guides that are applied to the grooved plywood panels.
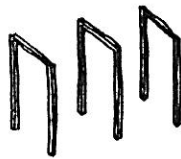
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Modular Storage Framework

The "module" dimensions will result from the small
artifact category dimensions, given as 1CF in volume
maximum. Study of the small artifacts also indicates
that generally they are compact in nature. Thus, they
will probably fit into an area of approximately 18" x
36" (compact), rather than the extreme of say 6" x
48" (long). This dimension will be "pushed and
pulled" by component requirements. For example, the
distance spanned by the component may have to be
minimized. Also, the "module" can be arranged as a
single-face unit or back-to-back as a double-face un-
it.

The modular framework for the small artifact housing
system can be of three basic types: 1) a panel sys-
tem; 2) an open framework system; 3) a cantilever
system. Each of these framework systems support the
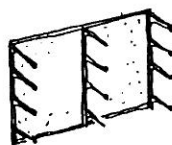components which actually hold or contain the arti-
facts.

- The Panel System would consist of solid side
  panels defining the system "module" or "stack".
  The panels would be grooved and/or receive
  hardware to support the components.

- The Open Framework System would consists of an
  open structural grid defining the system module.
  Channels and other hardware applied to the grid
  would support the components.

- The Cantilever System would consists of back
  panels or framework from which brackets would
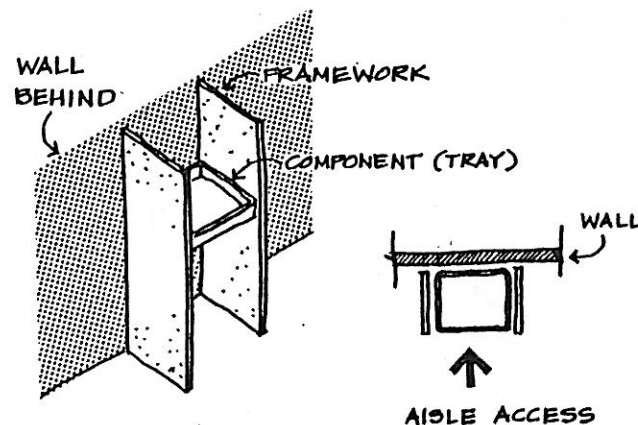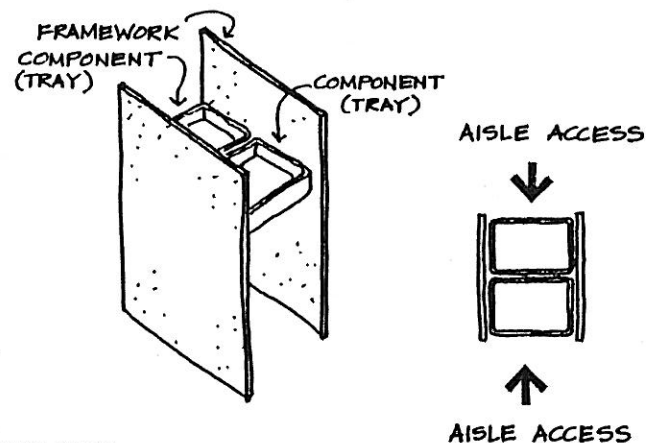 project and support the components.

SINGLE-FACE

PANEL   OPEN   CANTILEVER

DOUBLE-FACE

HANGING ROD FOR
CLOTHES HANGERS

HANGING RODS

D. TRAYS

A. SHELF

MODULAR SYSTEM WITH HOUSING COMPONENTS
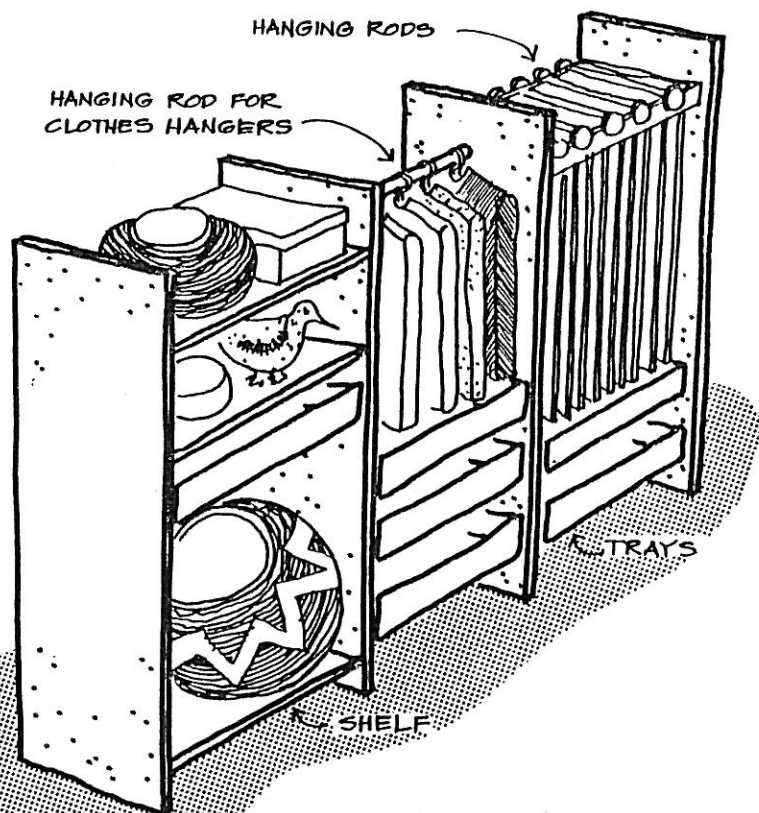
Various materials were studied for the panels and structural frame elements as to their ease of fabrication and installation. Each material was also evaluated from the standpoint of potential as a fire hazard, durability in terms of usage, and flexibility in terms of moving and cost.
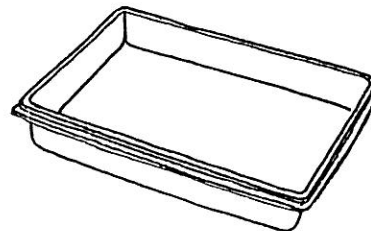
A variety of housing components have been studied to accommodate the differing objects within the modular framework system. The characteristics of the artifacts will determine which components are used. From a basic analysis of artifact characteristics, four component types are suggested: A) tray; B) shelf; C) hanging rod with hanger; and D) hanging rods. Additional study of the collections may result in other components to be added to the system in the final design process.

1. Trays

Generally, items which lay flat (as opposed to those which rest on a small base or stand vertically upright) are appropriate for housing in a tray. Since the major proportion of the museums' collections will fit into this description, the major component of the module system will be the tray. Trays also have an additional use as containers which can be pulled out of the system and used to carry the artifacts.

The following performance criteria have been developed for the design and/or selection of a tray:

a. Ability to fit into Framework System: Trays must have "lip" edges or grooves in order to be self-supported on runners or channels on the modular framework. Trays must span the module dimension and support heavy artifacts.

b. Weight: Trays should be lightweight for easy handling and carrying.

c. Fabrication Variation: The tray material and fabrication should allow flexibility in dimensions and details, allowing special inserts, covers, or details.

d. Durability: The tray should be durable, resisting deterioration under normal use and from the fumigates used. It should also maintain dimensional stability.

e. Ability to Protect Artifacts: The tray should protect the contents from damage.

f. Maintenance: The tray should be cleanable and restorable over time.

Many options for trays and containers are currently available on the market. Manufacturers specializing in trays and containers will also modify their products for some increase in purchase price. In general, tray types vary by material, dictating the tray's overall characteristics and performance. Review of manufacturer's literature has revealed the following tray types: 1) metal wire; 2) solid metal; 3) wood; 4) cardboard; 5) fiberglass; 6) molded plastic; 7) baskets; and 8) glass.

Basket and glass trays can be initially rejected for inability to fit into the modular system. The remaining types are compared in the following chart.

Of the foregoing materials, plastic was considered the most appropriate material for the tray unit. In addition further analysis of different artifacts within each museum indicated that two different tray depths (one of approximately 3" and the the other of 6") may more easily accommodate the range of small objects stored.

TRAY OPTIONS
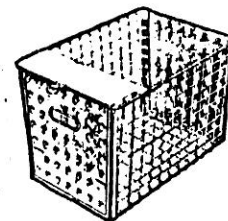
METAL WIRE
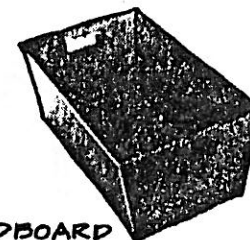
CARDBOARD

MOLDED PLASTIC

FIBERGLASS

METAL

CHARACTERISTICS OF AVAILABLE TRAY MATERIALS

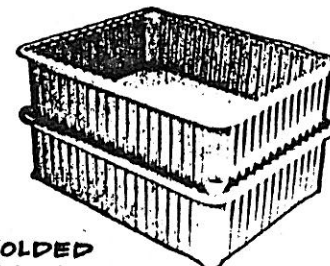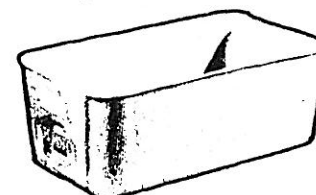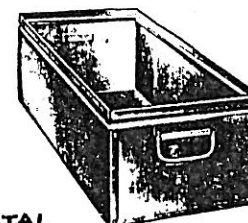| CHARACTERISTICS	WOOD	METAL	CARDBOARD	PLASTIC
IMPACT	not resistant to impact (box breaks apart)	will not break apart, but dents	not resistant - will not protect contents	will not protect as well as metal but "bounces back," good "cushioning"
MAINTENANCE	not easily maintained	paint scratches	throw away	easily washable
FABRICATION	reasonably "workable" can be made in sizes, routed for slots, etc.	limited in form & variations (large sizes become too heavy)	limited in form & variations (large sizes cannot support weight)	unlimited - can be formed in many shapes (integral)
COST	expensive/ unit pricing	expensive unit price	inexpensive	initial mold expensive/ lower unit price as quantity increases
DURABILITY	long-lasting with proper maintenance	long-lasting	deteriorates with wear	long-lasting (care must be taken to select correct plastics)
FIRE HAZARD	can be treated to be fire resistant	fire resistant	fire contributing	self-extinguishing plastics available
STABILITY	swells/contracts ith water & humidity	impervious to water (except over very long time - rust)	deteriorates with water	impervious to water, high thermal "creep" and weight deformation
VERMIN	can be affected	impervious	affected	material itself not affected, but insects ill go through
TRANSLUCENCY	opaque only	opaque only	opaque only	can be translucent/ transparent
FUMIGATION GASES	glues may be affected	not affected	not affected	some plastics are affected

2. Shelves

Shelves are appropriate for storage of vertical items
which should stand upright. If housed in a tray,
these items would topple over when the tray was
pulled out; use of a shelf will encourage lifting of
the individual item, which in many cases is to be
preferred. Pre-cut dividers set in grooves or mounted
on spring held rods could be used to subdivide
shelves for artifacts when necessary. Where more pro-
tection from wear is required, the individual arti-
fact could be covered with a plexi-glass cover, and
for larger areas could be protected by a pull down
vinyl sheet.

LABEL HOLDER

VARIES

PROTECTIVE EDGE
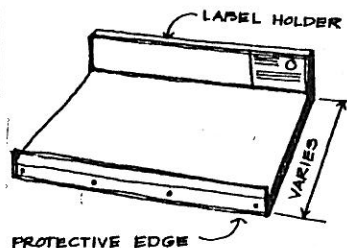
3. Hanging Rod for Clothes Hanger

For artifacts which are most appropriately housed on
a hanger, a clothes rod can be inserted into the
module frame system.

PVC OR WOOD ROD

PADDED CLOTHES
HANGER
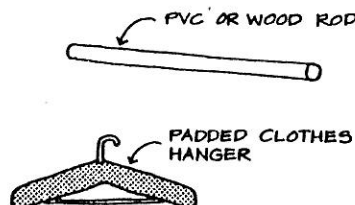
4. Hanging Rods

For artifacts which are most appropriately hung in
"towel" fashion, hanging rods can be inserted into
the system.

For both components 'C' and 'D', the rods can be in-
corporated in pull-out draw type frames.

PVC OR WOOD HANGING
ROD

WOOD RACK
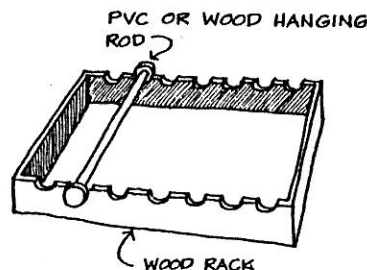
B. Medium Objects

Medium objects, or those artifacts which are approxi-
mately sized 1-27CF, require larger storage space
than that provided by components of the modular sys-
tem. Generally, because of their increased size,
many of the objects tend to be heavier and less
manageable and, therefore, are housed better at a
level lower to the floor. However, when ample
numbers of a particular type of medium objects occur
they could be housed within the modular framework
system.

Four housing options are proposed: 1) storage above
the module system; 2) cubicles; 3) open shelves; and
4) rolling tub containers.

36
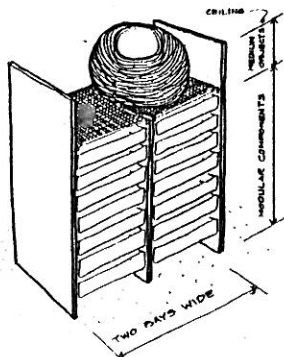
STORAGE ABOVE MODULAR SYSTEM

1. Storage above the Modular System

Objects which are lightweight and easily hand-
manageable could be stored above the modular frame-
work in a space equaling two modules in width. These
artifacts must be of materials and construction to
withstand the impact of a fall in case of mishan-
dling, or must be placed in protected containers.
Baskets, certain toys, children's furniture and plas-
tics could be housed in such a way above the storage
module system.

2. Cubicles

Cubicles, or spaces for individual objects, could be
provided under counters, in units against walls or
free-standing. Cubicle construction could be stan-
dard metal, or wood cabinet systems. These cubicles
may be open or have doors depending upon security or
other protection requirements. If visual access is
required, the doors should be glass or acrylic.

3. Open Shelves

Open shelves can also be used to provide housing for
medium-sized objects with the same provisions as
stated for the small artifacts.

4. Rolling Tub Containers

Containers with sub-divided storage compartment on
casters could be provided below shelving and counters
within storage spaces. They allow for easy access to
artifacts stored in a vertical position.
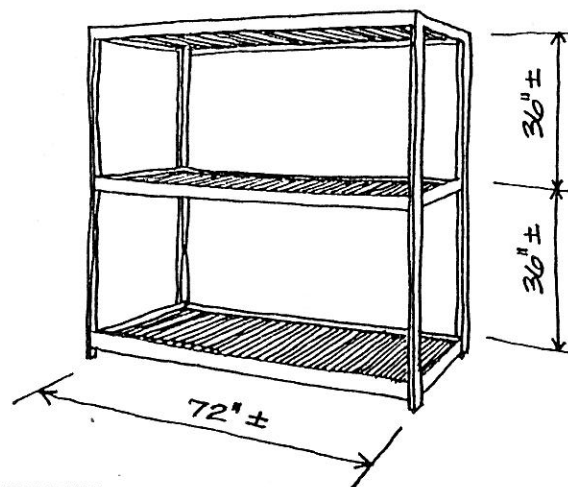
OPEN SHELVING

ROLLING TUB CONTAINER

36"±

OPEN

DOOR

UNDER-COUNTER UNITS

36"

36"

36"

STACKING CUBICLES

OPEN

CUBICLE DOORS

FULL-HEIGHT DOOR
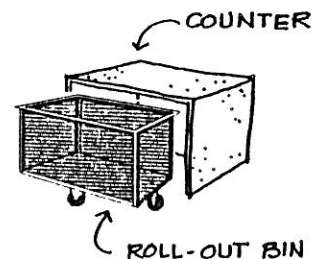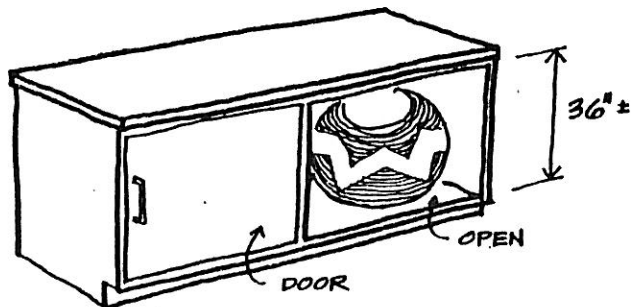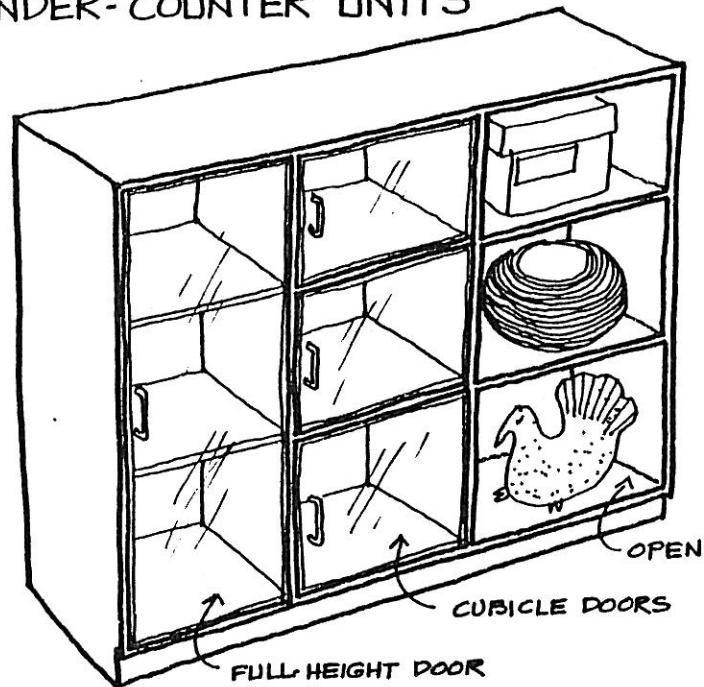
WALL UNITS
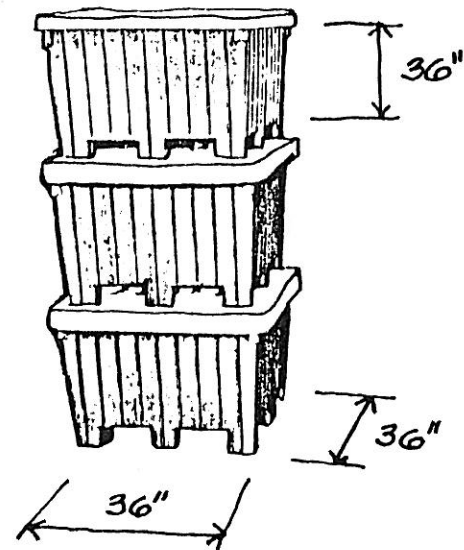
CUBICLES

C. Large Objects

Large bulk artifacts, objects over 27CF in volume,
are large enough that they can be housed appropriate-
ly in a space without necessarily requiring a specif-
ic "place". The space itself acts as the housing un-
it.

A very large storage space may require some defini-
tion of storage zones which could be accomplished by
partitioning or other space dividers. In the case of
vehicles, this zone definition could be accomplished
with painted lines.
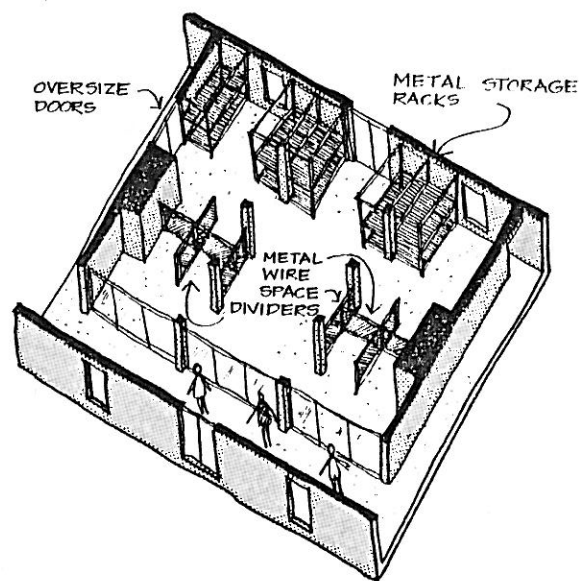
LARGE OBJECT HOUSING
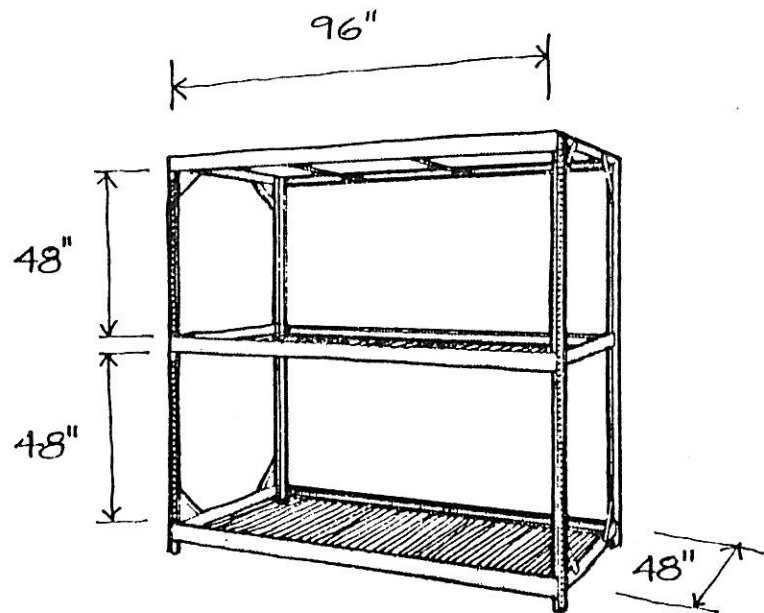
METAL STORAGE RACK

D. Special Objects

Special objects are those which require unique hous-
ing solutions because their physical characteristics
are not common to the major proportion of the collec-
tion. For example:

Unframed posters, maps, photographs, documents,
etc.
Framed posters, maps, photographs, paintings,
documents
Spears and other long, narrow artifacts
Rugs, tapestries, mats, etc.
Books
Photographic slides
Signs
Unusually shaped artifacts

Special housing units selected for the above-listed
special objects will be required, and they may be in-
corporated into collection housing spaces where need-
ed. The following are examples of special housing
units identified during this study; additional units
may be incorporated during the Final Design Phase:

1. Flat File Units - Large, thin, flat objects (such
as unframed posters, maps, documents) may be housed
in flat file drawer units. These units are available
from catalogs in wood or steel, or can be custom-
fabricated.

2. Vertical File Units - Shelving, other than that
provided in the modular system, can be used for bound
papers, periodicals, and/or books (such as the MOT
library). Standard library shelving is available from
catalogs in steel or wood, or can be custom-
fabricated.

3. Tube Storage Units - Rolled artifacts (such as
maps, drawings, tapestries) may be stored in racks,
positioned horizontally (resting on their sides) or
vertically (resting on end). Open or closed racks are
available from catalogs in wood, steel, or fibre-
board, or can be custom-fabricated. Individual tube
containers are available in cardboard and/or clear
acrylic.
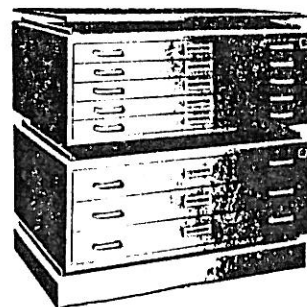
FLAT FILE
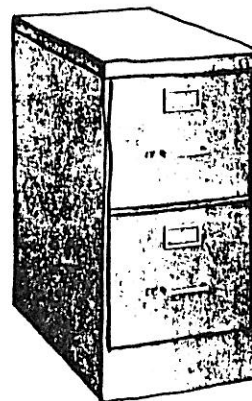
VERTICAL FILE

OPEN SHELVES
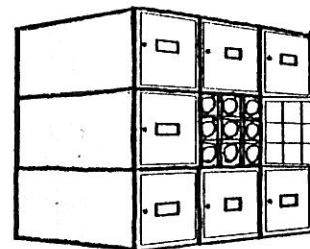
ROLLED HOUSING

4. Photographic Slide Storage Units - A number of options for storage of photographic slides exists. Many types of metal container boxes for slides and metal cabinets with slide drawers are available from catalogs. Vertical slide racks consisting of transparent and partitioned leaves permit slides to be viewed on a light table without removing the slides. Slides can also be inserted in vinyl see-through pages and bound in notebooks for shelf storage.

5. Vertical Panel Units - Large, flat artifacts (such as framed paintings, photographs, metal signs) could be fastened to vertical panels. Panel materials of a metal grid which accepts tie-downs and hooks and/or board (plywood, for example) which accepts screw-in fasteners could be used. Panels could be mounted on hinged swing-arms, or on sliding tracks. Dividers or stops would be required with the swing-arm configuration for artifact protection.

6. Vertical Hanging Units - Large, flat artifacts (such as tapestries, rugs) could be hung from metal rods and/or clips. The rods or clips would be mounted on metal swing-arms and/or sliding tracks similar to the vertical panel units described above. In addition, items such as metal signs could be hung from hooks in the ceiling above vehicle storage where floor to ceiling space permits.

7. Custom Storage Units - Long, narrow artifacts (such as arrows, spears, etc.) could be housed on end in racks. Protection for individual artifacts could be provided by containerizing each artifact in clear acrylic tubing.

8. Special Wall System - In general, the above-listed storage units will probably be used at walls rather than free-standing in space (except for open shelving), for these units generally tend to be deep in dimension. Where the collection space cannot accommodate them individually, an alternative wall-mounted system which combines these units flat to the wall could be used. This wall system is more a display device and is well suited for study/storage uses. Such a storage system accommodates many special housing conditions but is less efficient than any of the individual systems described above. It would consist of slotted metal strips occurring on a standard horizontal dimension; the metal strips would accept removable, interchangeable components (such as hanging rods, hook strips, slip strips, shelves, picture mouldings, and grid panels for tie downs) which would either project from the wall or span between the metal strips. Tack surface panels would be inserted flush between the metal strips.
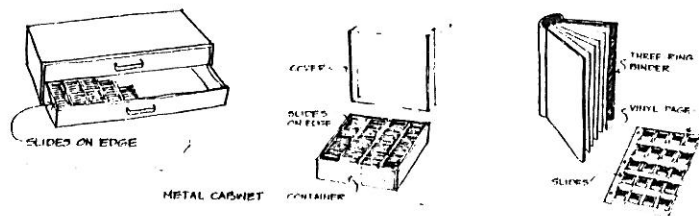
SLIDE HOUSING UNITS
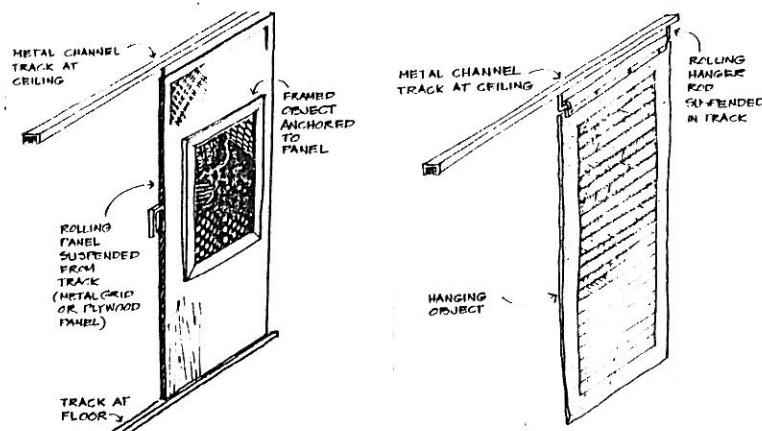
VERTICAL PANEL UNIT
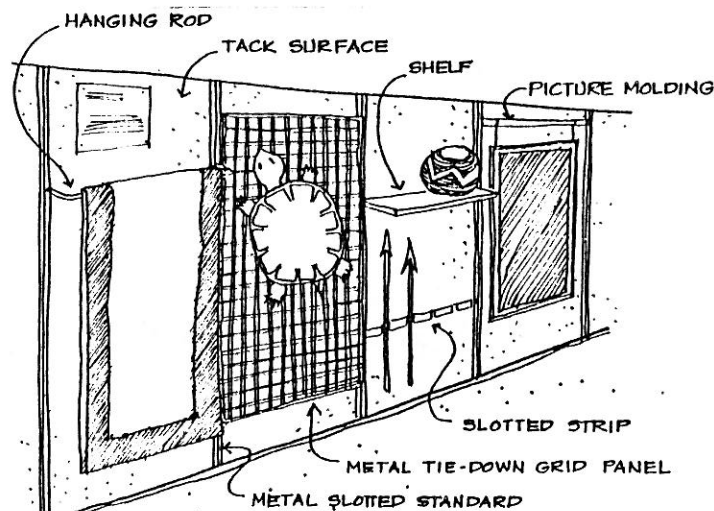
SPECIAL WALL SYSTEM

Conservation criteria will significantly affect the housing of collections. Unlike object characteristics (section B2.1) which primarily affected the housing units, conservation criteria will significantly influence both the housing units and the housing space. Elements in both the housing units and housing space can be designed to protect the artifacts from people-related damage such as theft (security), breakage and general wear from handling; and from other damage such as fire and related effects, environmental conditions (humidity, temperature, air content), and vermin.

A. Housing Space

A basic decision was reached by the Museums to treat security, fire and related effects, and environmental conditions by treating the housing space, thus providing a general protected environment in which to place the housing units. (The specific elements of the security systems, fire-protection systems, and environmental systems are discussed in Sections B4 through B7).

In addition, finish materials in the housing space and plan arrangement of elements within the space can be used to protect the collections from breakage, dust and vermin. Criteria for dealing with these potential hazards to collections are discussed below.

1. Dust: In collections spaces dust should be minimized; finish materials used in the spaces can be used to minimize dust. Wall surface treatments should "seal" existing surfaces and/or should provide new surfaces such that no dust is generated by deterioration of the surface itself. Floor treatment will also affect settled dust. A soft, textured surface will "catch" the dust and reduce movement caused by foot traffic.

CARPET ON SUB-FLOOR

CARPET OVER PAD
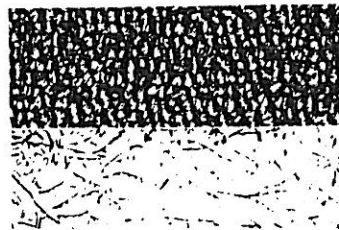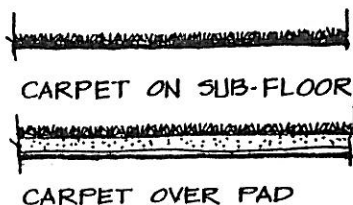
2. Breakage: Breakage can be lessened by providing a soft floor material to cushion objects if dropped and by providing workable plan arrangements of storage elements within the space.

CUSHIONED RESILIENT FLOORING

MAT OVER HARD FLOORING

MAT OVER SOFT FLOORING
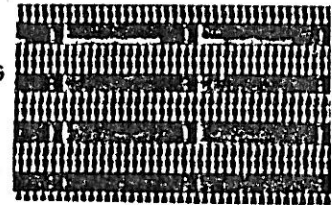
a.   Floor Materials: Floor materials should be durable, cleanable, and should not generate "fuzz" or lint. Additionally, they should not absorb dirt, fluids, odors or attract and house vermin. Several types of soft floor materials will meet this criteria:

Carpet: Generally, synthetic carpets of continuous filament nylon material or needlepunch carpets (indoor/outdoor) will meet the above criteria. Cushion materials are more limited. Hair and foam type cushions would be unacceptable. However, a cushion material composed of polyester pneumatic cellular fiber (DuPont "pneumacel" or equal) will meet the criteria.

Cushioned Resilient Flooring: Sheet vinyl is available with cushion backing. This material will provide a smooth, easily cleanable, impenetrable surface.

Protective Mats used over Finish Floors: Protective mats can be applied over the above-listed soft flooring or over hard flooring. This type of material is not permanently installed but set in place.

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b.   Plan Arrangement: A workable plan arrangement of
the module storage system in a particular space,
will provide unconstricted areas for use and
transport of artifacts within the space.

Aisle widths within the modular housing systems
should allow the user to easily take artifacts
or trays from the system and to carry them to
work spaces. The aisle width will thus be deter-
mined by the tray dimension. Tests conducted by
the Museums and Cambridge Seven Associates, Inc.
have indicated that a minimum aisle dimension
should be approximatley 12" greater than the
maximum tray dimension. This aisle dimension as-
sumes that only one person is in an aisle at one
time. If aisle space were to allow two persons
to pass carrying trays or artifacts, the poten-
tial of "bumping" still exists. Furthermore, al-
lowing aisle space to accommodate two users car-
rying trays would result in excessive floor area
devoted to circulation.

The plan arrangement can facilitate one-person
use of the aisle by providing "set-down"
counters where artifacts can be transferred to
carriers for transport to other museum areas.
Such a counter would also provide a "safer"
place for handling the objects than could be ac-
commodated within the modular system. The dis-
tance from modular system to "set-down" counters
and aisle length should be minimized. Such
"set-down" counters should not become a per-
manent work space as people should not be en-
couraged to stay in the housing space. The temp-
tation to smoke or work on projects, both pol-
luting activities, would be reduced if work
space is not provided.

Major aisles outside the modular housing system
which provide access to the modular system ai-
sles will require greater width due to both pas-
sage of people, and dimensional requirements of
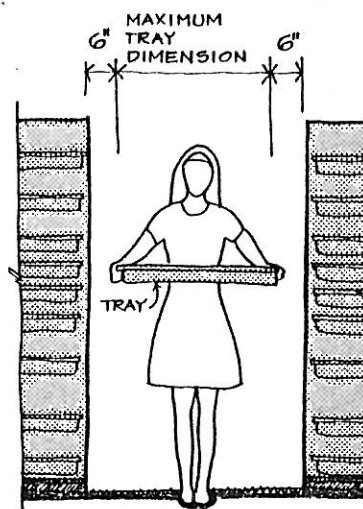
MINIMUM AISLE WIDTH   SET-DOWN COUNTER

43
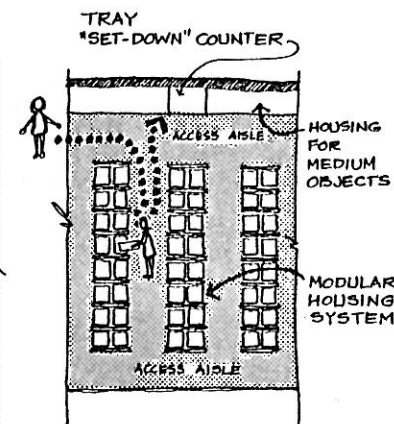
rolling work/storage carts.

Obstacles in aisle circulation areas which must be gone through, passed over, or travelled around, will create the potential for dropping artifacts. Thus, changes in floor level (trip hazards) and doors should be minimized, or ideally eliminated in storage areas prior to transfer of artifacts to safe transport containers.

3. Vermin: Sealing of the housing space will be required for effficient operation of mechanical systems and to allow fumigation of these spaces without contaminating public areas. This sealing will also discourage penetration by vermin. In addition, vermin can also be discouraged through the use of materials which are not attractive to them, generally synthetics or treated natural materials.

B. Housing Units

Design of the housing units should also reflect the following conservation considerations:

1. Security: Major security is provided by controlled, limited access to housing spaces. In addition, the housing units themselves can be secured further by providing locking doors on selected units. Although such doors provide additional safety if used only on housing units containing valuable artifacts, these doors "announce" the location of the objects. Random location of more valuable artifacts will also protect them from the untrained person.

All housing units located in public areas will require locking doors or mechanically fastened access panels.

2. Dust: Objects can be protected from dust by enclosing them in containers within the housing units. For example, trays in the module system could receive covers, or objects housed by tray or by other components could be enclosed individually in containers. Alternatively, the housing unit stack itself could be enclosed by adding a top and doors.

FLAT TRAY COVER

BUBBLE-TOP TRAY COVER

TOP PANEL OR CEILING

GLASS OR ACRYLIC DOORS
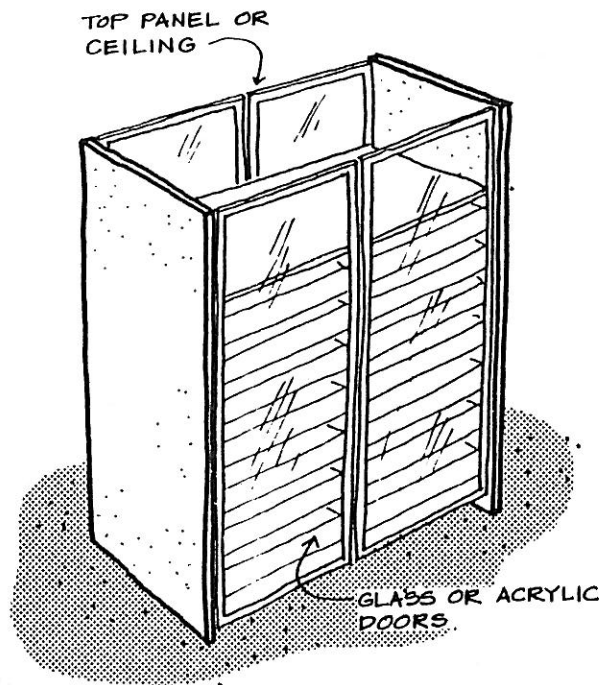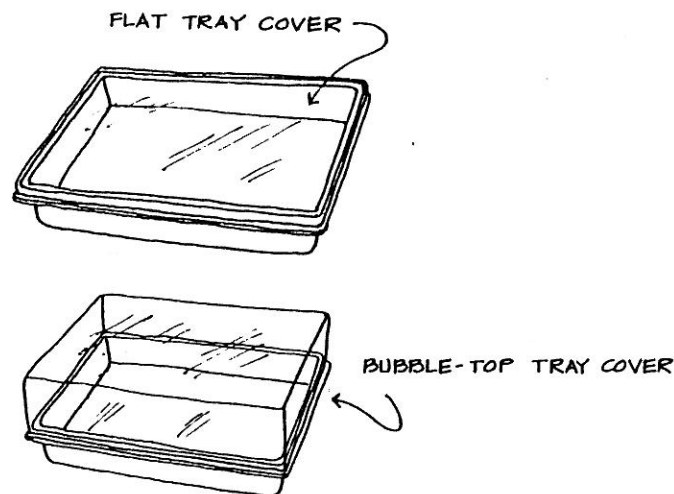
3. Breakage and Wear: Materials and fabrication details used in the housing units will provide protection from breakage due to impact while housed. Generally, materials, which resist penetration would be most protective, for example, solid, closed materials rather than open, perforated materials.

Containers which are resilient and/or absorb impact would protect the artifact from breakage if pulled from the housing unit and dropped. For example, plastic trays transfer less impact to the enclosed artifacts than a metal tray.
The housing units should be structurally stable. Removable components in the module system should be securely fixed in place. Trays which "pu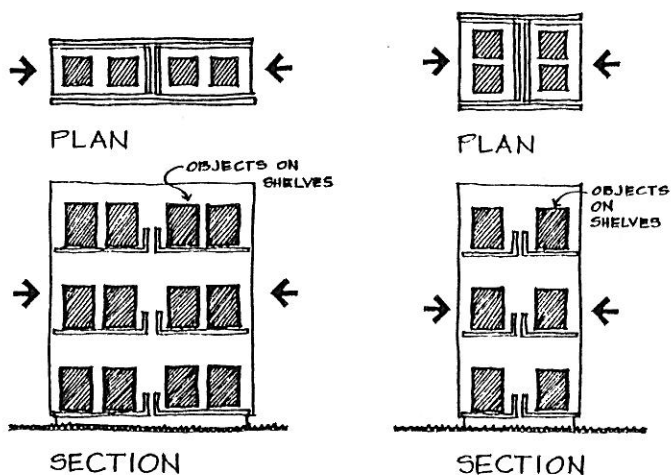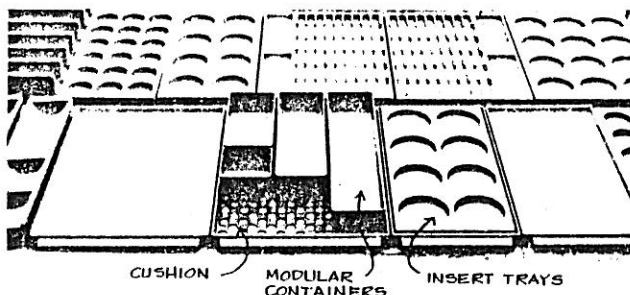ll-out" when in the module system (like drawers) may require "catches" to stop them before tipping or before falling off the end of supports.

A base added to the housing unit will protect artifacts at floor level from impact by cleaning equipment or from accidental kicking.

CUSHION   MODULAR CONTAINERS   INSERT TRAYS

Therefore, housing units should be designed to make all objects immediately available. The modular system framework should, therefore, be a depth which accommodates visual access to the maximum quantity of objects from the aisle.

Trays which house objects in a top to bottom configuration should, therefore, be a height encouraging only a single layer. objects. Furthermore, separation of the artifacts within the trays could be achieved by inserting trays defining artifact spaces, modular containers, or dividers. These inserts would also protect the artifacts when the trays are moved and indicate when artifacts are missing. Soft pads placed in the bottom of the trays will also protect artifacts in the tray although will not separate artifacts or indicate missing objects.

PLAN   PLAN

OBJECTS ON SHELVES   OBJECTS ON SHELVES

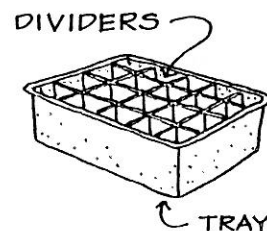SECTION   SECTION

DIVIDERS

TRAY

4. Object Density and Separation: Objects housed in a dense condition (for example, more than one layer deep or one layer high within a tray) may be self-damaging. Objects housed in this way are also subject to wear and potential breakage due to increased handling as artifacts in the top (or front) layer are sifted through to reach the ones at the bottom (or rear).

5. Ease of Use: Making the housing units physically easy to use will result in less breakage. For example, objects located very high so that a person has to reach to handle them are more subject to dropping than artifacts located closer to waist level. Pulling trays out of a housing unit is particularly difficult above certain levels. The housing units should there- . fore, be a height which is manageable.

The weight and shape of the artifacts may affect the housing units. Preferably, heavy and awkward objects would be located low in a system. Generally, this means that provision for small bulk artifacts should be a low system and provision for small objects could be a higher system. MOT collections which tend to be heavier the TCM collections could be housed in a lower system.

6. Containers: Placing artifacts in see-through containers will allow visual examination without "touching". Very fragile artifacts could be housed in containers fastened mechanically; making valuable artifacts more accessible to view will reduce handling which will result in less breakage. Less fragile artifacts could be in easier-to-open containers.
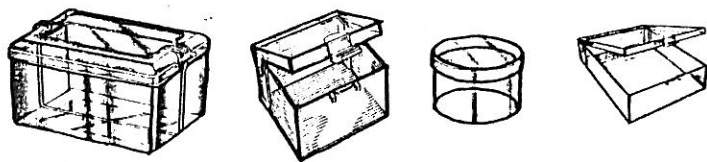
SEE-THROUGH CONTAINERS

C. Transport of Objects

Objects, while being transported, are subject to the same conservation criteria as objects or artifacts in the housing units. Therefore, a "safe" means of transporting objects within housing spaces and in other museum areas should be provided.

While the objects are being carried within the housing space, they will have the security and environmental protection provided by the space itself. Once outside the housing space, security precautions such as locking of storage units or mechanical fastening should be provided where possible. Environmental protection (temperature, HVAC, etc.) will not be possible in a moving system.

The type of carrier or transport device will be dependent upon the artifact to be carried. In some cases, it may be safest for the object to be hand-carried. As a general rule, however, transporting artifacts in an enclosed unit would provide more protection. The enclosed unit itself could be hand-held or on wheels.

All objects transported in containers, hand-held or wheeled, will require restraints which stop movement within the container. Inserts similar to those discussed earlier in "Object Density and Separation" would also be useful in this situation. Additional temporary "packing" such as "bubble-wrap" may also be required. Objects not transported in containers will require special, temporary packing as appropriate for the specific items.

One or two small objects could be carried in tubs or boxes. Hand "grips" should be provided so the container can be securely held. In order to protect the objects, the tub material should meet the same criteria as housing unit components.

For additional protection and security, the tubs could be fitted with tops. Locks may or may not be required. Hand-held transport containers should not project significantly from the body. This means that a maximum overall dimension not exceeding 16 inches is advisable.
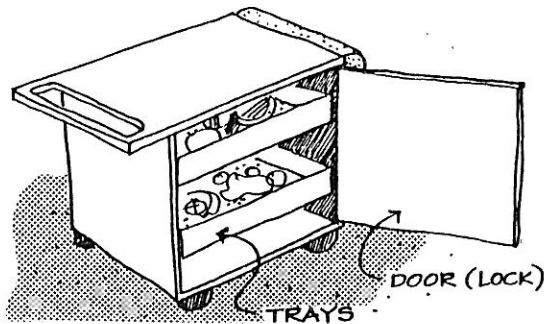
CART FOR SMALL OBJECTS

When more than one or two small objects or larger artifacts from the modular housing system are to be transported outside housing spaces, the use of a cart is recommended. Because the cart would be used both in staff areas and in public spaces, it should be very stable, have lockable tops or doors and probably have "locking" wheels. In staff areas the carts can also serve as temporary storage units.

Carts provide more protection than hand-held containers because less potential for dropping occurs. Doors, for example, present a significant hazard to hand-held objects because of difficulty in supporting the container while operating the door. This difficulty can be alleviated somewhat by providing set-down space immediately adjacent to doors.

Also, doors through which objects frequently pass should close very slowly, providing adequate time to pick up the container or object and pass through the opening. Carts, on the other hand, will support the artifacts at doors; however, they may be difficult to maneuver in this situation. Care will have to be taken in all building spaces where carts will occur to provide clear and easy paths for cart usage. For example, during final building design, ramps or elevator access, compact floor surfaces, adequate circulation space, and "parking" places should be studied carefully.

Medium sized objects, large objects and special objects will require a variety of transport options, all of which are used only for transport. It will be assumed for these items that they will always be transferred to and from safe places and be carefully supervised while being moved. Transport options include: 1) dollies; 2) hand trucks; and, 3) large carts.
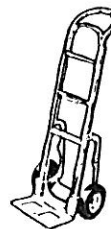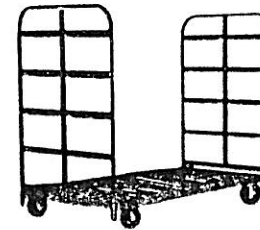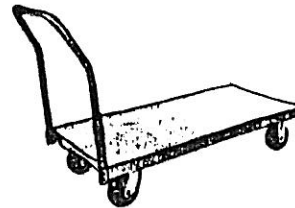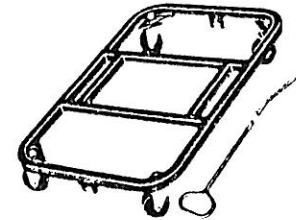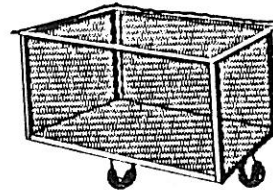
TRANSPORT OPTIONS FOR MEDIUM AND LARGE OBJECTS

D. Museum Policy

The collections housing spaces and system units can be designed to encourage and accommodate, but cannot guarantee, good conservation of artifacts.

The housing system has an intimate relationship with the people using it. The success of all of the previously listed design decisions related to artifact conservation are dependent upon museum operational directives gained from actual usage of the storage components and system.

For example, dividers are provided as tray inserts but only the user can "place" them. Heavy objects are recommended at low levels but they may in fact be placed high. It is suggested that no more than one person at a time be allowed in aisles, but nothing physically will stop additional people from walking in.

B2.3 IMPACT OF ECONOMICS ON COLLECTIONS HOUSING

A. Economic Objectives

Economic considerations will temper all components of the collections housing system. Evaluation of materials and detailing of the housing units and spaces will involve cost trade-offs. However, design of the system can also achieve economic goals, irrespective of the materials and detailing. For example:

1. Ease of Use

A housing system which is easy to understand and operate will result in less time spent by staff members, reduced chances of breakage and theft, and, thus, less operating cost. Staff size and time will also be reduced by developing conservational maintenance programs that are related to housing spaces rather than individual artifacts.

2. Flexibility

A housing system which allow interchanging of parts and/or moveable units will require fewer parts and less cost in future revisions. An additional benefit is staff participation. When the system is easy to use and adaptable, greater staff participation and responsibility will occur by incorporating the staff involvement with development of new storage components.

3. Minimum Number of Storage Spaces

Concentration of the maximum quantity of objects in one area of contiguous spaces as opposed to dispersion throughout the building may result in several savings. For example, time spent by staff in locating objects may be reduced; control over access, supervision of artifact condition is simpler; special architectural and mechanical requirements will be concentrated and, therefore, more economical.

4. Combined Collections

Objects with similar housing requirements from both TCM and MOT collections should be combined so that "dual" housing facilities are not required, thus reducing cost for both Museums. Presently, both museums are in agreement with shared storage but need separate access divisions for their own objects within common storage spaces.

5. Efficient Use of Space

Design of the housing units and their arrangement in the housing space can efficiently use space, reducing cost by reducing floor area required.
Generally, decisions as to use, conservation, goals, and other housing concerns must be made first. Then the housing spaces and units can be designed to use space efficiently with these "givens".

B. Use of Existing Storage System

TCM currently has a portion of their small objects housed in a modular tray system. Reuse of all or part of this system may result in a cost saving.

The existing system is comprised of approximately:

- 1,075 trays
  The existing tray is molded of ABS plastic and has dimensions of 30-1/4" x 20-1/2" x 3-1/8" deep. Presently the trays are supported on their long 30" side.

- 44 panels (double face) or 88 bays
  The panels are 3/4" thick texture 1-11 plywood. Double-face panels of approximate dimensions of 60" x 96" are comprised of four connected panels.

DEEP TRAY CONFIGURATION   SHALLOW TRAY CONFIGURATION
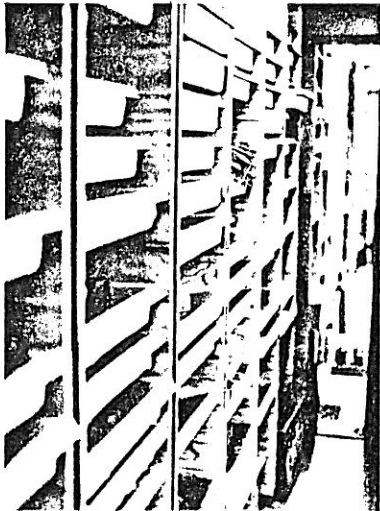
- Four 1 x 1 "unistrut" metal channels are used for each module bay to support the wood panels and are framed from floor to ceiling.

A bay of this system has an approximate current replacement of $14.00 for the side panels; $15.00 for the unistrut metal channel frame; $10.00 for tray guides and two hours of installation time at $13.00 per hour for a total bay unit cost of $52.00. Trays cost approximately $7.00. At the present storage density of approximately 12 trays per bay, trays required for one bay cost $84.00.
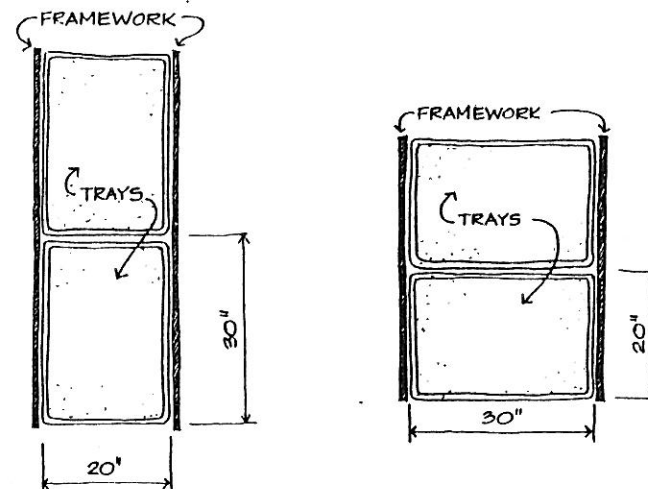
The total tray storage replacement cost is then approximately $12,000.00.

If the existing tray system is reused, it will only be part of the total housing requirements for the Museums' small artifacts needs. However, use of the existing tray system will affect the final design of the new system because of its dimensional size and means of support.

Several options are possible:

1. The existing system could be duplicated. This option would result in a cohesive system throughout both museums. Whatever limitations come with the existing system would continue; however, modifications could be made such as change in finish color, addition of components, and decrease in system height.

2. The existing system could coexist with a new system of different design, thus resulting in two different systems within the museums. By isolating the existing system in a separate housing space, no visual or use conflict would result; however, interchangeable components would be limited to within each separate system.

3. The trays, or a portion of the existing system could be incorporated into a new system design. This option could allow the design of a cohesive total system, the only limitation being that of the tray, which would dictate the "module bay" or "stack" dimension. Also, the 20" x 30" tray could be placed in the module so that the 30" dimension faces the aisle (shallow configuration) instead of the 20" dimension stack width now being used (deep configuration). The advantage of this arrangement is that the shallow configuration does make more artifacts immediately visable and available (as discussed in Section B2.2).

The shallow tray comfiguration requires more aisle length area but less aisle width per stack served. The deep configuration is slightly more space efficient. Also, if the tray is turned to the shallow configuration, the tray should be tested to determine if the tray will deflect due to the 10" increase in span. The mold for the existing tray has been destroyed so that a new design will be required for additional trays.

By keeping or modifying the existing system, additional benefits to the museums could be:

- the continual expansion of objects into the storage system prior to moving to the Wharf since occupancy is probably two years in the future;

- joint collections could be housed in either current museum facility; and

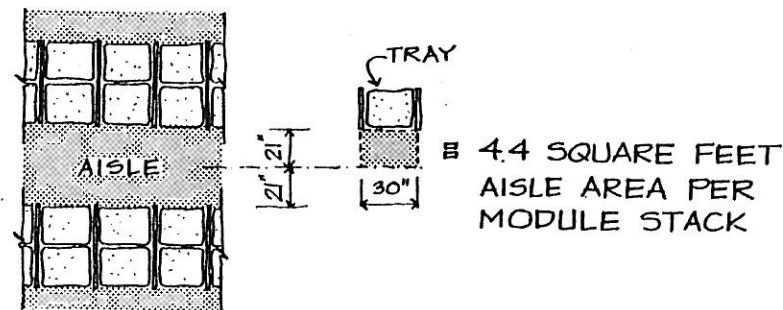- the objects would be kept in the same trays, thus reducing the handling, packing and restoring procedures during the actual move to the new building.

E 2.9 SQUARE FEET AISLE AREA PER MODULE STACK

DEEP TRAY CONFIGURATION

E 4.4 SQUARE FEET AISLE AREA PER MODULE STACK
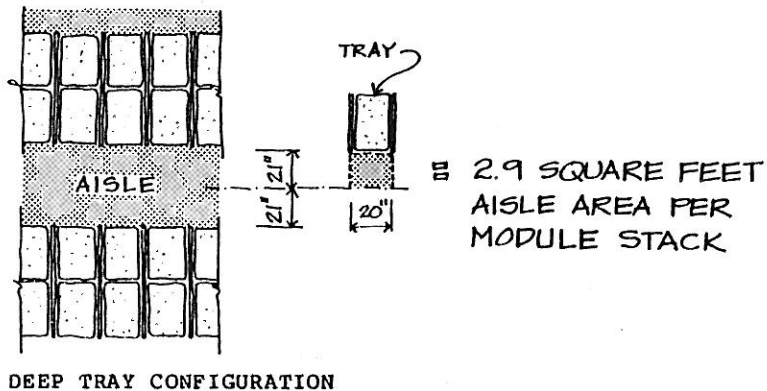
SHALLOW TRAY CONFIGURATION

A. Collections Storage

The museum philosophy, or goal, of encouraging public knowledge of the extent and resource value of the collections will affect design of the housing system. In order to achieve this goal without sacrificing security, visual access to collections storage spaces rather than physical access should be provided.

The two general options for the collections storage which have been previously discussed under Section B1.2 are horizontal and vertical arrangements.

Both horizontal and vertical solutions will require vision panels so that the public can see into the collections housing space. The extent of these panels can vary from "peep holes" to fully glazed partitions.

Where collections housing shares space with other functions within a building area, objects will be exposed, almost in a display fashion (see Section B2.1). Large artifacts in this situation would be to-

VISUAL ACCESS TO COLLECTIONS

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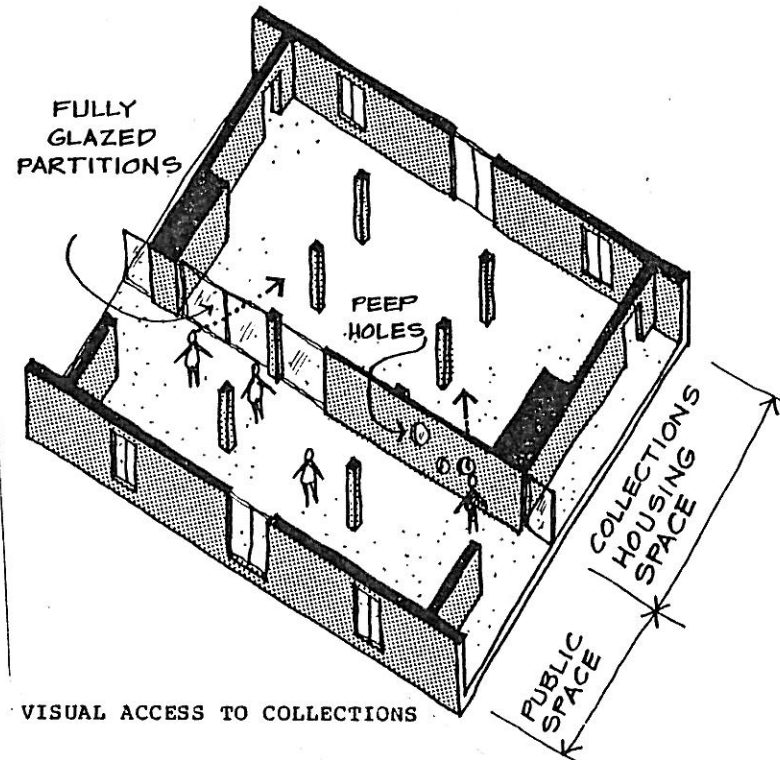
tally exposed to view. Public visual access to other collection support functions such as restoration or conservation areas, would show the public another aspect pf the Museum collections.

Generally, one will see "glimpses" of objects within a tray module system, although the shelf and hanger components may expose more objects. Clear containers and/or doors on the system units should be used if possible. so that enclosed objects are not further obscured. To further expose collection artifacts within the modular system, the exhibit display of representative objects from the housing units behind could be provided at the glass partition separating collections and public. Also, housing units could be backed up to the glass partition. providing a "cutaway" view of wnat is occuring in the housing units behind.

Opening the housing spaces and housing units to public view has visual implications because the space and its contents become a type of exhibit case. Therefore, the selection of materials and design of housing units should make the space attractive and complement the artifacts.

B. Satellite Housing

Another method to make collections more visible to the public is to provide small collection units in public spaces. In order to accomplish this, several options are available: a) collections closets; b) display units (collection "mini" closets); and c) carts.

1. Collections Closets

Where a large portion of collections is desirable in a public area, separate spaces with separate access control and environmental protection (or collections closets) could be provided. These spaces would accept the same housing units as found in the central storage area.

Collections closets could be fixed or could be a demountable system. Fixed collection closets (i.e, fixed partitions and "hard" connections to building systems) would be an integral part of the public area.

Demountable collections closets would be "knock-down boxes" comprised of connecting partition, ceiling, and flooring components which would plug in to building systems. These boxes would be variable in size and could vary with collection requirements.
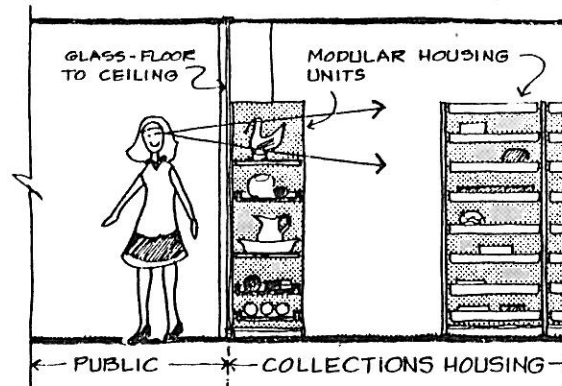
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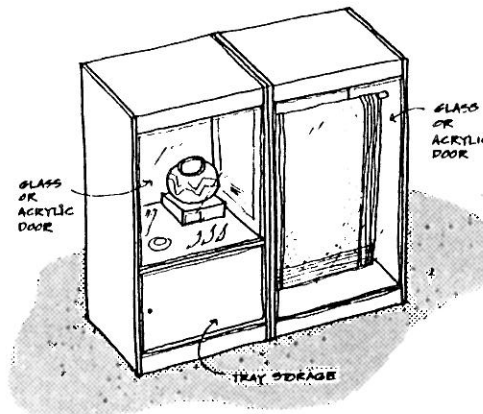
DISPLAY UNITS ("MINI" COLLECTIONS CLOSETS)

2. Display Units (collections "mini" closets)

Where a small portion of collections is desirable in an exhibit or public area, display units could be provided. Each display units would be a separate entity with individual access, locking doors (or mechanically fastened access panels). Since these units would not be connected to the same environmental systems as central storage. they would not be advisable for long-term housing of objects However. they would be appropriate for collections housing related to changing exhibits.

The display units should be designed to be stable when in place, but movable so that they can be redistributed throughout Museum areas according to need. The units could join together in quantities as required and they could do "double-duty" as room dividers within large public areas.

For further flexibility the units should be designed to accept components from the modular system in the central housing space. However, additional components and the "case" itself should be designed in keeping with its display and program use functions.

3. Carts

Supplementary to their transport functions throughout the entire Museum (discussed in B2.2) carts could be used as demonstration aids for staff members.

Trays, or other components, from the modular system would be housed inside the cart. The top of the cart could serve as a counter from which visual and/or "hands-on" demonstrations could be made. The top should provide a secure base for the tray and a cushioned surface (with an edge to protect rolling objects) on which to place the individual objects.
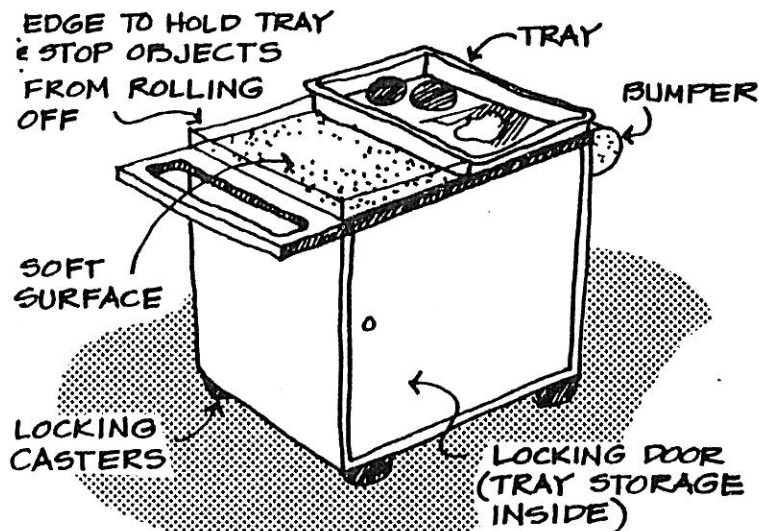
DEMONSTRATION CART

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During the course of this study, a physical inventory of the objects and artifacts was conducted by storage type category (small artifacts, small bulk, etc.). This inventory in conjunction with the proposed modifications to the storage systems and the projected growth in collections area demand, has been used in developing the storage area program for the building.

A. Present Collections

1. Small Objects - The Children's Museum

At current storage levels of object density per tray, a total of 3,852 trays would be needed to accommodate the small artifacts collection. In a separate study conducted by the Children's Museum, an experiment was conducted on the tray storage density of one particular cultural artifact group. The densities were varied to determine the optimal storage condition for access, visibility, and physical protection. From data developed for artifact handling generated by this study and through the actual testing of different tray densities, a tray density goal for housing just the current collections could be accomplished by twice as many trays. Therefore, for this study a tray count of 7700 has been used to determine storage space needs.

In order to determine the total number of storage bays required, studies to establish the maximum bay height for storage of objects within trays were conducted. Presently, the objects are stored up to eight feet in height which means many trays must be removed in order to view the object and there exists a high probability of dropping trays when removing or replacing them.

Using the existing tray storage system at the Children's Museum, a maximum height of a top tray was set at five feet and is used in this study as the criteria.

Based upon 7,700 trays, a total storage demand of the total number of storage module bays to a height of five feet is 856. This figure provides for nine trays per module bay.

The storage tray determines the module bay area, approximately 24" x 30". Therefore, the total net area for storing the objects to a five foot height at a reduced tray density is 4,300 square feet. The area required for circulation within the modular storage system (allowing a 42" aisle width) is approximately 3.5 square feet per stack when the 20" tray dimension is on the aisle (deep configuration) and 4.4 square feet per stack when the 30" tray dimension is on the aisle (shallow configuration). The total floor area required for housing of small objects is therefore, 7296 square feet for the deep tray configuration and 8066 square feet for the shallow tray configuration. These areas do not include perimeter circulation and temporary work counter areas.

2. Small Objects - The Museum of Transportation

Since the Museum of Transportation does not now employ a tray storage system, the staff inventoried their own collections and, based upon the same criteria, set as their storage area demands including aisles a total of 2,500 square feet.

3. Medium Objects Storage

Part of the Children's Museum medium objects storage occurs within this present tray storage system, (approximately 10 to 15%) and therefore will be removed when adequate provisions are made.

The Museum of Transportation has identified approximately 1,000 square feet for medium objects storage. The approximate total area required is then 5,000 square feet to accommodate these portions of the Museums' collections.

The space remaining above the five foot storage height of the small object storage module can house a portion of the medium size objects. Assuming a nine foot clear ceiling height and a double module storage bay of five feet by four feet, 5,500 square feet or 22,000 cubic feet of storage space is available for this use. However, at this point of the study, storage area demands for floor level storage have not been developed. In future work, these items will need to be inventoried and storage either developed at the bottom or top of the small artifact storage system, along the perimeter of the collections housing spaces, or in a specifically assigned separate area.

4. Large Objects Storage

The demand for storage of large objects is primarily for the vehicle collection of the Museum of Transportation. Presently, thirty-five cars are being stored in one 4,500 square foot bay of the Wharf Building. Ultimately, the number of vehicles that are to be stored as collections will probably be about 35 although the present storage density is too high. The Museum recommends that the vehicles should be stored at approximately half this density for use in collections; this would require approximately 9,000 square feet of space.

B. Growth and Change in Collections Storage Area

The impact of the increase in collections will in part be dictated by museum policy and their changing roles as community resources over time. It will also be dictated by the constraints of the building and site. A change in museum program development will probably change the emphasis of the collections both in terms of usage and accessibility.

A flexible building program must be developed to respond to change in how objects are used by the public and staff, and the degree of integration of object storage with exhibit and other related programs. The intensity of use of artifacts in program development has changed and increased substantially in the past five years. Also, the increased need to protect objects from abuse and theft, due to their scarcity and unique role in exhibit programs, has for the museums required greater staff and expenditures in terms of artifact conservation.

As an example, within the Children's Museum, the historical program development and growth of cultural collections, and in particular the Japanese, was reviewed in order to determine a pattern that may be applied to the building program development. The Japanese collections has doubled in its size in the past ten years due in part to the Children's Museum's unique ties with Boston's sister city of Kyoto. In addition, future plans call for similar cultural program development related to other nationalities within the next five years. Close use of these collections to supplement cultural exhibit programs will become more desirable; therefore, access to as well as protection of them must increase.

However, unlike cultural collections such as the Japanese collection, the use of certain portions of the collection, for example the Natural History Collections, has become less significant in the museums' program and, therefore, the requirements for access and program development are not as critical. In fact, certain collections may be de-emphasized to the point where remote storage within the building or at a completely different location might be warranted.

An additional possibility is a change in museum policy, where those collections that have been de-emphasized could be used to gain objects for program related cultural areas through an exchange with other museums.

The tools required in developing a strategy for the museums' changing use of collections consist of the storage component, the storage system unit, and the development of collections storage spaces. Therefore, the museums should be capable of expanding their collections storage capacity in each area by expansion a) within the storage component, b) within the storage housing system and, c) into new spaces of the building. Within the storage areas to be developed by the museums as described in this study, the collections components tray count is approximately 159 in excess of the necessary count. This excess will allow for both an initial level of unused storage compartments within the individual trays and unused trays within bays of the modular storage sytem. In addition, based upon the museums' future policy objectives for additional storage requirements, excess area will be provided within cultural storage spaces during the initial building construction, or additional space within the building will be upgraded for collections use at a future date.

To accommodate the requirements of the conservation criteria in spaces where future collections may be housed in the building, the museums will develop the Wharf to a level whereby changes in equipment and finishes will be all that is required to maintain the objects in storage. This will require the placement of an infra-structure of services and utilities to each museum building bay during the initial building renovation. Therefore, to change a typical museum bay into a collections storage facility will require 1) capping of the water sprinkling system and the installation of the Halon gas system, 2) installation of a finished ceiling and walls, 3) increase in security to the space with introduction of an automated access door system, 4) change in the flooring and lighting systems and, 5) additional environmental controls to the air treatment mechanical systems.