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DELIVERABLE D.T3.2.2

Handbook on best transnational rescue strategies – a digital, interactive version: The video game *CHRT: VItava Rising*

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1. Introduction

Work package WP T3 of the project ProteCHt2save deals with the development of appropriate preparedness strategies in order to strengthen the resilience of cultural heritage concerning threats caused by natural disasters, inter alia as the consequence of climate change. Deliverable D.T3.2.2 shall once again highlight the most important preparatory measures for the proper protection and recovery of cultural heritage in the case of a calamitous event and provide a practical and interactive approach regarding the development of preparedness strategies and rescue procedures as well as material handling.

Deliverable D.T3.2.2, as handbook on best transnational rescue strategies was developed as an interactive mobile training application for smartphones in the form of a video game in order to reach a broad audience and to raise awareness for the importance of preparing for a disastrous event. This paper will introduce the ProteCHt2save video game *CHRT: VItava Rising*, which was designed as educational game for cultural heritage responsible and interested persons. The game designer and developer Kimberly Himmer, retired Commander of the U.S. Navy, approached the project team and offered her services as expert on educational games, military and cultural heritage. She designed and developed a digital learning game for mobile devices in order to train cultural heritage personnel and emergency responders for the case of an emergency as well as to make the broad public aware of this topic. Based on a hypothetical scenario of a river flood in Prague the players learn how to organise and conduct the evacuation of cultural heritage objects exhibited in a fictional palace. Thus, the game will serve as a digital handbook on rescue procedures, taking all preparedness measures and strategies developed in ProteCHt2save into account.

2. Preparing for a calamitous event

Preparing for an emergency in the form of a calamitous event is mandatory in cultural heritage protection. Former deliverables of this work package have already dealt with this topic extensively and described the various preparatory measures in detail, especially D.T3.1.2 – Transnational strategies and implementation of existing plans in preparation to emergencies, D.T3.1.3 – Recommendations for rescuers in emergency phase for cultural heritage safeguard, and D.T3.2.1 – Guidelines for Cultural Heritage Rescue Teams (CHRT).

Disaster management aims at mitigating the impacts of calamitous events. Depending on how resilient a system is against a specific type of disaster, it will overcome it suffering more or less losses and harm. Its resilience is determined by different factors, which can take effect before, during or after the event. The so-called Disaster Management Cycle (Fig. 1) illustrates the different phases after and before a calamitous event resp. the phases between two consecutive events. In each phase, different actions can be taken which mitigate the impact of a past or a future disaster and lessons can be drawn from each phase to help prepare for the next disastrous event.

Fig. 1: Disaster Management Cycle.[1]

Immediately after a disastrous event the **response** phase starts. The relevant emergency responders are alerted; people's safety must be taken care of and guaranteed – human lives always come first – and measures to prevent further damage of cultural heritage need to be taken. Emergency responders and entities responsible for cultural heritage have to cooperate and closely work together in such crisis situations and this collaboration has to be practiced and trained in advance. During the **recovery** phase, the valuable cultural heritage needs to be identified. In the subsequent **development** phase, all events and actions as well as the lessons identified and learnt from the first two phases and the disaster event itself are documented. In the restoration of damaged structures, efforts should be taken to rebuild the system in a more resilient manner against future events. During the next phase - **mitigation** - the lessons learnt are implemented. All mitigation measures taken should be developed and conducted based on a sound risk analysis. Finally, during the last phase before another disastrous event, the **preparedness**

[1] http://aikya.info/aikyadevelopment/aikya/demos/demo_work/ksdma/page.php?id=141 (accessed 18.06.2020)

phase, various preparatory measures should be developed and anchored based on the findings of the preceding phases. Emergency evacuation plans for movable cultural heritage assets should be set up. Therefore, a close cooperation between cultural heritage experts and emergency responders is mandatory and joint trainings and exercises should be conducted in order to be able to easily and promptly retrieve the relevant information in the event of a disaster. During those trainings, the cultural heritage experts learn about the procedures and communication of the emergency personnel and the emergency responders learn about the adequate material handling.

In the fictional game scenario of *CHRT: VItava Rising* various preparatory measures and strategies have been set up at an earlier stage and can be easily applied by the Cultural Heritage Rescue Team (CHRT) at the beginning of the game (e.g. responsibilities in the event of disaster are clearly pre-defined, thus the members of the operation centre are instantly available on-site and fully aware of their scope of action and their responsibilities). However, other preventive applications are not available for the exhibition in question as it is a special exhibition. For example, no evacuation plans were prepared for this temporary exhibition, which is why the CHRT has to set them up ad-hoc.

At this point, the most important preparatory measures to strengthen the resilience of the cultural heritage and to mitigate the impact natural disasters can cause should be mentioned again. The first step in a proper preparation is a sound **risk assessment** that takes into account the incidents most likely to occur as well as the vulnerability of the cultural heritage in question. Therefore, so-called risk matrices (Fig. 2) are created enabling cultural heritage institutions and stakeholders to better assess the risks for the assets they are responsible for, caused by different types of disaster. On the horizontal axis, the impact on the cultural heritage in question is plotted reaching from "insignificant" to "severe" and on the vertical axis the likelihood of the occurrence of the different threats is plotted. Thus, after positioning the various calamities in accordance to (1) the impact they would have on the respective cultural heritage and (2) the likelihood that such an event occurs, a user can easily learn from the matrix, which threat is the more dangerous and which one is rather negligible.

Likelihood						
	Almost certain	Medium	High	High	Extreme	Extreme
	Likely	Medium	Medium	High	Extreme	Extreme
	Possible	Medium	Medium	High	High	Extreme
	Unlikely	Low	Medium	Medium	High	High
	Rare	Low	Low	Medium	High	High
		Insignificant	Minor	Moderate	Major	Severe
		Impact				

Fig. 2: Risk matrix.

Further, it is important that the **internal responsibilities** are clarified in advance to a disaster event and that everyone knows about the internal hierarchy that applies during an emergency. On the cultural heritage side in must be clear from the moment disaster strikes who is responsible for dealing with the emergency and who is allowed to take decisions.

Based on a proper risk assessment and the identification of the internally responsible emergency coordinator, an **emergency plan** has to be set up before the occurrence of a disaster. First, it has to

state the basic data of the institution (e.g. address, telephone numbers of the director and emergency coordinator) and indicate the assignment of authorities during a disaster event. It has to explain the situation to which it applies the internal chain of alert and the contact details of external personnel, experts, emergency responders etc. It is imperative that the data is regularly maintained and updated. It needs to be underlined that an emergency plan for cultural heritage is always based on three principles, which are:

1. Human lives come first.
2. Do not move cultural heritage unless compelling and only if the objects are safer at the new location.
3. Take care of your own safety when recovering cultural heritage.

During an emergency, it is likely that not every item displayed or stored in a cultural institution can be recovered. Therefore, a **prioritisation** has to be set in advance depending on the academic, art or historic value of the assets as well as on the (technical) possibility of recovering them during a calamitous event.

With regard to an evacuation of movable heritage items, a very substantial component of an emergency plan are prepared **route cards** (Fig. 3). They should be printed on DIN A3 paper and laminated in order to make them easily readable for the emergency personnel wearing helmets, easy to handle and robust. Route cards contain necessary information for the evacuating emergency personnel, most likely firefighters or civil protection, helping them to orient themselves in the building. The cards have to indicate the location of the room in question, the location of the relevant object within the room and information on how best to reach it. Photographs of the object showing and highlighting it at its installation site should be added to make it easily recognisable. Further technical details, such as weight, size, how many people are needed to move it, how it should be moved, tools necessary for removing it etc., should also be indicated. In case the item is not movable, the route card could indicate information on how to protect it best.

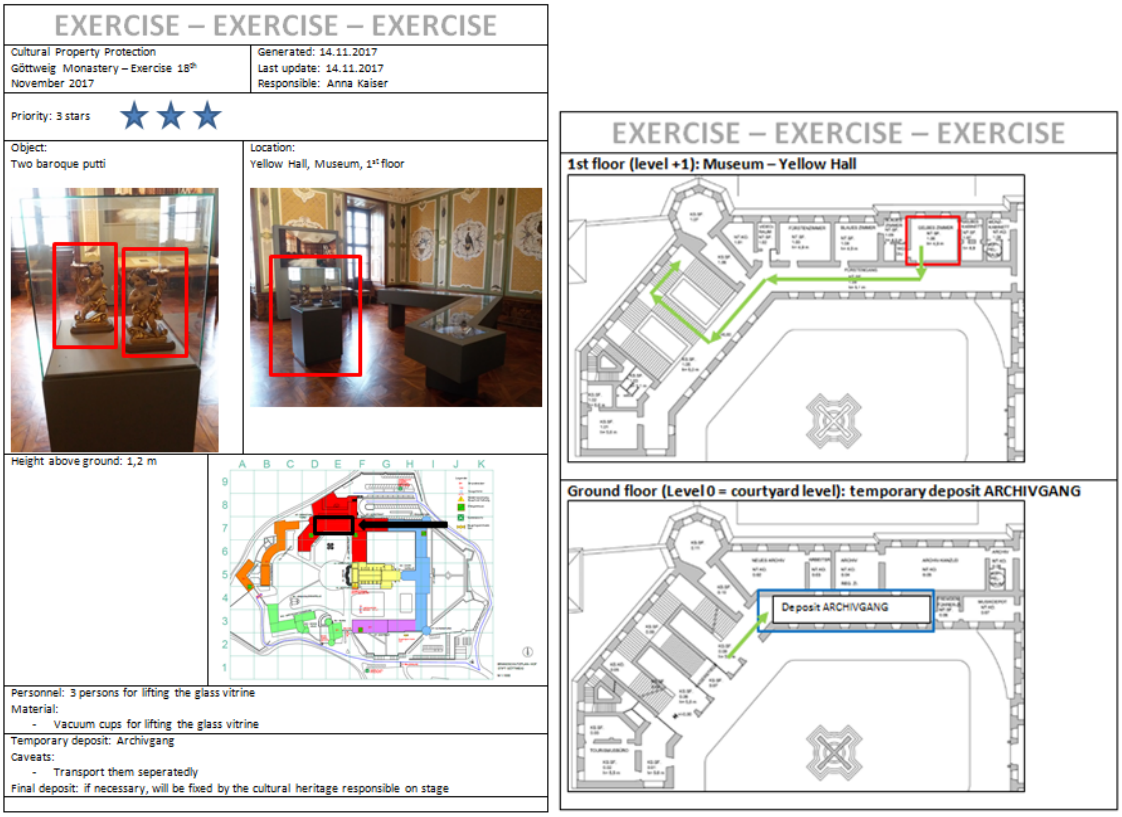

Fig. 3: Example of a route card, front and reverse side (© Kaiser 2018).

Depending on the material type of the cultural assets in question, different **packing and protection material** will be required for transportation, packaging or protecting it on-site. Restorers and curators should contribute their expertise on proper material handling on this and the required material should be stored in selected, marked areas which are easily accessible during a disastrous event and known to internal and external first responders. Further, temporary safe storage sites should be available in order to use it as interim storage room for the evacuated items.

ProteCHt2save inter alia aimed at establishing so-called **Cultural Heritage Rescue Teams (CHRT)** in the partner countries, which are intended to support the cultural heritage responsible stakeholders in the event of a disaster. The installation and preparatory training of such units can therefore be seen as another preparedness measure. Depending on the particular national conditions, the CHRTs can be implemented on national, regional or even local level. They have to be provided with the necessary authority to assist in the case of an emergency and the insurance of their team members must me ensured. The central task of CHRTs is to provide first aid for cultural heritage in the case of an emergency. They offer prompt response for the protection and recovery of movable and immovable cultural heritage during and shortly after the event of a disaster, be it natural or fabricated. They are interlinking the heritage side and emergency responder side and are able to deal and operate with both of them. In their structure, CHRTs consist of a leader, a deputy and a team of experts (e.g. on logistics, conservation and material handling, art history and inventory, structural engineering and informatics resp. data), depending on the particular situation and requirements in the relevant area. CHRTs should be able to handle security issues; they should have capabilities in management, coordination and logistics and they should be able to properly document, to decide, plan and lead as well as to teach and train. They should have the capacities to assess crises and their impact on the cultural heritage in question. Further, they should have adequate knowledge on appropriate material handling and should be able to take decisions as well as to develop action plans.

It is crucial that all the above-mentioned measures, plans and strategies are jointly developed and set-up in advance to a calamitous event, so that the cultural personnel as well as the emergency responders are best prepared for future disasters. They have to practice and train together in order to get familiar with the procedures and communication of the other side, to learn to cooperate in a stressful environment and to overcome possibly existing obstacles already before an emergency.

3. Digital Game-based Learning (DGML): A Game as a Tool for Knowledge Transfer and Education

Already since the 1990ies, digital games have been used for the dissemination of knowledge. Gradually, this approach became more and more established and today digital games are increasingly used in higher, vocational and adult education and are considered as an appropriate instrument for knowledge transfer. In the literature various terms related to DGBL can be found. Besides Game-Based Learning, terms such as Serious Games and Educational Games are used almost synonymously. Despite minor distinctions, what all of them have in common is that they describe the use of games with serious intentions in connection with education.

There are various types of games (action games, adventure games, role games, strategy games, etc.) which differ primarily in dynamics, structure and action request. Very often, a game can show elements of more than one genre. According to Christoph Klimmt, Professor of Communication Science at the Department of Journalism and Communication Research of the Hanover University of Music, Drama and Media, there are three main elements, which are primarily responsible for the entertainment caused by a game, namely a) self-effectiveness experiences, b) thrill and c) simulated life and role experiences (Klimmt 2008). The player experiences self-effectiveness when he/she can see a direct reaction of the game to an activity he/she has taken and realise his/her direct influence to the gameplay and the happening. The thrill, created by the need for action and the emotional involvement of the player, as well as the simulated life and role experiences that enable an immersion into the story outline also contribute to the entertainment during the game.

Assigning an active role to the learners, resp. players, makes the decisive factor of a successful (educational) game. The knowledge gained through the course of play can be immediately tested in a secure, virtual environment and the learners can directly experience the consequences of their decisions and actions. Thus, activatable knowledge is being generated which can be ad-hoc adopted, in contrast to inert knowledge which is theoretically available but cannot be applied effectively.

In an educational game, knowledge transfer follows the game cycle (Garris et al. 2002; Kerres et al. 2009). This consists of three stages: a) a certain gaming behaviour and the actions of the player, b) the subsequent feedback of the programme and c) the player's reaction to this feedback. The player evaluates the programme's feedback and adjusts his/her gaming behaviour. All of this happens based on the principle of trial and error, which is essential for the learning success. Depending on the outcome and the preparation of the feedback, it can influence the player's interest, ambition or pleasure. Therefore, the feedback is the critical key element for the effectiveness of an educational game. First, it has to be constructive, informative and motivating; and second, it is essential that there is a balance between challenge and sense of achievement (Le et al. 2011).

4. The ProteCHt2save Video Game *CHRT: VItava Rising*

4.1. General Information on the Game

CHRT: VItava Rising is a mobile game that takes place in a museum, fictionally based on the Béla Palace, near the banks of the VItava River in Prague. Prague is predicted to be inundated with a major flooding event in the next 72 hours. The player will control a team of cultural heritage experts as members of a CHRT and will be responsible for coordinating the team's activities with members of an Emergency Operations Centre (EOC). This will include representatives from the City of Prague, the Ministry of Culture, the Civil Defence, firefighters, police, a media liaison officer (PAO), and meteorological experts. In the further course of the game, the player will have to take the necessary security measures at Béla Palace and handle the evacuation of the special exhibition, which is displayed within its premises.

4.2. Style and Music

The game has a contemporary art nouveau style, in homage to the Czech artist Alphonse Mucha who worked as illustrator, painter and photographer in the late 19th and early 20th century. User Interfaces, buttons, text screens, and images of characters are in this style. The faces and character images are kept in bolder colours and hint at the character's expertise; e.g., the fire chief in the EOC (Fig. 4) has art that alludes to his profession (flames, equipment, etc.). Some of the fonts are also Mucha inspired.

Fig. 4: EOC Director and Fire Chief (© CHRT: VItava Rising 2020).

The overarching musical score to accompany the game is *The Moldau*, composed by Bedřich Smetana in 1874 and premiered in Prague one year later. Other sound effects created align with the tonal elements in *The Moldau*, thus including elements of immaterial heritage into the video game.

4.3. Genre

The main game mechanic follows a turn-based strategy (TBS) with elements of a role-playing game (RPG). In turn-based strategy games, the player has access to a number of units, and those units have

unique characteristics. Chess is an example of a TBS game; Pawns have different movement and attack characteristics than Knights. There are a variety of ways in which the player can employ those game pieces in order to achieve a win-state. Similarly, in *CHRT: VItava Rising* each CHRT member also has different strengths and expertise: how far he or she can travel; how many things he or she can carry at one time; stamina (health); and specific conservator experience. Since there are several ways that the player can employ those team members, there is also different ways in which the player can achieve a win-state.

In *CHRT: VItava Rising* the player is tasked to move team members around the EOC and museum in order to gather necessary information, assess the situation, prioritise cultural heritage objects for removal, and properly package those objects to be moved to safer locations. By clicking on the items or persons visible, the player gains more insight and further information on the different objects and materials, handbooks, roles and responsibilities, etc. This way he or she has the possibility to learn even more background details on the cultural heritage assets and the elements **of the rescue procedure.**

4.4. Narrative Introduction

The player has been called to Prague to lead the Interreg Central Europe Cultural Heritage Rescue Team (CHRT) to specifically prepare the building and surrounding area of the (fictional) Baroque Béla Palace, which is located on the bank of the VItava River, and to assist in the evacuation of objects in a special exhibit which are currently on display in the palace. The complex includes fresco-filled rooms, baroque furniture, and regularly displays paintings from the City Gallery. Professional predictions for the Central European region forecast that the city of Prague will encounter a fluvial flooding event in approximately 72 hours because of sustained, heavy rainfall throughout southeastern Bavaria, Lower Austria and the southern Czech Republic. The VItava River is expected to overflow its banks, and there is question if current flood barriers and other protective measures will be able to sustain the floods. The team will have up to 72 hours to assist in taking preventive measures for the building and removing items before the flood.

4.5. Outline and Learning Objectives

4.5.1. Level 1 – Gaining Situational Awareness and the Permission to Enter

Level 1 is set at the EOC in Prague. The player is supposed to learn how to assess a hazardous situation, how to organise an evacuation of cultural heritage objects, which legal and organisational issues have to be clarified in advance and which preparations have to be taken for such an operation. The overall constraint is the time. The player will learn in level one that he or she has only 72 hours before the VItava River will swell to a level that will require the team to stop their recovery operation and be evacuated. Each action will mimic a certain period, thus, the player has to take his or her actions as efficiently as possible.

In level one, the overarching goal for the player is to gain authorisation to enter Béla Palace. For this, he or she in the role of the CHRT leader must receive confirmation on six central key points:

1. The threat on the institution is real.
2. The current measures in place are not sufficient to protect the cultural heritage.

3. A safer place for storage is available.
4. The work force and resources for safeguarding and evacuating the cultural heritage objects are available.
5. The formal authorisation to evacuate the cultural heritage objects is available.
6. There is no threat to the personnel's safety and security.

To clarify these six issues the player can communicate to the various people and entities at the EOC and gather the necessary information and reports. Those, in turn, have to be presented to the respective decision makers who will declare that the conditions 1-6 are fulfilled. By clicking on the different characters and items in the EOC, the player gets further information on preventive measures in order to mitigate the impact of a flood.

The people and entities collaborating within the EOC are the mayor, a media liaison officer, the Ministry of Culture, a curator, the Civil Defence, the Fire Department and Police, a meteorologist and a civic organiser. The mayor who has the overall responsibility for the city and its residents is authorised for taking decisions and has the ability to set priorities. He is in close contact with the EOC Director who in the game scenario is Prague's Fire Chief at the same time. The media liaison officer handles public relations and provides the civilians with information on the current situation. The Ministry of Culture has to decide whether the threat to the special exhibition is real. To assess the hazardous situation accordingly, it needs reports from the respective experts and further has to gain authorisation from international (non-Czech) entities to remove, handle and store objects of other nations, which have been loaned for the special exhibition. The curator has information on the inventory and the building of the fictional Béla Palace. The Civil Defence, responsible for safety and security, and the Fire Department, responsible for the safety of the citizens and rescues, can organise work force and transportation for the rescue and evacuation of the cultural heritage objects. The Police, also responsible for safety and security, will escort the evacuation vehicles and is supposed to prevent looting. The meteorology experts provide the decision makers with accurate weather and flooding predictions and the civic organiser is in close liaison with the citizens, support groups, churches, etc. and therefore can organise additional manpower and gets on-site information from different parts of the city.

4.5.2. Level 2 – Mitigation Actions On-Site and Creation of an Emergency Inventory

Level 2 is set at the premises of Béla Palace. In this level, the player is intended to train the appropriate assessment of the flooding threat and to learn about the tasks of a structural engineer during the evacuation of an endangered building. Further, the player has to determine where the water might ingress, take mitigating actions to forestall the ingress and complete an emergency inventory of the objects.

In this level, the player has various experts of a CHRT at his / her disposal, which in the game scenario consists a structural engineer, an inventory manager, and experts on data and informatics, material handling and logistics. Further members of a CHRT would be a team leader and a liaison officer as deputy. The player can control the different characters alternately and let them fulfil their tasks in a certain sequence. The different experts possess necessary skills. The structural engineer has expertise on the restoration of immovable heritage and can take certain steps to mitigate the damage to

immovable buildings and objects during a crisis event. The expert on material handling is a professionally trained conservator and knows how to package properly the objects for transport. The expert on data and informatics is responsible for ensuring proper records regarding the location, packing, storing and movement of the objects. This team member closely cooperates with the inventory manager who creates and maintains the evacuation inventory and has to keep track of the relocated objects and the temporary storage site. This has to be a safe location within the building for staging the objects before they are removed or also a location which is unaffected by the upcoming flood (e.g. room in an upper floor) for storing them safely on-site. The expert on logistics is trained in the proper methods to transport cultural heritage objects and can obtain materials the team might need for fulfilling their tasks.

The objectives of this level are:

1. To identify the structural elements that need reinforcement and to take appropriate measures.
2. To identify if there is an appropriate kit available to evacuate safely each object.
3. To identify an appropriate space to temporarily store the objects on-site before transport.
4. To take inventory of each object to be evacuated.

By working on these bullet points, the player learns how to assess the flooding threat and how a fluvial flood can affect a building and its contents. He or she learns about the importance of a structural engineer to a CHRT and how to determine where floodwaters can enter a building. Level 2 therefore conveys the best strategies to mitigate fluvial flooding and the employment of those strategies, which are:

- Flooding the basement with fresh water to counter hydrostatic pressure from outside the building.
- Shuttering the doors and windows, possibly using sandbags to reinforce them.
- Reinforcement of floor structures from uplift forces of the water.
- Closing and tightening all openings in the sewer system in order to reduce the pollution in the water.
- Removing the interior doors in cases of expected full flooding in order to prevent them from floating away and damage or block other objects.
- Assessment of the stone masonry and installations of supporting structures if needed.
- Assessment of the timbers supporting the ceiling and installations of supporting structures if needed.
- Walls perpendicular to the flow of the water should have relief holes drilled to allow pressure of water to equalise.

Finally, the player learns in level two how to create an emergency inventory and what information is important for conservators and curators. The inventory manager has to indicate the type of the object, its material, dimensions and weight as well as its original and new location.

4.5.3. Level 3 – Documenting, Packing and Moving of the Cultural Heritage Objects

Level 3 is also set in the premises of Béla Palace. In this last level, the player with his or her CHRT must package and stage as many objects as possible from the emergency inventory before the mandatory evacuation order is received. For this, a temporary storage room has been designated in level two where the objects are collected ready to be evacuated. The objectives, which have to be achieved in level, three are:

1. To package all objects properly.
2. To maintain the inventory and accountability for all objects in the storage.
3. To transport the packaged objects to the storage room.

In this last level, the player learns the correct handling and packaging of different materials in order to prepare properly the objects for transport (Tandon 2018, 57-66). Info boards in the lower floor give instructions on the appropriate treatment and the required packaging material.

Bone and **ivory** objects can be very brittle, and therefore must be handled carefully. The packaging materials needed are:

- acid free tissue paper to wrap the object and fill the box,
- a polyethylene foam sheet,
- a reusable plastic bag with small holes pricked on one side,
- an acid free cardboard box.

Ceramics and **glass** are very fragile. The must not be lifted by their handles but from their sturdiest part or their base. The packaging materials needed are:

- acid free tissue paper to wrap the object and fill the boxes,
- an acid free cardboard box,
- an additional, larger acid free cardboard box in which to pack the first.

While **stone** can appear robust, it can be easily chipped or broken. The packaging materials needed are:

- acid free paper to wrap the object and fill the space around it in the box,
- polyethylene foam padding,
- an acid free cardboard box.

Small stone artefacts are to be packaged in the same way ceramics and glass are.

(Leather) Books need to be packed standing on their bottom edge (foot) or packed flat, and wrapped in rag paper. The packaging materials needed are:

- rag paper,
- acid free tissue paper,
- an acid free cardboard box.

Metal objects need to be wrapped in Pacific Silvercloth to prevent corrosion. The packaging materials needed are:

- Pacific Silvercloth,
- plastic wrap,
- desiccant,
- padding,
- an acid free cardboard box.

When packaging **paintings**, the CHRT members must ensure that the packaging material is not exposed to the painted surface. The materials needed are:

- a large sheet of acid free cardboard, slightly larger than the frame,
- bubble wrap,
- an acid free cardboard box.

Loose paper/parchment must be kept on a flat backing surface. The packaging materials needed are:

- a large sheet of acid free cardboard, slightly larger than the document,
- acid free paper,
- an acid free cardboard box.

Textiles must be rolled, with decorative or piled side facing outward. The packaging materials needed are:

- a rolling tube,
- acid free tissue paper as interleaf,
- plastic wrap to protect the rolled object.

Wooden objects must have protective wrap shock and vibration protection, and an outer shell. The packaging materials needed are:

- plastic wrap,
- polyethylene foam padding,
- an acid free cardboard box.

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