Estonian Academy of Art
Department of Conservation and Cultural Heritage

THE TEXTILE ENVIRONMENTAL CONDITIONS AND THE RESOURCE NEEDS OF BUILDING UP SHARED STORAGE FACILITIES FOR MUSEUM COLLECTIONS

Master's Thesis

By

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MÄRKUSED

I hereby declare that I have written this Master's Thesis independently. References have been indicated for the publications, claims, options and different sources from other authors.

…..... …...../T. Kormpaki/

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Introduction

The aim of museums is to collect, care for and preserve cultural heritage. All of their collections usually increase continuously. In order that the objects be successfully maintained, it is vital to follow the necessary procedures. The conservation process includes not only treatment of the object but also its preservation. This Master's thesis deals with the management, maintenance, condition and preservation of the textile collections of Estonian museums' depository facilities and the providing of information for a shared depository facility. To support the practical section, a group of museums was selected where the survey was carried out. The proper functioning of a depository facility requires measurements that the museum should undertake, as well as the organisation of items. Every condition detail should be taken into consideration in order to ensure the correct maintenance of items. Accordingly, such key function elements as item condition assessments, mapping, labelling, buildings' situations, environmental conditions, equipment and methods of storage are subjects that are presented, based on specific references, and which afterwards are possibly implemented at four Estonian depositories.

The thesis is separated into two sections, theoretical and practical. Because materials and methods of manufacture are important aspects of preservation, the theoretical section gives an overview of the preservation knowledge of textiles, the materials and dyes that exist in Estonia and a historical overview of Estonian textiles. A description of the technology of textiles is presented, so as to describe their structure and the problems museums may face during preservation.

The third chapter of the Master's thesis provides information about the main elements for ideal storage conditions and the functions of depository facility needs. The main storage steps are the mapping of textile collections and continuous condition assessment. The mapping of collections provides the actions which should be taken into account to organise a collection and the condition

assessment presents the specific needs that should be considered in order to develop and stabilise the collections. The general storage procedures deal with the environmental conditions, the physical standards and the protection that textile items should have. The storage facilities and the method of storage are parts of preservation that have to be planned carefully by experts. Finally, the Master's thesis presents the purpose and importance of the labelling system that museums can use. This knowledge aspect is the basis of the practical section in order to compare, observe and emphasise the conditions of Estonian depository facilities.

The practical section consists of observation work, communication with museum collection managers, research in four Estonian museums' depositories (the Estonian Open Air Museum, Estonian History Museum, Tallinn City Museum and Museum of Harju County), as well as the selection of items to evaluate current conditions and photos taken during the visit. The information that is collected is about the mapping of the textiles collections' sizes, the description of museum measurements of environmental conditions, the method of labelling and the condition of items. Practical work was undertaken through the use of a report that was created in order to collect all the necessary information (Appendix 1, 2). The condition assessment was created as a case study that consists of the possible damages that may be found in textile objects. The survey reports were based on the best practices used in several museums, (e.g. the Victoria and Albert Museum) and case studies and surveys were customised and adapted for use in Estonian museums' collections. Analyses were conducted of the records, providing an opportunity to compare the actual organisation of preservation with system needs.

In the last chapters, suggestions are introduced that can improve Estonian depository facilities' conditions, based on the theoretical framework. Then there is a summary of the Master's thesis, after comparing and analysing the information that was collected, as well as references. The appendices follow.

The purpose of this Master's thesis is to provide a theoretical framework for Estonian shared storage facilities, focusing especially on textile items, which can be applied in practice, and the creation of better depository facility conditions. Incorrect procedures can lead to irreversible damage to items or whole collections.

Textiles are sensitive materials and their housing should be carefully considered, as inappropriate storage can cause huge damage to important cultural heritage material.

1 General characteristics of textiles

This chapter concerns the characteristics of textile objects, the types of textiles and the dyes that have been used, focusing on the use of textiles that are found in Estonia.

The knowledge of fibres' technology clarifies the physical characteristics of textile fibres and types of damage that can occur. Most textile deterioration is due to mechanical, chemical and photochemical factors during their use.

1.1 Technology of textiles

Textiles have been widely used since prehistoric times. The original word "textile" refers to a woven fabric and the processes involved in weaving. Over the centuries, the term has taken on broader connotations, including: (1) staple filaments and fibres for use in yarns or the preparation of woven, knitted, tufted or non-woven fabrics, (2) yarns made from natural or man-made fibres, (3) fabrics and other products made from fibres or from yarns, and (4) apparel or other articles fabricated from the above which retain the flexibility and drape of the original fabrics[1]. So nowadays the term “textile” refers to a flexible woven material, constructed of natural or man-made fibres, that is formed by weaving, knitting, knotting, crocheting and pressing fibres together.

A fibre is defined as a unit of matter with a length at least a hundred times its diameter, and a structure of long chain molecules having a definite preferred orientation, a diameter of 10–200 microns, and flexibility[2]. Textile fibres are separated into natural and man-made fibres (Table 1).

1 Howard L. Needles, *Textile Fibers, Dyes, Finishes and Processes. A Concise Guide*, (USA: Noyes Publications, 1986), 1.

2 Sheila Landi, *The textile conservator's manual,* (Oxford: Butterwoth – Heinemann, 1998), 8.

Table 1: Type of fibres

Natural fibres			Man-made fibres	
Plant	**Animal**	**Mineral**	**Natural Polymers**	**Synthetic Polymers**
cotton	wool	asbestos	viscose	nylon
flax	silk		glass	acrylic
hemp			cupro	vinyl

Natural fibres are produced by plants, animals and mineral sources, and do not require fibre formation or re-formation. Plant fibres are generally composed mainly of cellulose (Figure 1): examples include cotton, jute, flax, ramie, sisal and hemp. The most used plant fibres are cotton, flax and hemp, although sisal, jute, kenaf, bamboo and coconut are also widely used. Animal fibres generally contain proteins, such as collagen and keratin; examples include silk, sinew, wool, catgut, angora, mohair and alpaca. The only naturally occurring long mineral fibre is asbestos.

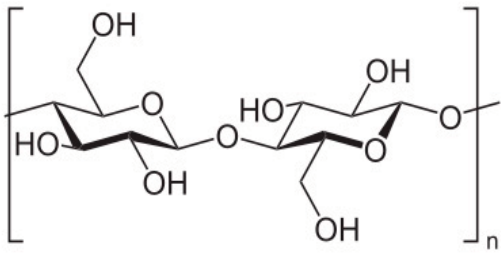

Figure 1: Cellulose[3]

Man-made fibres are either basic chemical units which have been formed by chemical synthesis, followed by fibre formation, or polymers from natural sources, which have been dissolved and regenerated after passage through a spinneret to form fibres. Those fibres made by chemical synthesis are often called synthetic fibres, while fibres regenerated from natural polymer sources are called regenerated fibres or natural polymer fibres.

3 Wikipedia, *Cellulose*, http://en.wikipedia.org/wiki/Cellulose, 3 Dec.2011.

The synthetic man-made fibres include polyamid (nylon), polyester, acrylic, polyolefin, vinyl and elastomeric fibre, while the regenerated fibres include rayon, cellulose acetates, regenerated proteins, glass and rubber fibres. The man-made fibres started to appear in the first half of the 20th century.

As plant fibres, cotton and linen/flax can be found in museum collections (Figure 2&3). Cotton and flax fibres consist of polymer cellulose built up from cellobiose units. Cellobiose is composed of two glucose units linked by a 1, 4-β linkage. The number of repeating units in cellulosic fibres can vary from less than 1000 to as many as 18,000, depending on the fibre source.

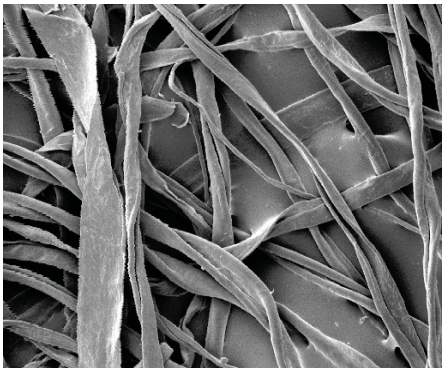

Figure 2: Electron microscopic observation of cotton fibres[4].

Figure 3: Microscopic observation of a flax fibre[5].

Cellulose is characterised by the fact that it wrinkles easily because of its poor elasticity and resilience, although it has resistance to alkaline solutions, and insects do not eat it. It can be digested if it is in combination with animal yarn. Threats to cellulose include sensitivity to acids, fungi and mildew, yellowing and a gradual loss of strength (due to humidity and natural light).

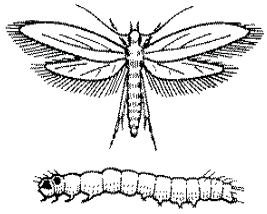

Figure 4: The cloth moth.

Animal threads (wool and silk) contain protein and are composed of high molecular weight polypeptide chains of amino acids. As protein fibres, they have excellent moisture absorbency and are elastic. They are resistant to acidic solutions but,

4 Wikipedia, Cotton, http://upload.wikimedia.org/wikipedia/commons/7/76/C21a.jpg, 10.Nov. 2011.
5 Flax, http://media.npr.org/assets/news/2009/09/10/threads/thread2.jpg?t=1252616044&s=2, 9.Nov. 2011.

compared with plant threads, animal threads are sensitive to alkaline and oxidation agents, such as chlorine bleaches. Insects that attack these fibres are the clothes moth (Figure 4)[6] and carpet beetle (Figure 5). Animal and plant threads are sensitive to natural light and heat.

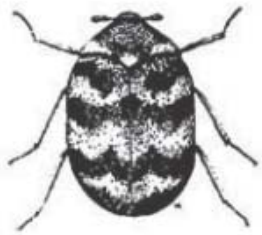

Figure 5: Carpet beetle.

The molecular arrangement and natural crimp of wool is responsible for its great elasticity[7], which is lost over time. The main wool damages are the result of agitation and abrasion in combination with heat and moisture. This can cause felting to the item, although it is not irreversible. Silk's benefit is its strength when is not dyed. It is constructed of protein *fibroin*, which contains a high degree of molecular orientation. When silk is dyed, it can easily be stained, and its ability to absorb materials is one of the main reasons for silk's deterioration.

Textiles in museums are definitely some of the most sensitive objects. Textile damage can be mechanical, chemical, physical and biological. Mechanical damage to textiles is extremely common. Mechanical damage includes tears, holes, deformation of material, splits, inappropriate earlier repairs and insect damage. Of the physical types of damage, the most serious is light damage. Textiles are amongst the most light-sensitive of all objects in museum collections, similar to parchments, photo and paper-based items. Light damage occurs progressively. The items lose flexibility and connectivity and become weak and brittle. This process can be accompanied by general yellowing or browning of textiles, which is usually an indicator of their poor state.

Textiles, especially those made from natural fibres, absorb water easily.

6 UC IPM Online, *Clothes moths*, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7435.html , 8 Dec.2011.

7 Sarah Wolf Green, *Managing Textile Collections,* 2007 http://www.ideals.illinois.edu/bitstream/handle/2142/580/Green_Managing.pdf?sequence=2, 25 April, 2011.

Fibres swell and become longer and, as they dry, they shrink and become shorter. The changes depend on the type of fibre. Repeated expansion and contraction of textile fibres causes internal friction in fibres and fabrics, and so causes damage.

Chemical damage may be due to both the chemical composition of the fibres themselves and a variety of chemical compounds that come into contact with the fibres. Biological damage is caused mostly by mould and insects.

1.2 The typical textiles in Estonia

In Estonia, there is a long tradition of using textile items - from clothing to home textiles. The creation of textiles was always the work of women. Until the beginning of the 20th century, most textiles were hand-made and the threads were natural. After 1920, industrial-made threads appeared.

Archaeological finds reveal that the first clothes in the area of Estonia were mentioned from the 11th-13th centuries[8]. The periods of Estonian textiles can be separated into:

- up through the 18th century
- 19th century
- 20th century

Up through the 18th century, there were mostly national costumes and handmade textiles for every occasion of Estonian life. The term “folk costume” refers to the clothes which were worn by peasants in the feudal period. The costumes improved according to the economy and the development of technical skills (Figure 6). Estonian folk costumes were influenced by neighbouring costumes and by the fashions of the higher classes[9]. More specifically, in the 17th century, elements of central European and Scandinavian fashion were adopted by Estonians[10].

Generally, the most common type of traditional clothing for women and girls was the woollen wrap-skirt and linen shirt, and for men woollen trousers and linen

8 *Estonica, Encyclopedia about Estonia,*2009, "Folk costumes." , http://www.estonica.org/eng/lugu.html?menyy_id=100&kateg=41&alam=55&leht=9 ,18 May, 2010.

9 Melanie Kaarma, Mari Sumera and Aino Voolma, *Eesti rahvarõivad*, (Tallinn: Eesti Raamat,, 1981), 21.

10 Ibid, 22.

shirts, which survived until the 19th century. The folk costumes contained different parts and the style depended on the geographical region. The typical folk costume had several parts: shirts, skirts, trousers, aprons, belts, bodices, bonnets and of course accessories[11].

At the end of the 19th century (the tsarist period), peasants' clothes inspired by Danish, Swedish and Russian nobility clothes started to appear. Some elements of these clothes were adopted in the traditional costumes.

Figure 6: Estonian folk costumes from different regions.

The types of changes depended on the region. There are four main regions: South Estonia, West Estonia, North Estonia and the islands (Figure 7&8). However, inside the regions, there were also differences within different areas[12].

The textiles can be divided into those used in everyday life and those used on special occasions. Generally, the flat and two-dimensional items that can be

11 Kaarma, Sumera and Voolma, 74-79.
12 Ibid, 21.

found are home textiles (carpets, blankets, tapestries, towels, bedsheets etc.), church textiles, and various other textile objects produced over the years.

Figure 7: Stamp which shows folk costume from Seto.

Figure 8: Stamp which shows folk costume from Ruhnu island.

1.2.1 Textile fibres in Estonia

The main materials that were used until the beginning of the 20th century were wool, linen, nettle and silk. Cotton was used mostly at the end of the 19th century for city clothes.

Man-made threads started to be used at the beginning of the 20th century. In general, the most widely used man-made fibres found in Estonian clothes are viscose, artificial silk/rayon, nylon or atlas, synthetic leather, polyester, poly-amid and acrylic. The last three fibres can be found mostly in clothes made since 1970.

Figure 9: Hat decorated with different materials (fake stones, threads, lace and sequins).

A wide variety of materials have been used for the decoration of textiles over time (Figure 9). The most common are ceramic/glass/plastic pearls, metallic

threads, fake/original stones, sequins, buttons, paper, handmade/industrial laces etc.

1.2.2 Dyes

Textile dyes are separated into natural and industrial dyes. Industrial dyes were first produced in the 19th century. In Estonia the dyes that were used until the second half of the 19th century were natural. The oldest dyed cloth that has been found in Estonia dates from the 14th century.

Table 2: Natural dyes that have been used in Estonia.

Colour	**Estonian natural dyes**	**Imported natural dyes**
Red	•*Galium borale* (värvmadar), •black currant (mustsõstar), •*Aronia melanocarpa* (must aroonia), •birch bark (kasekoorepunane), •*Origanum vulgare* (harilik pune)	•*Kermes*, •*Coccus lacca*, •*Rubia tinetorum*
Brown	•*Tanacetum vulgare* (Soolikarohi), •Salix sp- (paju), •*Picea abies* (harilik kuusk) •*Allium cepa* (harilik sibul	•*Acacia catechu* (beetelakaatsia) •*Uncaria gambir* (gambiir)
Yellow	•*Primula veris* (nurmenukk) •*Salix sp* (paju) •Birch leaves (kasepuu lehti)	•*Curcuma longa* (kollajuur) •*Bixa orellana* •*Crocus sativus* (safranikrookus)
Blue	•*Centaurea cyanus* (rukkilill) •*Urtica dioica* (kõrvenõges)[13]	•*Indigo* •*Igatis tinctora* (sinerõigas) •*Haematoxylum campechianum* (kampesipuu)
Black	•*Alnus incana* (hall lepp) •*Allium cepa* (harilik sibul)[14] •*Hypericum maculatum* (kandiline naistepuna)[15]	•*Acacia catechu* (beetelakaatsia) •*Uncaria gambir* (gambiir)
Green [16]	•*Calluna vulgaris* (kanarbik) •*Alchemilla sp.* (kortsleht)	•*Rhamnus chlorophus*

13 It gives blue-grey colour at the cotton and linen threads.
14 It gives black colour to the woollen threads.
15 It gives black colour to woollen and silk threads with iron sulphate mordant.
16 Green colour with natural dyes usually is given to cotton and linen.

Natural colours in Estonia were produced from tree bark, plants, flowers and berries (Table 2). However, some were imported, such as *indigo*. The basic colours used for Estonian textiles were white, black, yellow, green, brown and red. It was usually difficult for natural colours to be adsorbed by the threads, so for that reason mordants were used. Mordants are also responsible for the different colour tones and intensities that a dye can give in combination with the type of threads. The mordants that were used in Estonia are presented in Table 3[17].

Table 3: Mordants used in Estonia.

Mordants	
Sauerkraut juice	Blue vitriol/Copper sulphate ($CuSO_4.5H_2O$)
Cranberry juice	Alum stone/Potassium alum ($KAl(SO_{4.})_2.12H_2O$
Sour Kali	Iron sulphate ($Fe_2SO_4.7H_2O$)
Rhubarb water	Tartaric acid ($C_4H_6O_6$)
Tannin	Sodium Chloride (NaCl)

Industrial dyes produce brighter and more intense colours, and this is easily recognisable from the change in colours when industrial colours started to be used in the dying of traditional costumes. The main industrial dyes that have been used and some of their characteristics are given in Table 4.

17 Eve Järvoja, *Taimedega Värvimine*, Renovatum Anno (1991).

Table 4: Industrial dyes.

Industrial dyes	**Textile substrate**	**Characteristics**
Basic/Cationic	Wool, silk, acrylic, jute	•first industrial dyes; •sold as Sodium Chloride (NaCl); •intense colours; •non-resistance to light.
Acid	Wool, silk, nylon	•Sodium nitrate ($NaNO_2$); •water soluble anions.
Direct	Cotton, viscose, linen, jute, nylon	•Water soluble anionic dyes; •affinity with cellulose fibres; •difficulty in cleaving; •2/3 of the dyes stay in the solution after the process[18].
Vat	Cotton, rayon, wool	•Water-insoluble dyes; •reduction in an alkaline bath, then exhausted on fibre and re-oxidised[19].
Sulphur	Cotton, rayon, and their combination	•By applying an alkaline reducing bath with sodium sulphide as the reducing agent; •oxidation with oxygen.

18 Tatiana Kousoulou. *Notes for the lesson Conservation of textiles,* (Athens: Technological and Educational Instituete of Athens,2003), 21.

19 Klaus Hunger, *Industrial Dyes-Chemistry,Properties,Applications, (*Germany: John Wiley and Sons, 2003), 4,5.

2 Textile preservation

Textile preservation refers to the processes by which textiles are cared for and maintained to avoid future damage, ensuring the durability of textile objects. The establishing of preventive programmes in museums supports the reduction of deterioration agents and the rate at which items need treatment[20]. A specific and clear plan of museum preservation measures can be significantly less expensive than conservation treatments.

The storage of items is one of the most important preservation principles, in terms of maintenance. Every museum should continuously pay attention to the storage of its collection.

The first steps when an item is added to a museum collection is to create documentation. Documentation should, if possible, include all the information about the item: origin, maker/manufacturer, date, the name of the owner, whether it was a donation or the museum bought it, usability, materials and condition, as well as economic background and value[21]. Determination of the damages can be observed and the further risks that may be encountered can be mitigated.

The correct housing of the objects is achieved by systematic planning, accessibility, physical environment monitoring and evaluation of museum collections. Planning includes policies, manuals, short and long term goals and objectivity. The information system deals with the documentation and records of the collections, and accessibility refers to the organization of the collection, the depository facility and the usability of it. The physical environment involves environmental conditions and the preservation of items, as well as monitoring; evaluation of museum collections includes maintenance, surveys and inventory of museum collections[22].

20 Frances Lennard and Patricia Ewer, *Textile Conservation, Advances in Practice,* (Italy: Butterworth – Heinemann, 2010). 199.
21 Museums & Galleries Commission, *Standards in the Museum Care of Costume and Textile Collections,* (London: Spin Offset Limited, 1998).
22 Green.

2.1 Environmental factors affecting the preservation of textiles

The main cause for decay in textiles is almost always the environment in which they are stored. In some cases, the textiles are weakened not by outside causes such as light or pests, but by chemical reactions taking place within the fabric itself, such as the oxidation of iron-based mordants over time, which can cause darkening and discolouration in the surrounding fibres[23].

One example which is cited frequently is the case of "shattered silk." During the late 19th and early 20th centuries, many silk manufacturers treated their fabrics with metallic salts (usually containing tin and iron) to give them a heavier, more luxurious appearance. However, as these fabrics aged, the metals in the fibres accelerated their decay and caused them to become extremely brittle[24].

The main environmental factors which influence the condition of textiles are the following:

- relative humidity and temperature
- light
- pollutants and dust
- pests

2.1.1 Relative humidity and temperature

Depository facilities reveal important information about temperature and relative humidity. Temperature (T) is the motion of molecules in material; temperature increase leads to the faster movement and increased spreading out of molecules (expansion of material), and when temperature decreases the molecules slow down and come together (contraction of material). High levels of temperature support chemical reactions, increase in biological activity and material softening or stretching[25].

23 Finsh,Karen and Greta Putnam, *Caring for Textiles,* (London: Barrie & Jenkins, 1977), 19.
24 Ibid, 19.
25 NPS, *Chapter 4: Museum Collections Environment*, 2001 http://www.nps.gov/history/museum/publications/MHI/CHAPTER4.pdf, 10 Nov. 2011.

Relative humidity (RH) is the relationship between the volume of the air and the amount of water vapour it holds at a given temperature, and it is directly related to temperature. In closed areas (e.g. closets) where there is no air circulation, the RH is inversely related to T. All organic materials and some inorganic materials absorb and give off water depending on the relative humidity of the surrounding air. Moisture in the air is responsible for chemical reactions in materials[26].

The condition of the building affects the maintenance of relative humidity and temperature, maintaining the right levels. Generally, in a depository facility the preferred level of relative humidity should be 55% +/- 5%, and of temperature 18 °C +/- 2°C. Concerning textile collections, the RH should be 45 +/- 5 % and T 25 +/- 5°C. If RH rises over 65%, it can lead to the creation of mould, and lower than 35% with attendant high temperature levels can lead to desiccation and shrinking of textile fibres[27]. Of course, different materials require different levels of RH and T and should not be stored together, e.g. metal objects need lower levels of RH than wooden ones. Large fluctuations in environmental conditions can lead to further damage to textile items, including shrinking, brittle fibres, mould and insect deterioration, deformation and discolouration.

The stabilisation and ideal values of relative humidity and temperature can be successfully maintained by methods that are established in the depository facility. As has already been mentioned, the outside of the building should support these methods, as the building should be protected from water: using water-proof materials, drainage pipes and water tanks which prevent water from entering the facility[28]. Accordingly, a limited number of storage rooms should be used; the investigation or storage preparation of items can occur in a workroom outside of the building. Keeping doors and windows closed, and limiting light exposure significantly improve the maintenance of conditions.

There is a variety of commercial climate-control equipment available. The selection and use depends on the conditions of the rooms, as well as several

26 NPS, *Chapter 4*.
27 Foekje Boersma,*Unravelling Textiles- ahandbook for the preservation of textile collections,* (London: Archetype Publications, 2007). 81
28 Museums & Galleries Commission, 36.

other factors, e.g. economic resources There are two types of climate-control equipment: spot measuring and continuous recording devices.

•Hygrometers measure both T and RH, and there are three types of them: dial and digital hygrometers and humidity strips. Dial hygrometers contain hygroscopic materials that expand and contract, regulated by a dial. They give +/-5% values and are inaccurate at a low of 40% and a high of 80% RH. Digital hygrometers can measure the T as well and helping to calibrate thermo/hygrographs. Humidity indicator strips are made of paper coated with cobalt salts. This is an inexpensive method of humidity measurement, but it does not give precise values. The colour is blue at low RH levels and pink at high[29].

•Thermo/hygrographs are commonly used in museums to measure RH and T. If they are properly calibrated, they can be accurate within +/- 3-5%, but they are inaccurate at levels lower than 30% and higher than 60%[30].

•Electronic data loggers are nowadays in wide use in museums as they can accurately measure RH, T and light levels. Data can be downloaded onto computers and, using a specific software programme, data are presented in graphs and tables, making it easier to compare and control conditions. Moreover, they require less calibration than thermo/hygrographs, but it is important to change the battery before it dies[31].

The monitoring of environmental conditions can be improved with a good ventilation system/air conditioning, which provides air circulation and avoids the creation of a closed system[32], monitoring equipment or an effective heating system. In order to decrease the amount of humidity, dehumidifiers can be used. A “traditional” way of dehumidifying the environment is the use of silica gel, especially in small spaces. Electronic humidistat[33] systems, which switch on in

29 NPS, *Chapter 4,* 16.
30 Ibid. 16-17.
31 Ibid. 17.
32 Museums & Galleries Commission 36.
33 Humidistat is electronic device that controls the relative humidity and temperature. It is utilized

response to RH levels in the room, have been used by museums[34]. Also, establishing a sophisticated heating system (radiators and floor heating) helps to control RH and T.

Regardless of the climate-control equipment chosen, it is important that all the devices should be controlled and calibrated as suggested by the manufacturer to create firm bases for decision making. Also, systematic records are important in helping to create better analyses and understanding of existing conditions.

2.1.2 Light

Daylight, fluorescence and incandescent light include the ultraviolet spectrum and, to a lesser extent, infra-red radiation. Ultraviolet radiation is most destructive and should be completely separated from storage light, and infra-red radiation is responsible for increases in heat[35] - both can cause irreversible damages. The reducing of light levels can reduce energy expenditures and heat, and improve the environment for light-sensitive objects, including textiles. The level that is preferable in storage rooms is whatever is needed for optimum viewing of collections and safe movement within the building[36]. Lighting conditions lead to changes in colour, but the most serious problem is the loss of textiles' strength. Long exposure to daylight and strong artificial light can lead to weakened and brittle fibres.

Figure 10: LCS card.

Daylight in the ideal depository facility should be avoided; lighting should be controlled by technical solutions. The allowable light level should be a maximum of 50 lux falling on textile items and a maximum level of 150,000 lux hours/year[37]. Windows should be covered with UV filters or should be hermetically closed with shutters. The standard limit of UV is 75 µW/l. When storage rooms are not in use, they should be kept totally dark. A solution is the division of lighting into sectors, so as to provide light only when necessary. Special movement sensors, which turn

in a number of devices dehumidifiers and humidifires and is used where constant RH conditions should be maintaned. http://en.wikipedia.org/wiki/Humidistat (29.11.2011)

34 Lennard and Ewer, 212.
35 Green, 117.
36 Lennard and Ewer, 207.
37 Ibid, 212

on/off lights automatically, are useful but expensive. Moreover, the lights for emergency exits should be away from objects that are stored on open shelves[38].

The measurement of light can be done with lux-meters and light data loggers, which can also be used to monitor relative humidity and temperature. The data is kept in a computer, on Light Plan sheets, with which collection managers or conservators can create work-flow plans and thus control the levels of light. A cheaper method of measuring light and the influence it has on objects is the use of light dosimeters, such as ISO's Blue-Wool standard cards (from TALAS), light-damage slide rules (from CCI), and Light Check Sensitive (LCS) and Light Check Ultra (LCU) cards (from European Project LiDo).

The LCS (Figure 10)[39] is a card that contains eight samples of blue-dyed wool and every sample is more light sensitive than the following (sample 1 is the most sensitive, while sample 8 is the least). The change in the blue colour shows the destructive quality of the light. The light damage slide rule is a sliding plastic rule that aligns projected light types, light levels and exposure times to predict the fading of a blue-wool card[40]. The LCS card contains a blue dye incorporated into heteropolysyluxane and applied on glass, and the LCU card is a mixture of blue and red dyes coated on paper. The LCS and LCU cards are mainly used in the same way as the Blue-Wool card, but both have more sensitivity[41].

The reduction of light deterioration can be accomplished by the use of specific lamps. These can be conventional incandescent lamps that emit very little ultraviolet light and do not require UV filtering. These lamps are Reflectorised (R), Ellipsoidal Reflectorised (ER) and Parabolic Aluminised Reflector (PAR)[42]. Tungsten-halogen, led and plasma lamps are used for exhibitions and emit UV light that does not require filtering.

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38 Boersma, 82.
39 LightCheck®, http://www.lightcheck.co.uk/whatis.htm , 17 Nov. 2011.
40 Beth Lindblom Patkus,*Protection from Light Damage,* n.d. http://www.nedcc.org/resources/leaflets/2The_Environment/04ProtectionFromLight.php, 5.Nov. 2011.
41 Hannerole Römich, "*Light dosimeters for monitoring cultural heritage:benefits for stakeholders (LiDo Project),* 6th European Commission on Sustaining Europe's Cultural Heritage, September 2004, http://www.ucl.ac.uk/sustainableheritage/conference-proceedings/pdf/2B.5_romich.pdf , (28.11.2011).
42 Patkus.

2.1.3 Dust and Pollutants

Careful attention should be paid to the protection of items from dust, dirt, pollutants and pests by keeping the depository facilities clean and tidy.

Dust

Dust, depending on the type, moves in different ways through a room; lightweight inorganic particles and airborne dust moves about a room through the air, and heavier inorganic dust accumulates at the point where it enters the room[43]. Dust can accumulate in new buildings from building materials, e.g. the dust from concrete, which has very fine alkaline particles and can be avoided by effectively sealing the walls and by proper cleaning of storage rooms[44]. Even in perfect storage conditions, there is always dust but it should be minimised by systematic control and cleaning.

Dust particles penetrate textiles and deteriorate them, because dust's hygroscopic nature holds moisture, encourages the fading of colours, the photo-deterioration of fibres and metal corrosion, as dust contains minute particles, such as silicate and salt. Silica have sharp surfaces and can cut textile fibres, especially when an object expands and contracts in relation to RH fluctuations[45].

In order to prevent dust and dirt from entering depository facilities, the inner doors should be covered with large loop-piled doormats and under-door brushes. The air should be filtered through an air-washer, which removes the particles with an elaborate shower-bath or electrically draws the particles towards a surface where an electrostatic precipitator removes them[46]. The filters should be changed often in order to achieve better results.

Moreover, the entrance to the storage area should be equipped with Tyvek coats, hats and plastic covers for shoes. The storage rooms should be cleaned thoroughly at least once a year. It is advisable that the cleaning of the rooms not be done with wet cleaning, as the values of RH can rise. It is preferable to use a

43 Lennard and Ewer, 213.
44 Simon Knell, *Care of Collections,* (USA: Routledge, 2005), 151.
45 NPS/Museum Management Program, http://www.nps.gov/museum//publications/MHI/Appendix%20K.pdf (object name, Appendix K: Curatorial Care of Textile Objects, November 28, 2011).
46 Knell, 183.

cylinder-vacuum (with specific filters that do not allow dust to come out), which contains a range of nozzles and brushes. The filters should be cleaned regularly; otherwise there is an increased risk of spreading pests. In addition, vacuum bags should be changed regularly. The Museums and Galleries Commission suggests specific extra fine filters whose requirements conform to Section 2.2 Supplement 1 in BS 5412: Specification for Type H Industrial Vacuum Cleaners for Dusts Hazardous to Health[47].

Pollutants

There are two types of pollutants that can deteriorate textile items, outdoor and indoor pollutants.

Outdoor pollutants come from heating, ventilation and air-conditioning (HVAC) systems or open windows and doors. The main deterioration agents are:

- sulphur dioxide (SO_2), which is responsible for photochemical deterioration and brittle fibres;
- nitrogen oxide (NO) and dioxide (NO_2), which can be created by deteriorated nitrocellulose film, negatives and objects;
- ozone (O_3) from electric or light equipment, such as photocopy machines, printers and some air filtering equipment[48].

Indoor air pollution is created by elements of the building and also by the materials that textiles consist of. Pollution from building elements can be emitted by:

- wood which releases acids (oak);
- some paints and varnishes which release peroxides, organic acids and solvents;
- plastics that release plasticizers[49].

The materials that textile objects consist of and that can also cause pollution are:

- degraded rubber (carpet backing, raincoats and shoes), which can

47 Museums & Galleries Commission, 47.
48 NPS, *Chapter 4.*
49 Ibid.

release sulphur;

•plastics (dolls, buttons, modern clothing and shoes), which can release plasticizers;

•metals (buttons, zips and metal threads), which can tarnish and corrode textiles;

•cellulose nitrate (buttons, combs, buckles and purse-frames)[50].

An ideal depository facility must provide an environment for objects with acceptably clean air, and this is connected with the depository facility's location. The use of activated carbon filters in ventilation systems or air-washers (purifiers) creates a cleaner environment[51]. In order to achieve proper results, filters should be replaced regularly. Objects that consist of polluting materials should be stored separately and in good ventilation. Of course, materials that emit acids should not be used in storage facilities. When a depository facility is new, before beginning to use it it is suggested to apply the “Oddy” tests[52], in order to minimise pollutants and dust during storage.

2.1.4 Biological activity

Depository facilities should be free from mice, rats, birds, insects and mould, which all can cause irreversible damage to collections.

Specific measurements should be taken and a detection plan should be established. The first method of avoiding incests, pests, mice and mould in storage areas is to maintain an environment that does not support their development, typically one that is dry and clean[53]. The prohibition of food in storage areas should be clear to the staff, as food particles can attract insects and pests. Before items are added to the collection, they should be cleaned either with a freezing technique, or with the use of gases (carbon dioxide or nitrogen) in barrier film bags in order to prevent cross-contamination. The whole collection should be checked

50 Museums & Galleries Commission, 48.
51 Knell, 183.
52 It is a test that uses reactive metal coupons and by closing them, in glass bottles, with textile samples (or the material we want to investigate), we can see the reaction. If there are corrosive gases, such as acetic acid and formaldehyde. http://www.icn.nl/en/kenniscentrum/onderzoeksmethoden/oddy-test , 16 May, 2010.
53 Lennard and Ewer, 209.

at least once a year. Moreover, the monitoring of the storage room and building every time it is visited can minimise the possibility of deterioration. A quick response to deterioration is also necessary.

Passive measures, such as the use of traps (for mice and insects) can also be taken. However, the use of anti-pest substances should be carefully considered, as some of them consist of substances that are dangerous to humans or attract other pests and insects. Substances dangerous to humans are dichlorodiphenytrichloroethane (DDT), lindane (HCH), pentachlorophenol (PCP) and naphthalene. Less dangerous are permethrin and deltamethrin. Nowadays, more methods can be used and there are specialists who deal with the monitoring of buildings and the use of pest control substances[54].

In general, the establishing of an Integrated Pest Management (IPM)[55] programme is a method that can prevent not only insect and pest deterioration but also mould development.

The IPM basic steps are:

1. Low temperature and low relative humidity are good conditions for preventing mould and insect development. The creation of a micro-climate should be avoided by good ventilation and air circulation in storage areas. The water reservoirs in dehumidifiers and humidifiers should be regularly checked for insects. The maintenance of the building should provide for the removal of birds' nests, plants and rubbish that are close to the building and can attract insects and pests [56].

2. All the holes, cracks in the walls, seal damage around pipes and ducts should be repaired, and in ventilation holes filters or screens should be fitted, these should be inspected every autumn, and spring and the filters should be cleaned and replaced when necessary.

3.Places where insects are found should be cleaned very carefully and checked often.

54 Lennard and Ewer, 209.

55 Integrated pest management (IPM) is the strategy that its aim is to reduce the harmful pesticides with alternative ways. It is applied mostly in agriculture. (http://en.wikipedia.org/wiki/Integrated_pest_management). 17 May, 2010.

56 Boersma, 69-70.

4.The policy that should be followed is the use of Tyvek coats, hats and shoe covers and the prohibition of bringing hand bags into storage rooms. This will ensure that the area will be kept cleaner and that biological deterioration will be minimised.

Biological deterioration is one of the hazards in dealing with textile materials. A clear and specific program can mitigate the possibility of deterioration only if the programme is adhered to by all of the staff.

2.2 Preservation principles of depository facilities

Before starting any stabilisation of the storage room, it is important to evaluate the condition of the building. Many museums have storage areas in the same building, often in the basement or in secondary rooms. However, without proper renovation, these places can be unsuitable for storing objects, and especially textile objects. The correct planning of a depository facility requires the cooperation of different experts, including architects, engineers, conservators, collection managers etc. Only then can the possibilities of an inappropriate depository facility be minimised.

The building construction should not allow fluctuations in environmental conditions. It should protect textile collections from weather hazards, pollution, dust, sand, insects and dirt. For that reason, careful planning of the outside of the depository facility, e.g. walls, roof, floors and foundations, is important. The location of a depository facility should not increase problems. If it possible, the facility should not be situated in the city centre or near the seaside or other water areas, thus avoiding pollution deterioration, high levels of humidity and corrosion.

The building should be planned to have a rain water collection system (water-pipes), so that water is transferred away from the outside of building walls. The water system should be planned so that water will not enter the storage rooms. The design of the electric system, while taking into account minimal energy expenditure, should guarantee suitable energy levels free from functional problems. Nowadays, low energy facilities with full functionality can be created.

The interior should be designed so that it provides maximum safety for the

staff and the collections. All the doors should open outward, avoiding damage during item transfer, allowing the best use of space and also providing security to the staff, for example in the case of fire. It is suggested to have two doors, one normal size that is used usually for entrance and one double size, which opens wide (180°) for transporting items or in emergencies. Corridors should be wide, to prevent any damage to objects[57]. Furthermore, it is important that the surfaces of the depository facility walls and floor be smooth, so that cleaning is easier. Concrete and wooden floors should be covered with durable varnishes, ceramic tiles or synthetic materials, but synthetic materials should be chosen carefully to avoid emitting pollutants. Preferably, the walls should to be light-coloured or white, because this facilitates cleaning and the spotting of insects, and provides more light.

The HVAC system is vital in a depository facility, as it helps stabilise environmental conditions. The air–conditioning shouldn't be vulnerable to mechanical failure and power cuts. In addition, unreachable critical connections or connections mounted inside the wall should be avoided. This can cause sudden changes in the storage room's inner climate, particularly in relative humidity. Anti-fire and anti-theft systems will protect personnel and collections.

The depository facility will not function appropriately without an organised plan which helps to keep everything under control and to minimise the possibility of deterioration.

2.2.1 Physical disasters

The depository facility should protect items from such physical disasters as fire and flood and their associated types of damage.

To prevent fires in the whole depository facility, an anti-fire system (detection and suppression) should be established. There are several anti-fire systems available, and the selection should be careful as some of them have been found to be inappropriate for museums because they increase the possibility of damage to objects or don't provide quick enough reaction time. Anti-fire systems, such as sprinklers having different types of fire suppression, fire detectors and

57 Boersma, 82.

extinguishers are widely used. A combination of them can provide maximum reliable protection against fire.

However, the anti-fire system should be designed to suit the conditions of the depository facility, the storage equipment that is used and the way items are stored. In particular, the suppression of fire by a system that uses water (e.g. sprinklers and water extinguishers) can cause further damage to objects that are stored in the open (e.g. on racks). Sprinklers require construction in storage rooms, which can lead to possible water leaks, especially with a wet-pipe water system[58]. The benefit of dry-pipe and pre-action systems is that water is not present in the piping system until it operates. However, the dry-pipe system has the disadvantage of suppression delay[59] and dry-pipe and pre-action systems are costly to build and maintain. Regular and proper maintenance of the sprinkler system will provide for the proper functioning of the system and minimise the possibility of water leakage and non-function of the system at critical times. With extinguishers, the use of foam is preferable to water.

In addition, fires in storage rooms can be prevented by low levels oxygen. Having low levels of oxygen in the atmosphere means that the oxygen is so low that a fire cannot easily start, and this level of oxygen can be achieved by introducing nitrogen into the air during construction (Figure 11)[60]. It is preferable to maintain oxygen at 15-17%. The amount of oxygen that exists in a room is the level necessary for human respiration[61].

58 Wikipedia, *Fire sprinkler system*, (2010), http://en.wikipedia.org/wiki/Fire_sprinkler_system .
59 Lennard and Ewer, 206
60 Wilhelmesen Technical Solutions, http://www.wilhelmsen.com/services/maritime/companies/wts/safetysolutions/nitrogensystems/unitorgeneronmembrane/Pages/IGSSystemdesignandconfiguration.aspx ,7 Nov. 2011.
61 Boersma,.82-83.

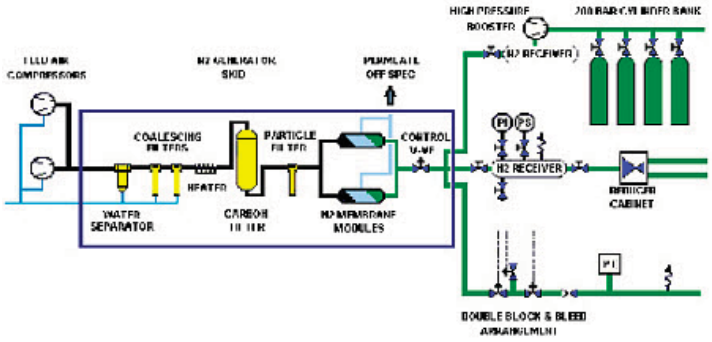

Figure 11: Possible construction of an oxygen-reducing system.

Furthermore, a number of preventive actions can limit fire occurrence. In depository facilities, smoking and open fires should be forbidden. Electrical wiring and equipment should be installed according to the standards of the country. The same should occur in the use of gas, oil and mechanical equipment. Some materials that are made from cellulose nitrate, such as belts, buttons, handbags and fans, can increase the chances of a fire. Storage of them under proper ventilation, such as the use of activated carbon filters, will prevent fire occurrence. If the anti-fire system contains water, it should be clear and not contain any oil or other harmful ingredients[62].

In order to protect the building from floods, a clear and specific plan should be organised for the maintenance of canalisation, water pipes and tanks. The items should not be stored on the ground, but at least 15cm higher, protected in case of flood. Moreover, as has already been stressed, the water system tube connections of air-conditioning and anti-fire systems should not be mounted inside the walls and should be reachable. A sensor system for flooding[63] is useful for the protection of the depository facility.

Employees should be trained for all contingencies, so that they can react adequately in every kind of situation. Clear plans should be organised so everyone reacts properly and lives are not endangered. A management plan should be set up as well to prevent further damages to collection objects.

62 Museums & Galleries Commission,.51-52.
63 Ibid. 54.

2.2.2 Anti-theft system

In a depository facility, it is necessary to secure stored items from theft. All entrances to the building should be secure. Doors should be metal, but if they are wooden they should be at least 50mm thick. Locks should be secure and staff should handle keys/cards responsibly. The alarm system should cover every room and every possible entrance. Items of high value, such as jewellery, should be kept in a separate, special safe box. Visits to the depository facility by researchers, students etc. should only be allowed with personnel supervision[64] and should be pre-arranged. Visitors' names and the purpose of visits should be written down, and visitors should always be accompanied by a member of the staff when in the storage rooms.

2.2.3 Storage equipment

The storage of collections is an important part of preservation; proper storage helps to ensure proper maintenance of objects. The purpose of storage equipment is to protect items, not cause further damage, and also to be convenient and accessible to the staff. This can be accomplished through good planning, design and monitoring.

The storage space should be organised so that proper use will be maximised, leaving enough space for entering the area (at least 1m in a corridor). The determination of the storage space depends on the amount and types of items to be stored. In order to be organised in the best way, the cooperation of the architect, interior designer and conservator is necessary[65]. The equipment should be planned in a way that corresponds to the size of the items. The furnishing of the storage area is an important step for the preservation of objects and expensive, so decisions about equipment should be carefully made.

Ideal storage equipment includes closed units that provide protection from dirt and dust deterioration, and mechanical damage that can happen during the use of the room. The proper use of materials provides security in the case of floods and fires. Drawers, sliding archive shelves and cupboards that can combine

64 Museums & Galleries Commission, 40.
65 Knell, 173.

shelves and drawers for items that will be stored can be used for the storage of textile collections[66]. Storage can be fixed or mobile, in units that can be packed and unpacked by rolling (Figure 13)[67]&(Figure 12)[68], thus saving space. A vibration absorber should be mounted in order to minimise the movement of objects.

Figure 12: Hanging cupboards that can hold shelves or drawers.

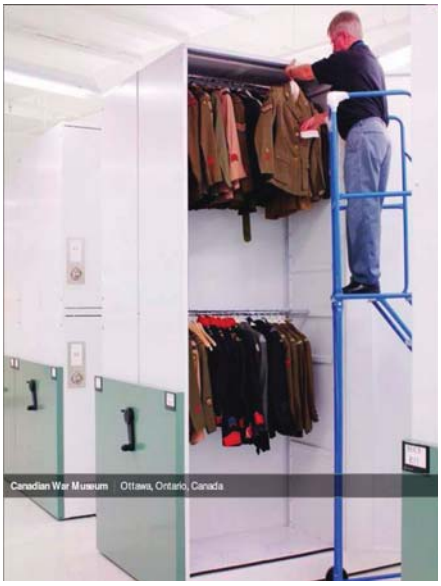

Figure 13: Compact rolling cupboards.

In closed units, attention should be paid to avoid the creation of a non-controllable micro-climate between units, as this prevents air circulation[69].

Another type of textile storage that is more economical is the use of open units (e.g. racks with shelves, cupboards and stands for rolled objects); this system is used by some museums. However, this requires ideal environmental conditions, and the elimination of hazards and any textile deterioration. Racks should be covered with curtains which will close so that they do not allow dust inside. Sometimes a combination of open and closed units is necessary; for instance, when rolled objects are large storage in a closed system is not possible and should be done in open stands (Figure 14)[70].

66 Sherelyn Ogden and Ann Frisina, *Storage for Textiles,* Conference on Museum Storage for the Midwest Regional Conservation Group, Nov. 2004. (2006), http://www.mnhs.org/preserve/conservation/reports/textiles_storage.pdf , 10 Nov. 2011.
67 Storage Solved®, *Museum Storage & Special Collections Guide book,* http://www.spacesaverinfolinx.com/literature/MuseumGuideBook.pdf, 24 May, 2010.
68 Montel, http://www.montel.com/eng/applications/museums/museums.htm 24 May, 2010.
69 Boersma, 83.
70 Montel, http://www.montel.com/eng/applications/museums/museums.htm (24/5/2010).

Cupboards are useful for hanging costumes and, depending on the space inside them, can be organised so that drawers and shelves are included. The items can be easily observed and found without coming into contact with them. The items can be stored horizontally or rolled in drawers. The depth of drawers should vary depending on the objects' size and method of storage (rolled or horizontal). By creating proper mounting in drawers, a lot of small items can be stored that can be observed at a glance[71]. On fixed shelves, items on panels can be stored.

Figure 14: Rolling storage of textile items.

Often the storage of textile objects is in boxes made of buffered acid- free cardboard, whose size depends on the size and type of the object. If there are closed storage units, the use of boxes is necessary for sensitive and brittle items that should not come in contact with other objects. Boxes can be stored on open racks or closed shelves.

Storage equipment should minimise the unnecessary movement of items (e.g. by the opening of a drawer), should close tightly so that dust, dirt and insects do not enter and provide sufficient space. They should be suitable for the items which will be stored.

The storage rooms should be equipped to facilitate access to and the movement of objects. Having different sizes of customisable ladders is a good solution to reach objects stored high, and the use of trolleys is useful for the transportation of objects.

2.2.4 Used materials

The materials used in storage equipment should not affect the objects and should help in their maintenance. For that reason, shelves and cupboards should

71 Ogden and Frisina.

not be made of materials that release gases[72] and the materials should be chemically inert.

Storage equipments has traditionally been made of wood and wood products, joined and lined with adhesives and metals, as these are cheaper materials and form a natural buffer for RH values. However, over the years, a wood-based system has been found to be inappropriate for storage as it is not chemically inert and can expose items to acids, which can deteriorate the stored objects. Less acidic and more stable wood products reduce the possibility of deterioration, but do not eliminate it[73].

Gases that can be emitted from wood and wood products are:

- Formaldehyde, which appears in wood and wood products, paints and coatings, Formica, Masonite, fibre-glass, paper, and textiles with formaldehyde finishing. It reacts with oxygen and moisture and releases formic acid (HCOOH);
- Acetic acid, which can be released by wood, polyvinyl acetate adhesives, plastic, polyester, non-vulcanised rubber, and such sticky tape as Sellotape or Scotch. It is not as harmful a solution as other gases;
- Gases that contain sulphur, such as sulphur dioxide and hydrogen sulphide, which can be released from vulcanized rubber, paint, wool felting, parchment, leather, bone animal glue, ply-sulphide adhesives and plastics;
- Nitrogen oxides, which are released from cellulose nitrate adhesives and imitation leather;
- Ammonia, which is mainly emitted from organic materials depending on age.

The emission of acids depends on the temperature and relative humidity: at high values (e.g. RH > 80%), emission increases. Woods that have low levels of

72 Boersma, 85.
73 Knell, 144.

free acids are mahogany, pine, meranti and birch. Moreover, such wood products as MDF, plywood, chipboard and hardboard release less acid but more formaldehyde, as they are laminated with sheets of Formica. There are different types of covering sheets but the phenol-formaldehyde is the most harmful. Zero formaldehyde (ZF) is especially designed for museums because museums require formaldehyde-free binding agents. However, although it has lower formaldehyde, it still has high acetic acid emission.

An alternative material for storage equipment is metal, which has been found to have a number of advantages:

- it provides smooth finishes, so mechanical damages to objects are avoided;
- usually it will not release harmful products (depending on the finish);
- it requires less maintenance than wood;
- it does not attract insect;
- it is not affected by changes in RH and temperature, so in normal conditions it will never crack or lose its shape.

The decision to use metals should be made carefully as some metals can lead to chemical changes. The metals used should be enamelled or the particles of the finish may produce an electrical charge[74]. For some metals, additional steps must be taken. For instance, aluminium should be anodized; otherwise, it can emit peroxides as it oxidises. For that reason, it is preferable not to use aluminium for drawers holding sensitive materials. Steel must be galvanised so that it does not emit formaldehyde. It is important that metal products have high quality continuous coatings, in order to avoid rust in areas where paint peels off or is scratched[75].

Materials (buffered acid-free tissues and cardboard, unbleached muslin or cotton, polyester film, Tyvek etc.) that isolate storage items from the metallic surfaces of storage areas should be used in order to avoid any possible damage. All the additional materials should be acid-free and chemically inert. These

74 Boersma, 87.
75 Knell, 148.

materials will provide a moisture buffer during short periods of relative humidity fluctuations.

Textile objects should not be touched without wearing gloves, because the skin's salts and oils can be transferred to the items, causing yellowness and greasy discolouration.

2.3 Methods of textile storage

Textile objects are separated into three types[76]:

- Flat textiles
- Two-dimensional objects
- Three-dimensional objects.

These categories contain subcategories. The flat textiles can be separated into: a) those which have a pile, such as knotted carpets and velvet or ceremonial church textiles, and b) composite textiles, such as flags, banners and frame textiles. The two-dimensional objects can be separated into a) large and/or long textiles, such as tapestries, ribbons, lengths of fabric, etc., and b) smaller ones, such as archaeological fragments and fabric samples. Finally, the three-dimensional objects can be a) such textiles as costumes, etc., and b) those which combine different materials, such as accessories, hats and dolls[77].

Depending on the type of items, they should be stored differently so that they will not be damaged. The main types of storage are rolling, hanging, laying in drawers, putting in boxes and items of special storage. Of course, depending on the object, a conservator could invent a newer type of storage that could also be acceptable.

2.3.1 Rolling storage

Rolling storage is usually used for long and/or wide two-dimensional objects. With some small two-dimensional objects, their length does not allow them to be stored in boxes. This is also true of flat textiles with pile.

76 Kousoulou, 68-70.
77 Boersma, 89.

The benefits of rolling storage is that big items can be stored without taking up a lot of space. A lot of attention should be paid during the process, because it can create unexpected further damage. The materials that are necessary are acid-free cardboard tubes, which should be quite big in order to avoid putting pressure on the item. The diameter should be 100 to 200 times bigger than the item, and the length and depth should be 10cm longer on each side than the object[78]. It should be mentioned that if the tube is not acid-free, then Melinex or buffered acid-free tissue and/or pre-washed cotton should be used to separate it from items[79]. These materials can be applied after the rolling, in order to protect it from the dust.

The item that is prepared for rolling should not have any sharp creases or crumpling, because it will be damaged during the process. If the item has a layer of paint which has crackling, it is best not to roll it, or it can be rolled if silicon-release paper is used. Items which have painting, ornaments or pile should be rolled from the back side, to avoid damage to the micro-anaglyph[80]. Woven fabrics are usually rolled in the direction of the warp. During the rolling, some layers of buffered acid-free tissues or pre-washed cotton should be applied, in order to prevent mechanical damages (Figure 15)[81].

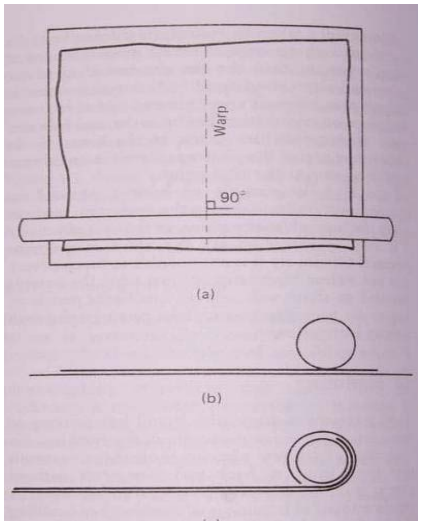

Figure 15: Way of rolling textile objects.

Moreover, steady tension should be maintained over all the textile during the process and it should not be stretched and tight. Finally, the textile should be stored horizontally on blocks or pads, to eliminate tension. Because gravity will affect the rolled textile, it should be turned occasionally, so it will not be compressed.

78 Boersma, 90.
79 Landi, 170-171 .
80 Kousoulou, 68-70.
81 Landi. 170-171.

2.3.2 Hanging storage

Hanging storage is used with such three-dimensional items as costumes, only if the items' condition allow. Support should always be provided, even if the costumes are in good condition.

However, costumes that are in bad condition or are made of sensitive textiles (e.g. flimsy, fragile lace or silk organza) or are heavy (embroidery) should not be hung, because gravity will cause more damage (Figure 16)[82] & (Figure 17)[83]. It is better to store these items horizontally in boxes or drawers. Also if a decision is made to hang a very heavy costume (e.g. a wedding dress), then it should be supported in order to minimize the creation of strains and stretching of the textile. In this situation, it is again advisable to store it horizontally.

Figure 16: Costumes hung in composite cupboards

Figure 17: Costumes that are hung.

For the hanging, plastic hangers should be used, according to the size of the textile. These are available in different sizes, such as 26, 33 and 38. Careful attention should be paid to their use; the plastic should be chemically stable, such as polyethylene or polypropylene, and should not contain any plasticizers. In shops, there are also hangers made of recycled plasticizers, which should be avoided, as it is not known what kind of plastic has been used[84]. Also, wooden

82 Wornthrough, http://www.wornthrough.com/blog/wp-content/uploads/2010/02/compact-storage-4-225x300.jpg 24 May, 2010.
83 Philadelphia Museum of Art, http://www.philamuseum.org/images/pageImages/conservation/costTextMove/6_17a_move.jpg 24 May, 2010
84 Foekje Boersma, 94.

hangers can be used if they are varnished. Wire hangers should be avoided, because they are not stable enough[85].

Before using, hangers should be padded to fit. The size which will be used should be smaller than the width of the shoulders, as it will be wider after the item is place on it. First, the hanger should be filled with polyester batting. Tyvek 1422A or pre-washed, unbleached and non-dyed fabric should be applied on the outside. The fabric can be cotton-calico, stockinette or towelling (Figure 18)[86]. The last two are suitable for the hanging of heavier costumes, as they prevent friction.

Costumes with high necks (e.g. military uniforms) should be supported at the collar, in order to avoid distortion. With heavy costumes, in order to relieve the tension on the shoulders, it is advisable to stitch pre-washed, unbleached and non-dyed cotton strips around the waistband. The stitches should be hidden, should not be done in damage areas, and should be on the inner side of the

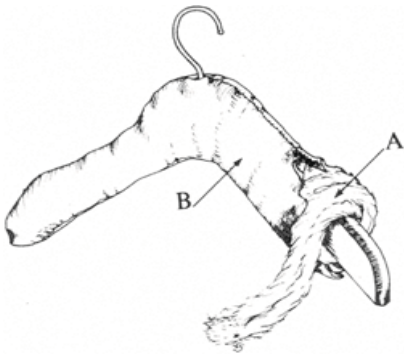

Figure 18: Padding a hanger. A) polyester and B) cotton covering.

Figure 19: Hanging of costume by the use of strips.

costume. The strips should be tied around the hanger. Using these kinds of strips is good for hanging skirts and trousers (Figure 19)[87].

Furthermore, for some costumes, mainly women's coats of the 19th century, in order to preserve their shape and to avoid tension, it is necessary to create a hanger with a body that supports the waistband. Hangers with rolled acid-free

85 Museums & Galleries Commission, 43.
86 Canadian Conservation Institute, http://www.cci-icc.gc.ca/crc/notes/html/images/13-05/13-05_image1.gif 24 May, 2010.
87 Ibid.

cardboard rollers at the sides can be prepared for the support of priest's robes that have slanted and heavily decorated sleeves.

It is better to cover the hung objects with dust-free covers, especially if they are not stored in cupboards. Materials that can be used for the covering are pre-washed Tyvek or pre-washed, unbleached and non-dyed calico[88].

2.3.3 Horizontal storage

Horizontal storage is useful for flat composite objects, costumes that cannot be hung and small two dimensional objects. Drawers, shelves, boxes and panels are used for horizontal storage. Depending on the items' conditions and types, they can be stored together or separated. For example, some flags and banners are heavily decorated, with thick cardboard containing metal fibres, and it is advisable not to store them with other items in order to avoid mechanical damage (Figure 20)[89].

More precisely, flat or two-dimensional items can be placed on rigid acid-free boards, which are covered with pre-washed, unbleached and non-dyed cotton textiles. Depending on the items' sizes, panels can be fitted in drawers or on shelves. The folding of these items should be avoided. However, if this cannot be avoided, the items should be filled with buffered acid-free tissue paper in a “sausage[90]” shape.

Figure 20: Flat storage on a panel.

Three-dimensional objects stored horizontally in boxes or drawers should be placed so that wrinkles are avoided by the use of “sausages” or preferably mounts and, if they are stored in boxes, it is preferable to separate them.

88 Landi, 449.
89 Odgen and Frisina.
90 Rolled acid-free tissue at the shape of *sausage*.

2.3.4 Three-dimensional items with combined materials

Three-dimensional items will be described individually because their storage requires different constructions. In this category are found accessories of costumes (bags, hats, gloves, shoes, umbrellas and parasols), as well as such objects as dolls, fans, masks and headdresses.

Shoes should be supported in order to preserve their shape. For that reason, a model of a foot is created (Figure 21)[91]. It is important to separate the area of the toes from that of the ball of the foot. On the ankle, use plastic foam, covered with a smooth textile. The two other places can be filled with cotton. However, cotton socks can be created, which are filled with poly-fibre. Shoes can be stored in boxes or in drawers, after the creation of specific places made of acid-free paper[92].

Figure 21: Shoes supported with a foot model and mounted on an acid-free carton base

With hats, it is better to store them by creating a head model. This can be made from several polyethylene foam sheets covered with cotton stockinette or models which can be found commercially. Soft hats can be filled with pads made of cotton stockinette filled with soft padding. Hats should be stored separately in boxes, especially those which contain fur, or are decorated with feathers.

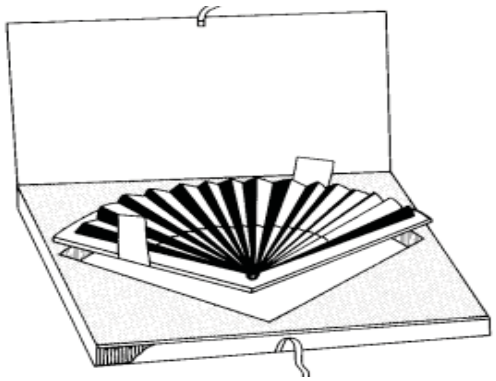

Figure 22: Box for mounting of fan.

Bags and gloves require softer support. The fingers of gloves should not be overstuffed with filling because they can tear. Pads can be filled with cotton or acid-free tissues, as can the support for bags. Gloves can be stored in drawers, and bags, depending on their size, can be store in drawers, on shelves or in boxes.

If fans are not damaged, it is better not to store them closed but semi-open,

91 Odgen and Frisina.
92 Ibid.

mounted on supports. The support can be made of layers of acid-free card or inert foam. The model should be placed so as to totally support the fan, and placed in a drawer or box (Figure 22)[93].

Dolls can be stored in boxes upright or laid flat, depending on their condition. If a doll is stored horizontally, it should be supported with acid-free tissues to prevent wrinkles and deformation. Upright storage can be done by putting a cotton strip around the waist, on which are stitched four cotton strips. The strips can be supported at the top of the box; also, a base should be created, in order to make the item more stable[94].

2.4 Labelling

Labelling is very important for conservators and people who need information about an item. Labelling occurs when an item enters a collection and one has the information about the item (material, date, origin, owner and type) and storage information. This helps in the management of the collection. The general rules of labelling from CIDOC are:

- "Numbers (e.g. inventory or accession number) are the connection between objects and documents related to them. They must therefore be physically attached or applied to the objects;
- When an object is or becomes part of the collection, it receives an accession number. To apply the number to the object a secure method should be used, which means the method should be safe for the object while ensuring that the number cannot be accidentally removed;
- If a temporary number (e.g. a loan number) has to be associated with an object, tags can be used;
- Labelling and marking of objects should be done in a consistent manner, by trained employees. Enough time should be allowed to examine the object, to clean the surface using a suitable method and to apply the number;

93 Pauline Webber, T*he consrevation of fans,* 2002, http://web.mac.com/elandbas/papier_sem-3/waaiers_files/IPC%2084%2008%2003.pdf, 23 Nov. 2011.
94 Boersma, 98.

•When doubt about the right method arises, a conservator should be consulted. It should be noted that no given method can be considered entirely safe and that some of the products and methods most frequently in use have not yet been systematically tested;

•A number should be applied without causing damage to the object. At the same time it should be possible to remove the number safely, even though for security reasons museums like to consider using a permanent mark;

•The number should be easy to locate without unnecessary handling of the object and at the same time without defacing any aspect of the object likely to be displayed or photographed;

•Although different types of objects have their own requirements for numbering, it is recommended that the range of methods and materials in use be kept to a minimum;

•When an object is made of several materials (e.g. paintings, uniforms, furniture), the number should be applied to the most secure place, given the method used;

•When an object consists of several components likely to be dismantled or separated, each part should be numbered. The same applies to fragments of a broken object;

•A museum should set out its numbering rules (including rules for number formats) in a report that is made available to all relevant staff members"[95];

The "traditional" method of labelling textile items involves the use of labels made of pre-washed, unbleached and non-dyed cotton or nylon. They should be stitched on the item and never glued, pinned or ironed on. The ink used should be permanent, chemically inert and non-toxic. Before using, it is necessary to test for water resistance[96].

95 Cidoc, *Fact Sheet No2- Labelling and marking objects,* n.d. http://cidoc.mediahost.org/FactSheet2%28en%29%28E1%29.xml 10 May, 2010.
96 Museums & Galleries Commission,.22.

Nowadays, there are more sophisticated and more easily accessible systems of labelling in which the labels do not need to come in contact with items, including machine-readable ID bar codes and Radio Frequency Identification (RFID) tags. The ID bar code system is linear, or one-dimensional, and it carries information represented through different codes (Figure 23)[97]. The reading of the codes is done with special readers, usually through software which captures data that is relayed to a computer. The readers can be hand-held (e.g. a smart phone) or in a fixed position. The benefit of this system is the control of the item's location and re-location through the data that are stored either on the device or directly updated to the collections management system. The bar codes can be hung on the items or attached to them with acid-free tags[98].

Figure 23: Item with a hung bar code label, Gementee museum, Copyright: Julian Tomlin.

Figure 24: RFID tag.Copyright: Intellident Ltd.

Figure 25: RFID reader, Copyright: Washi WrapTM LLC

RFID tags are interactive labels made of polyethylene, copper and silica and a variety of data about items (photo, condition, location and materials) can be stored on them. Some types of RFID provide 44 memory locations for storing data

97 Julian Tomlin, *Review Machine Readable Labelling System for Collections Management Access,* 2008 http://www.smarttrackrfid.com/pdfs/reviewing_machine-readable_technology_for_collections.pdf , 15 Oct. 2011.

98 Julian Tomlin.

(Figure 24)[99]. The accessibility is the same as the ID bar codes (hand-held readers, or in a fixed position (Figure 25))[100] or, with the appropriate software programme, to certain mobile phones.

The benefits are:

- with the use of movable readers, static readers can be placed at the facilities;
- the item's movement is automatically logged to the collections management system;
- the reading can be done up to several meters away;
- tags can carry unique numbers that can be locked;
- they are not affected by dirt and moisture[101].

It is preferable to catalogue items on a museum's database, thereby saving detailed information about the items.

2.5 Mapping and condition assessment of the textile collection for shared storage

A shared storage depository should be planned for storing more than one museum's collections. The understanding of quantity, condition and necessary treatment of museums' textile collections can be beneficial with the proper planning (space and facilities), organisation and function of the depository. The mapping of the museum's collection is one of the first steps that should be taken, in order to have an acceptable shared housing of the items. It is important to know the exact number of the items in a collection, so as to organise and furnish the depository facility in the most effective way. During the mapping, the items should be separated according to their dimension type and material.

The collection of information requires the creation of a case study. Each museum or conservator can create its own appropriate report form. Mappings

99 RFID for Asset Management at Museum Boijmans Van Beuningen, http://industrial.omron.nl/nl/expert_area/industries/entertainment/museum_boijmans_van_beuningen_rfid_for_asset_management.html?page=1, 15 Oct. 2011.
100 Tomlin.
101 Ibid.

have been used in different museums in order to get detailed information about their collections[102].

Because collections have become larger, conservation and preservation have became more expensive. There is a need to understand the whole collection condition on the item level. An items assessment is a systematic survey system of conditions. Museums use item-condition assessment, together with collection mapping, to create a better preservation plan: the recognition and mapping of deterioration agents can offer important information for the preservation plan and necessary treatment. The main goal is to get information about items' preservation in the museum and the immediate preservation measurements of the items that they need[103]. To get a necessary overview, the item-condition assessment can be organised for all or one part of the collection.

The condition survey system contains data which provide clear information about the item's condition, including: type of collection, store room description, storage location, researched items' types and materials, and the date of the survey[104]. The survey report should contain a description of all the existing damage. According to the results, items' conditions can be evaluated. The terminology of evaluation can vary but should be as clear as possible. The output of the survey report should contain graphics. The survey report of the practical section of the thesis is shown in Appendix 3.

The benefit of collections' mapping and condition assessment is the proper organising and functioning of the depository facility. The number of objects, their type and the types of damage indicate the processes that are necessary. Deciding on suitable storage equipment, organising the space of the storage room, storing items in a suitable way, stabilisation of the environmental conditions and limitation of other hazards are some of the conclusions, leading to actions that can be undertaken to better preserve cultural heritage.

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102 Museums Australia Victoria, *Small Museums Catalouging Manual: A manualia to catalogiung objecs and images collections,* 4th edition, Ericken Hilay, and Unger Ingrid (Australia: Museums Austarlia Victoria, 2009), http://www.mavic.asn.au/assets/Small_Museums_Cataloguing_Manual_4th.pdf. 20 May, 2011.

103Suzanne Keene, *Managing Conservation in Museums*, (Oxford: Butterworth-Heinemann, 2002), 139.

104 NPS, *ApendixF: NPS Museum Collections Managment Checklists,* 2005, http://www.nps.gov/museum/publications/MHI/AppendF.pdf , 20 Oct. 2011.

3 Survey of textile collections in museums

The practical section contains the research work carried out at four Estonian museums' textile depository facilities (the Estonian Open Air Museum, Estonia History Museum, Tallinn City Museum and Harju County Museum).

To collect information about museum needs and their collections, reports were created according to a theoretical framework (Keen, 2002; Ashley-Smith, 1999). For the practical section of the thesis, report forms were created for the mapping of different types of textile items, collecting information about depository conditions, storage equipment, museums' preservation plans and item-condition assessment. The mapping of collections was worked out according to item-dimension type; an attempt was made to calculate the number of items and the item storage methods (Appendix 1).

Appendix 2 is a report on the museums' environmental preservation plans, security, storage conditions, labelling and depository conditions. The aim was to collect a variety of information in order to identify possible risks to the collections. This survey report was based on a theoretical framework and surveys that have been carried out by such museums as the Canadian Museum of Nature[105] and the National Museum of Denmark[106], and these were adapted to the needs and types of the Estonian museums.

The item-condition survey system (Appendix 3) was created according to textile items' characteristics and possible damages that were found. In addition, a scale of the damages of items is given. The items' archival numbers, materials, dimension types and dates of survey are useful data for the accuracy of condition assessment and also for possible future research. The evaluation of item conditions was made according to a damage scale of Very Good, Good, Bad and Very Bad, depending on the items' conditions. The item selection was made

105 Garnet Muething, Robert Waller, and Fiona Graham, "Risk Assessment of Collections in Exhibition at the Canadian Museum of Nature," *Journal of the American Institute for Conservation*, 44 (2005): 233-243, http://www.jstor.org/pss/40025153, 8 Dec. 2010.

106 James M. Reilly, Jesper Stub Johnsen and Lars Aasbjerg Jensen, "Documenting and Optimising Storage Conditions at the National Museum of Denmark," *Museum Microclimates,* T. Padfield and K. Borchersen, (National Museum of Denmark, 2007), 2008, http://www.natmus.dk/graphics/konferencer_mm/microclimates/pdf/reilly.pdf. 16 March, 2011.

randomly and always in cooperation with museums' collection managers. Different textile materials and types of textile items were researched. The condition report system was created according to the theoretical framework, researched items and textile deteriorations, and also in cooperation with the thesis tutor, K. Konsa. During the research, the items were photographed (Appendix 4).

3.1 Estonian Open Air Museum

The Estonian Open Air Museum (EOAM) was created in 1957 on the shore of Kopli Bay near Tallinn, at the 19th century Rocca al Mare summer residence. The type of the museum is ethnographic and it was established to collect, preserve, study and exhibit historical rural architecture and the rural way of life[107]. The museum contains furniture, textile, metal, glass, painting and photograph collections. There are two depository facilities, both located in the museum territory.

3.1.1 Textile collection

The museum has a large collection of textile items, flat, two- and three-dimensional. The collection contains:

- national costume textiles;
- costumes from the end of the 19th century up to the Soviet period;
- accessories of the costumes: hats, gloves, scarves, belts, headdresses etc.;
- home textiles: carpets, sheets, tablecloths, towels etc.;
- and a small collection of dolls.

At the present time, the precise number of the textile items cannot be determined; the collection database has 1197 items. A general list contains the textile items that have been recorded so far (Table 5).

107Marike Laht, “Environmental Problems in Preserving Wooden Buildings at the Estonian Open Air Museum.” *Wood Structures: Global Forum on the Treatment, Conservation and Repair of Cultural Heritage, ASTM STP 1351.* S.J. Kelley, J.R. Loferski, A.J. Salenikovich, and E.G. Stern. (West Conshohocken, PA : American Society for Testing and Materials 2000). 95-101.

Table 5: General list of textile collection items.

Flat items	**Number**
Fragments of blankets	43
Blankets	317
Hand towels	272
Carpets	28
Bed covers	37
Bedsheets	30
Three-dimensional items	
Women's costumes and dresses	62
Skirts	15
Women's blouses and short jackets	37
Women's coats	25
Men's suits	30
Men's uniforms	6
Men's coats	17
T-shirts	6
Girls' baptism dresses	12
Dolls	18
Traditional gloves	37
Scarves	40
General accessories	165

3.1.2 Condition of the depository facilities and measurement equipment

1st depository facility

This depository facility is the oldest in the museum and is located close to the conservation laboratory and in the territory of the exhibition. It is a wooden building, built on stone columns, and the roof is covered with tin plates. The building was built as a summer cottage. The walls are thin and do not keep the environmental conditions stable. The stored collections are textiles, metals, leather, paintings and wooden items (Figure 26).

Figure 26: 1st depository facility of EOAM

The depository facility is a two-storey building with an inner staircase. There are three storage rooms on the ground floor (Figure 27), with a small hall at the entrance and two storage rooms on the first floor. In the back room of the ground floor, there is a fireplace. Two rooms have humidity and mould problems; in one room on the first floor and in the back room of the ground floor the mould problem was created by the chimney of the fireplace. The main entrance of the building is a double wooden door.

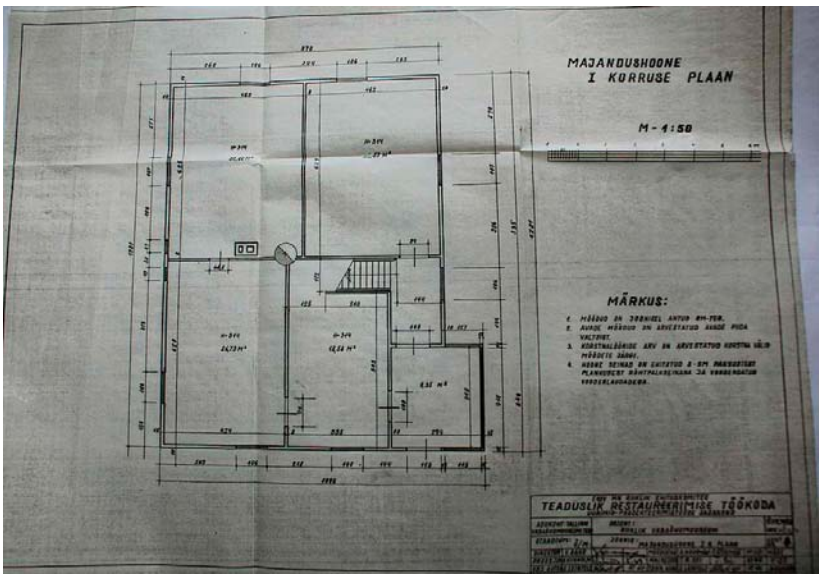

Figure 27: Architectural plan of the ground floor. The textile store rooms are at the left of the entrance.

The textile collection is stored in the two front rooms; in one room, the

metallic, leather, painting and photographic collections are also stored. In the ground floor's back room, as well as on the first floor, wooden items are stored. The first floor's storage room, which has a mould problem, is no longer in use, and cleaning has been undertaken using UVC lamps. Moreover, in the corridor of the first floor, there are mirrors hung on the walls and, in the ground floor corridor, there is a cupboard with textile fragments (Figure 28).

Figure 28: Hung mirrors in the corridor of the first floor.

In the depository facility, measures to prevent hazards and to control environmental factors have been attempted. Concerning anti-fire protection, the measure that has been taken is establishing an anti-fire system, with fire detectors, sprinklers and fire extinguishers. The textile items are stored in cupboards, so in the case of fire suppression items are partly protected. However, wooden, metal items and paintings are stored in open storage areas. The materials in the building and storage equipment do not provide any possibility of halting the expansion of a fire.

The only action that has been taken to deal with a flood is that textile items are not stored on the floor. However, some wooden and metal items are stored on the floor. In the depository facility, there is no canalisation system and outside there are no water pipes. A possible danger is that electrical cables are mounted on the wall and in a flood they could short circuit.

The building has some anti-theft protection; visiting the depository facility is possible only with the agreement of the collection manager. The visitor's name and the purpose of the visit is written down and a member of the staff is always with the visitor.

The textile collection storage rooms are connected by a double door. The room's dimensions are: first room- 18.58 m^2 and second room 26.73 m^2. The walls are painted with a light grey paint and the floor is covered with a plastic brown covering. The furnishings of the rooms are: in the first room, there are three rows of cupboards parallel to the entrance and one which is vertical to it. There are three corridors between them that are less than 1 m wide. The upper part of the corridors is reached by ladder. In the second storage room, there are two rows of cupboards which are connected in the centre of the room. On the walls are stored items on shelves.

The measurement of relative humidity and temperature is taken electronically with HOBO 1996 ONSET data loggers and with electronic thermohygrometers. The thermohygrometers' measurements are taken almost every week and written in a book. The electronic data are downloaded into a computer and saved on a hard disk.

Figure 29 shows the monthly average of relative humidity and temperature for eleven months. It reveals that the values of RH and T are not stable and from month to month there are big fluctuations. The biggest deviation in monthly average is shown in Table 6.

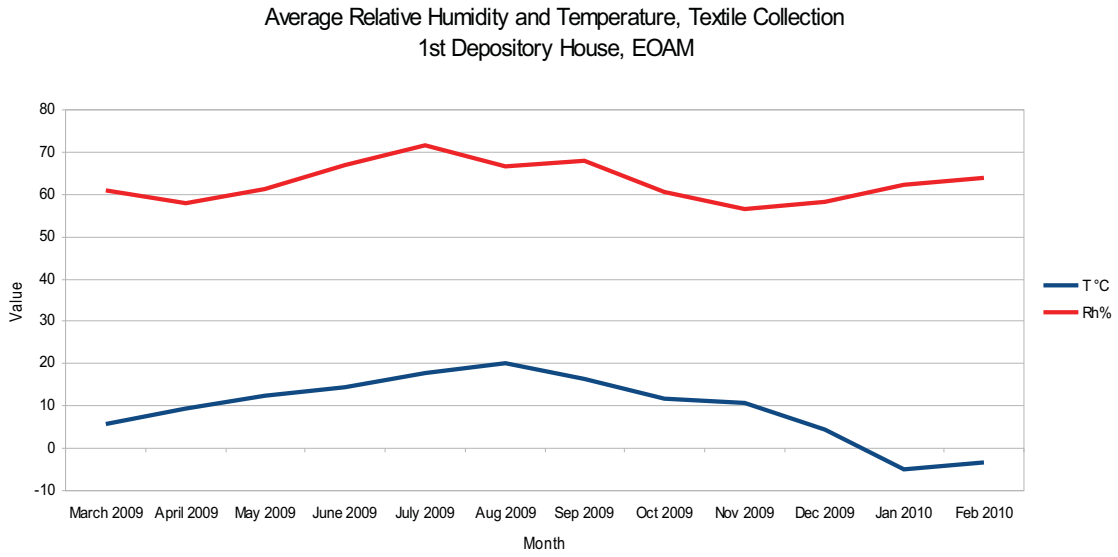

Figure 29: Graphic of the average relative humidity and temperature

Table 6: Biggest deviation in monthly average Temperature & Relative humidity.

Month	**Average**		**Biggest Deviation**	
	T °C	**RH%**	**T °C**	**RH%**
March 2009	5.7	61	2.6	64.7
April 2009	9.5	57.9	13.7	53.2
May 2009	12.3	61.2	8.9	55.8
June 2009	14.4	67.1	18.3	70.6
July 2009	17.6	71.6	21.4	76
Aug 2009	20	66.5	16.7	60.1
Sept 2009	16.5	67.8	20.7	60.8
Oct 2009	11.8	60.6	14.8	52.5
Nov 2009	10.8	56.7	11.9	48.7
Dec 2009	4.5	58.3	-2.5	48.3
Jan 2010	-4.8	62.3	-11.2	67.3
Feb 2010	-3.2	64.1	-1.5	60.1

Figure 29 shows that in most months the average RH is over 60%, the T from April until November varies 10-20°C, and in the winter the average temperature is under 0°C. The relative humidity in relation to temperature in March-April 2009 and Nov. 2009-Jan. 2010 is notable, where the RH is inversely related to T. This is especially true for the values of Nov 2009-Jan 2010, where the

average temperature fell from 10.81° C to -4.82° C, and the RH increased to 62%. This probably happened because of the closed system, as in the storage rooms there is no ventilation system. Another possibility may be that the unsuitable building materials do not stabilise the RH and T and, as a result, the building is highly influenced by outdoor RH and T values.

The climate control equipment that is used includes simple dehumidifiers (usually for home use) (Figure 31) and portable dehumidifiers, and these are used when necessary. In the storage rooms, there are electric radiators, which are in use in extreme conditions (Figure 30).

Figure 30: Use of radiators.

Figure 31: "Home" type dehumidifier and electronic thermo/hygrometer.

The lighting of the storage rooms is supplied by halogen lamps, and reduced light levels are used. The light are on only when the rooms are in use. The windows in the second room are closed, with wooden solid blinds.

In order to minimise the transfer of dust, dirt and insects into the depository facility, Tyvek coats and hats, plastic shoe covers and cotton gloves are worn. Moreover, in the rooms in which there is a mould problem extra clothing protection is worn, so as to avoid the transfer of mould molecules into the other rooms. Cleaning of the storage rooms is done at least once a year, using a vacuum cleaner.

The storage rooms are continuously observed for the presence of insects and other pests. More precisely, once a year the whole collection is checked for insect deterioration. Insects traps are used in the storage facilities and in some corners.

Second depository facility

The second depository facility (Figure 32) is located outside of the exhibition's territory. It is a two-storey building and the textile collection storage rooms are on the first floor. The collection is located in three rooms, which connect to each other with doors.

Figure 32: 2nd depository house,

The depository facility is built with blocks of plasterboard on a cement base. The used building materials are inappropriate for a depository facility, as the indoor environmental conditions are influenced by the outdoor conditions. On the outside of the building, it is apparent that the walls have a humidity problem, as the colour in some places has changed to dark grey and the paint on the walls is starting to peel off. On the cement base, there is algae growing (Figure 33). Moreover, in some places there are big holes that can easily serve as entrances for pests, e.g. for mice (Figure 34).

Figure 33: Back side of the depository house.

The interior walls of the textile collection storage rooms are painted white

and the floor is faux mosaic. In the rooms, there are no windows, but there are two entrance doors.

The room dimensions are: the first and second room are 42 m^2 and the third is 32.5 m^2 (Figure 35). The furnishings in the storage area are: in the first room there are two rows of drawers and on the right wall there is a row of shelves and drawers. In the middle room, there are two rows of four bar stands and two bars stands and bars for the hanging of costumes. There is sufficient space in the room.

Figure 34: Hole in the wall of the building.

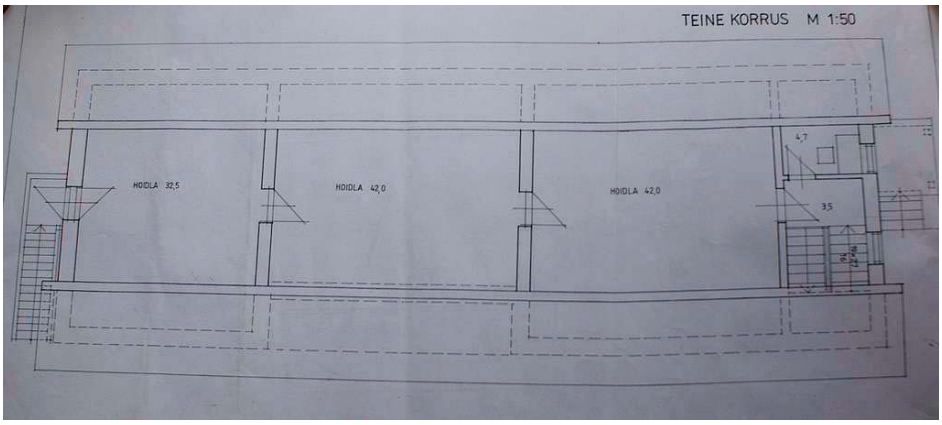

Figure 35: Plan of the textile second depository facility.

The condition of the storage rooms is not the best, as humidity and mould problems are apparent, especially in the third storage room (costume collection). The presence of mould was detected by the change of the walls' colour to grey, and white spots on some woollen coats. In the corners, there are cracks, allowing the entrance of dust, humidity and possibly insects (Figure 36).

Figure 36: Cracks at the corners.

The building is protected from fire, theft and flood. The building is protected with an anti-theft alarm, and visits to the depository follow the procedures

described above. The anti-fire measures that have been taken are the placing of fire detectors and extinguishers outside of the storage room. In the depository facility, there is no canalisation that comes through the store rooms, and outdoors there are no water-pipes. However, the naturally collecting rainwater may be responsible for the algae and humidity on the cement.

The measurement of RH and T is the same as in the first depository facility: HOBO 1996 ONSET data loggers and electronic thermohygrometers. The frequency of measurement is every week with thermohygrometers and, in addition to the storage rooms' RH and T, the micro-climate measurements of the drawers are also taken (Figure 37). The results are written in a book and the electronic data are saved on a hard disk.

Figure 37: Measurement of drawers' micro-climate.

Figure 38 shows the average monthly relative humidity and temperature for 17 months. The fluctuations in RH and T are big when outside conditions change. A characteristic feature is the increase in humidity in summer to 60% and decrease in winter to 30%. The same is noticeable for temperature: in summer the average is 20° C and in winter 8° C. Table 7 shows the biggest deviations in average RH and temperature.

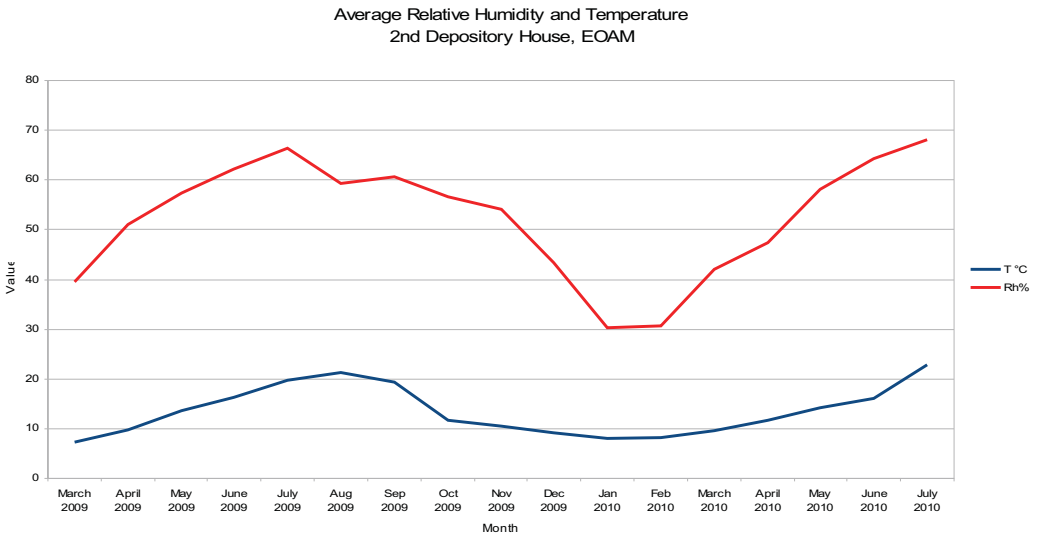

Figure 38: Graphic of average relative humidity and temperature.

Table 7: Biggest deviation of in monthly average Temperature & Relative humidity.

Month	**Average**		**Biggest deviation**	
	T °C	**RH%**	**T °C**	**RH%**
March 2009	7.2	39.5	9.3	51.8
April 2009	9.8	51	13.1	37.9
May 2009	13.6	57.4	15.8	66.8
June 2009	16.3	62.1	19.7	49.5
July 2009	19.7	66.4	20.8	75.4
Aug 2009	21.3	59.2	23.4	69.2
Sept 2009	19.3	60.7	16.5	48.2
Oct 2009	11.7	56.5	16	71.9
Nov 2009	10.7	54.1	9.2	40.1
Dec 2009	9.2	43.4	11.4	63
Jan 2010	8.1	30.4	9	20.5
Feb 2010	8.2	30.7	7	41
March 2010	9.6	41.9	11.2	31.4
April 2010	11.8	47.5	9.9	38
May 2010	14.3	58.1	17.3	73
June 2010	16.1	64.3	18	53.4
July 2010	22.8	68.1	18.9	76

The biggest deviations in the average temperature were mostly under 20° C and the lowest value was in February, 9° C, when the outdoor temperature was -10° C. Furthermore, the values of the relative humidity seemed to be more unstable. In July 2009, the biggest deviation was 76%, when the outdoor relative humidity was around 93%.

The equipment for climate control includes portable dehumidifiers, and in the storage room with mould deterioration a UVC lamp and silica gel are used. In addition, in the storage rooms there is a ventilation system and electrical radiators, which are used only when necessary.

The lighting of the storage rooms is controlled (artificial), and it functions separately for every room. When the rooms are not in use, the lights are turned off.

In order to minimise the possible transfer of dust and dirt into the rooms, shoe covers, Tyvek coats, hats and cotton gloves are used. The rooms are cleaned once a year with a vacuum cleaner.

Detection of the presence of insects is done every time the storage rooms are visited. However, the type of floor makes detection difficult. The whole collection is checked once a year for insect deterioration. If an insect is found, it is observed with a microscope in order to identify it. Finally, the policy of the museum is that with every new textile item that is added to the collection appropriate treatment steps are taken: cleaning with a freezing technique.

3.1.3 Materials and method of storage

First depository facility

In the old depository facility, the textile items are stored in closed wooden storage units, modified according to the type of the items; there are cupboards, shelves, drawers and bases for rolled items. The items are mostly national costumes and some of their accessories, home textiles (carpets, sheets, tablecloths etc.) and a few dolls.

The costumes are mostly hung on wooden hangers, and a few of them are padded. The items are packed together because of a lack of space and facilities. Moreover, the items come into contact with wooden surfaces, increasing the possibility of mechanical and chemical damages and item deformation. Moreover, in the cupboards where such heavy items as coats (Figure 39) are stored, the wooden bar is deformed. The skirts are hung on the metal hooks of hangers and textile strings are sewed on skirts' sides.

Figure 39: Winter coats stored in cupboard.

Some three-dimensional objects, such as blouses, children's clothes and dolls, are folded and stored on top of each other. The items are separated from the wood surfaces and between the items sheets of buffered acid-free paper are placed (Figure 40). However, except for the dolls, the other items are not filled with “sausages”, increasing the deformation of the items. Three dimensional items, usually children's dresses, are stored in normal cardboard boxes, with a depth of around 20 cm; in some cases, two items are stored in the same box. The items are separated from the box surface and, although “sausages” are used to fill the items, deformation and wrinkling occur.

Figure 40: Child's dress stored in non-acid free box.

Different flat items (long and short), such as carpets, curtains, tablecloths and towels, are folded and stored on wooden shelves, inside cupboards. Tyvek and buffered acid-free tissue is used to separate items. Because of a lack of space and equipment, the items are stored one atop another. Traditional silk scarves are stored vertically in cupboards (Figure 41). The scarves are rolled around wooden bars, which are padded with many buffered acid-free tissues; in some cases, acid-

free cardboard tubes are used. The top of the items are covered with acid-free tissues or pre-washed, unbleached and non-dyed cotton textiles. The vertical storage of silk scarves is not suitable as this increases tension on the material but, due to a lack of equipment, it is a temporary solution. Using the rolled method, some fabric samples are also stored, and they are kept horizontally at the base of the cupboard.

Figure 41: Silk scarves rolled and stored vertically.

Figure 42: Paintings covered with Tyvek.

Of the other material items that are stored in the second storage room, some are kept on shelves (metals, leather and paintings covered with Tyvek) and some in cupboards (photographic material) (Figure 41).

Second depository facility

In the second depository facility, the items are stored in closed and open wooden units (drawers, open shelves, stands and units with metal bars). The items that are stored are textiles from different periods and of different types (national costumes, city costumes from the 18th and 19th centuries, 20th century costumes and accessories, a collection of carpets and fabric samples, and a small collection of paper materials (Figure 43)).

Figure 43: Closed storage unit-drawer.

Long flat items, such as carpets, are rolled. The rolling process follows the same steps as in the first depository but all the items are rolled around acid-free cardboard tubes. The rolls are kept on wooden bases that have been specifically designed (Figure 44). Small two-dimensional items, such as ribbons, fabric samples and belts, are stored in drawers and some belts are kept in normal cardboard boxes. To separate the items from the wood and cardboard surfaces, layers of acid-free cardboard and acid-free tissues are used. The fabric samples are stored in layers horizontally (Figure 45).

Figure 44: Rolled flat dimmension items.

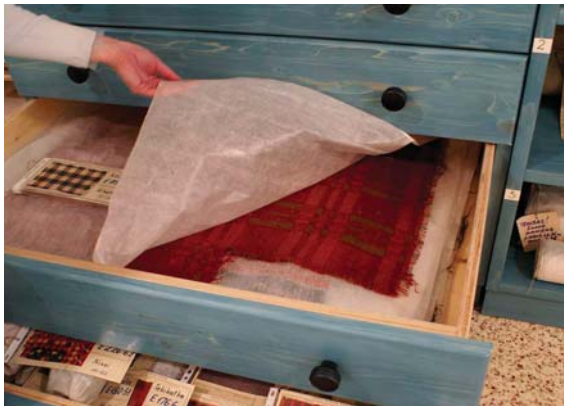

Photo 45: Fabric samples stored in drawers.

Three-dimensional objects are stored in drawers or hung from metal bars. In the drawers, accessories of the costumes, headdresses and blouses are stored. A lot of objects are kept in drawers and, because of a lack of facilities, many are stored together. Cases have been designed to fit in the drawers, in which small hats and headdresses are stored. Pot hats are stored one inside the other and are filled with buffered acid-free paper (Figure 46). Some blouses are stored together and are filled with “sausages” to prevent deformation, although wrinkling does occur. Gloves, socks, ties and other accessories are laid in drawers and they try not to pack them too tightly. All the items are separated from the wood surfaces and layers of buffered acid-free tissues are used if many are stored together. Opening the drawers is difficult and slight movement of the stored items is inevitable, causing further mechanical damage over the years.

Figure 46: Pot hats are stored horizontally in drawers.

Costumes are hung on metal bars (Figure 47). Most of the hangers are padded and, to hang skirts, strips have been used, as in the first depository facility. The items are covered with Tyvek to protect them from dust.

Figure 47: Storage of costumes on metallic bars.

3.1.4 Method of labelling

Every item has its own museum number. The old method of cataloguing was to write down in the museum collection manager's book detailed descriptions and sketches of the items. Later the cataloguing of items was transferred to MS Excel files, with small descriptions and photos of a few items, and since 2009 data has been continuously entered on MUIS.

The labelling of items is done with textile labels that are sewed on the items. All the necessary steps have been taken that were described in Chapter 2.4. In closed storage units, labels are used, with the type of items (blouses, skirts, carpets etc.) that are stored and also there is a catalogue of the items (Figure 48 & 49). Moreover, in both depositories, there are catalogues listing the items that are stored.

Figure 48: Catalogue list has been placed on the door cupboard, (1st depository facility).

Figure 49: Catalogue list in drawers, (2nd depository facility)

3.1.5 Condition of items

The researched items were chosen randomly, with the help of the museum collection manager, separated into different types and materials.

First depository facility

At the first depository facility, 20 items were investigated. The types and materials of the items are (Table 8):

Table 8: Researched items during the condition assessment, (first depository facility)

Object	**Material**	**Number of items**
Dolls	Cotton, linen, wool	3
Traditional bodices	Wool	3
Traditional skirt	Wool	1
Children's dresses	Cotton, gauze	3
Women's bags	Silk	2
Scarves	Silk, brocade,synthetic silk	3
Hand towel	Cotton and linen	1
Decorative tablecloths	Linen,cotton	3
Tapestry	Wool	1

The condition assessment of the objects is shown in Figure 50. 47.4% of the items were rated as in Good condition; these have some deterioration, but not enough to influence their condition dramatically. 36.8% of the objects were rated as in Bad condition, with considerable damage. 10.5% of the researched items were in Very Bad condition, and only 5.3% were in Very Good condition.

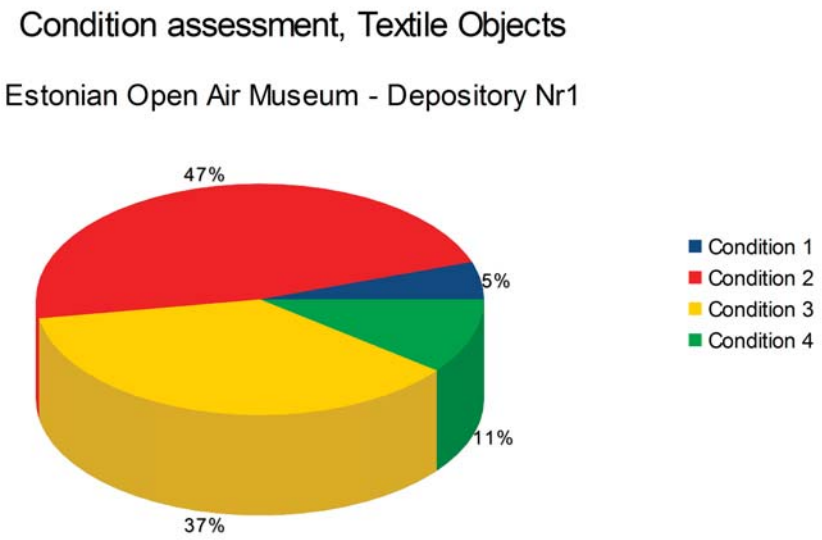

Figure 50: Graphic of items condition.

The items that were in the 4th condition (Very Bad) were silk; they seemed to have the greatest amount and severity of damages. Linen items were mostly in the 3rd condition (Bad).

The most common material damages identified are presented in Figure 51.

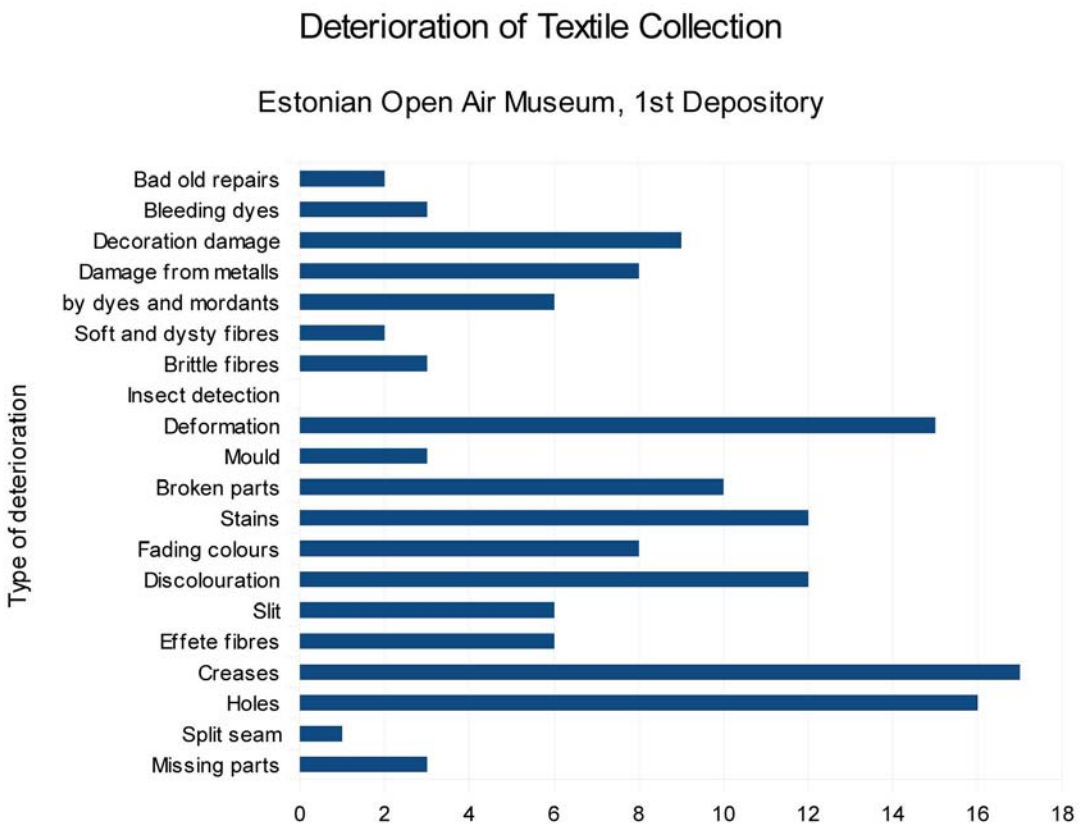

Figure 51: Deterioration of textile items.

Most of the objects seemed to be wrinkled and deformed, a result of the lack of storage space and facilities. Holes are a typical form of deterioration of textile items and are usually created by the textiles' use and not by the method of storage. However, unnecessary movement during the opening, for example, of drawers can increase the number of holes or other mechanical damage. The fading of colours and discolouration are forms of deterioration that sometimes result from the use of items (from exposure to light) and from the contact of items with wooden surfaces. Textiles' delicate fibres should be taken into consideration in the method of storage, and fluctuations in environmental conditions can increase the problem. The mould stains on some items were probably created during the use of the items, as in the storage rooms there was no problem with mould. However, the commonly high relative humidity in the storage rooms (over 60%) may have been a cause of mould.

Second depository facility

At the second depository facility of the museum, 11 objects were observed. The types and the materials of items are (Table 9):

Table 9: Researched items during the condition assessment,(second depository facility).

Objects	**Material**	**Number of items**
Traditional coats	Wool	2
Men's suit	Wool, cotton	1
Shirt	Wool	1
Blouses	Cotton, silk	2
Woman's costume	Wool, silk, cotton lace	1
Dress	Cotton	1
Pot hats	Silk	3

Figure 52 shows the results of the condition report. Generally, most of the items were in Good condition (58.3%). 33.3% were rated in Bad condition and 8.3% in Very Bad condition. None of the researched objects were rated in the first condition (Very Good), although the third room's items (costumes collection) could not be rated because of the appearance of mould in that room.

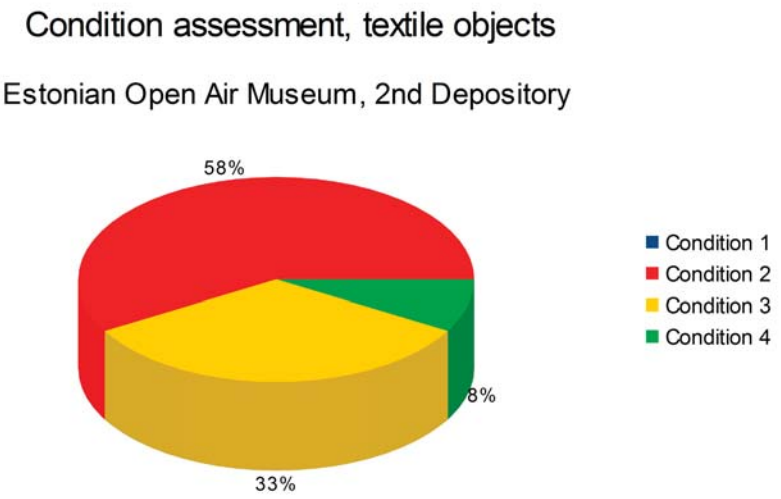

Figure 52: Graphic of items' conditions.

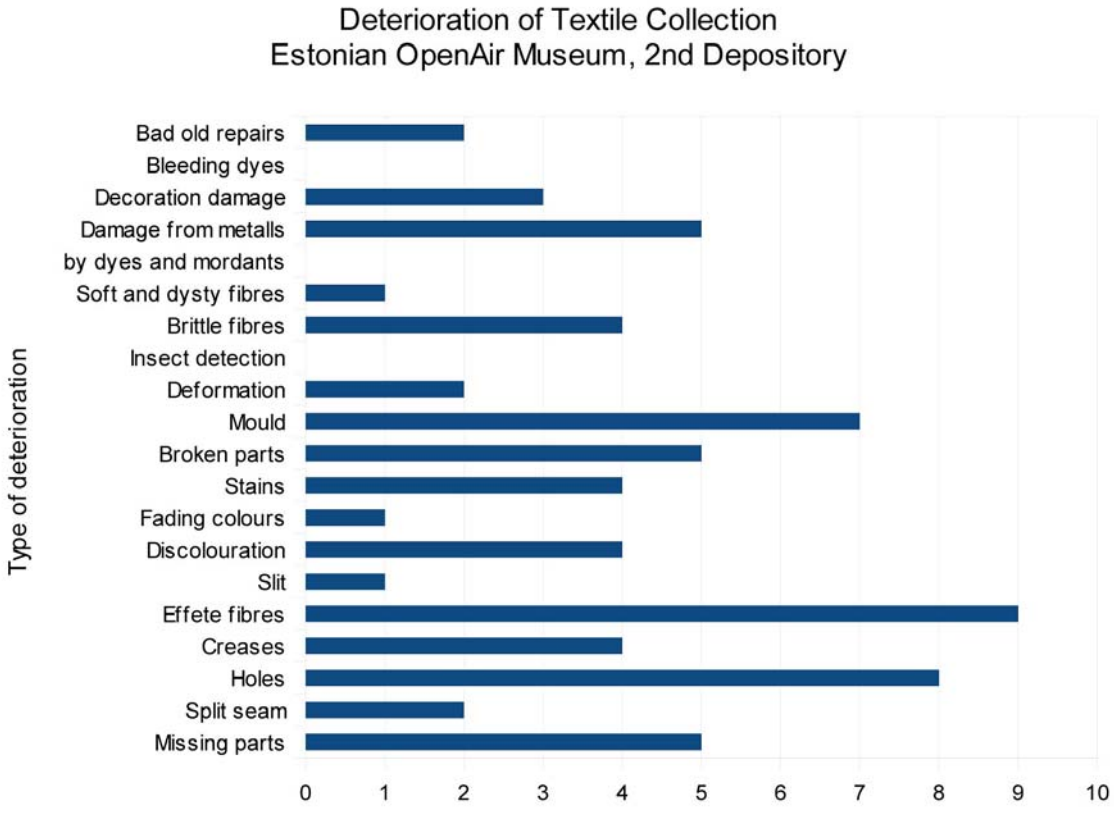

Figure 53: Deterioration of textile items.

The main deterioration problem of the items was due to the delicate nature of the threads, which is logical as most of the researched objects were silk (Figure 53). The damaged threads were a result of the items' use and age. However, in some cases (pot hats), deterioration was increased by the storage facilities and particularly from the abrasion that developed while opening drawers. Several of the objects had hole deterioration, which probably came from the use of the items. There was a large amount of mould deterioration in objects in the third storage room.

3.1.6 Conclusion

The Open Air Museum has a very rich and important collection, not only of textile objects but also of other ethnographic materials. The depository facilities face quite important problems that influence the condition of the items. The museum's preservation management plan would have been better if there were only one depository facility; of course, in the current situation, the conditions are less than ideal. Moreover, the results of the preservation plan and actions (treatments) depend on the museum's general economic situation.

The main problems of the depository facilities start with the outside of the buildings. The materials that were used for the construction of the buildings are not suitable to sustain stable environmental conditions, especially at the first depository facility, which was not designed to store museum collections. In order to stabilise the climate, the conservators and collection manager use the increasing/reducing of temperature and humidity. The regular use of radiators requires energy and their use is rather expensive. Moreover, the cracks in the corners of the second depository allow the entrance of dust and also possibly various micro-organisms.

As for the storage equipment, wooden equipment is cheaper than metal. However, to cover the wooden surfaces mostly acid-free materials should be used and replaced often. The main problem is the fluctuation of wood's dimensions (expansion/shrinking) and therefore deformation of equipment occurs, resulting in difficulties in opening drawers. Also, wooden cupboard doors do not close well (hermetically).

The problem of lack of space and of equipment creates difficulties for the proper storage of the objects. The narrow corridors in the first depository facility make accessibility to the items difficult, and increase the possibility of mechanical damage when items are moved, as for example the use of ladders is difficult and not secure. Due to the lack of space, the items are stored tightly, packed together. Some of the items stored in the second room of the depository facility (metals and wood) are not suited to the climate conditions that textiles require. For example, metal items require an RH of 35%; at higher levels, corrosive[108] oxidisation and transfer of particles onto the textile objects occurs.

Additionally, the building materials of the first depository facility increase the risk of quick fire spread.

To sum up, the risks that the textile collections may face at the depositories are:

First depository facility

- biological deterioration;
- increase in mechanical damage;
- deformation;
- chemical deterioration;
- fire risk;

Second depository facility

- biological deterioration;
- deformation;
- increase in chemical damages.

108 NPS, *Appendix O: Curatioral Care of Metal Objects,* 2004 http://www.nps.gov/museum/publications/MHI/Appendix%20O.pdf, 03 Dec.2011.

3.2 Estonian History Museum Castle of Maarjamäe

The Estonian History Museum (EHM) at the Castle of Maarjamäe is located on the Bay of Tallinn in the Pirita area. It is a complex of buildings that were used as summer houses and, beginning in the 17th century, had the name Strietberg. Over time, the place was owned by different people (Johan Gottlieb Clementz, Christian Rotermann, Anatoli Orlov-Davõdov et al.). Every owner built and changed the area and the use of the buildings. In 1975 the manor house was given to the Estonian History Museum. The main building is used for exhibitions and has some offices. The textile depository facility is located in the previous servant's house opposite the castle, on the first floor. The collection contains different types of textiles, mainly from Estonia, and mostly urbanized and city clothes.

3.2.1 Items

The Table 10 shows the collection's items, but unfortunately the precise number of items cannot be determined, as not all of the items are registered; the data have not yet been entered on the MUIS database, and new items are continuously coming in. The textile collection does not contain folk costumes, and there are mostly costumes from city life. The oldest items date from the 16th century, embroidered priest robes. The majority of the collection is three-dimensional, with some flat textiles and a few two-dimensional items.

Table 10:

Type of textile collection

Three dimensional	Costumes	Folk	
		16th century	√
		19th century	√
		20th century	√
		Modern	√
		uniforms	√
		theatrical	√
		priest's clothes	
		replicas	√
Costumes' accessories	gloves		√
	bags		√
	fans		√
	sun's umbrellas		√
	umbrellas		√
	hats		√
	scarfs		√
	belts		√
	socks		√
	textile shoes		√
	hairdressers		√
	pins		√
	other type		
Flat dimensional	carpets		√
	church furnishing		√
	flags		√
	banners		√
	blankets		√
	towels		√
	cartins		√
	sheets		√
	table clothes		√
	decorative home textiles		√
	other type		
Two dimensional	tapestries		
	ribbons		
	length of textile		
	fabric samples		√
	archeological		
	other type		

3.2.2 Condition of the depository facility and measurement equipment

The depository facility is a stone building, which helps to maintain quite stable environmental conditions. On the outside of the building, there are no cracks or humidity problems. The outside and the roof of the building seem to be in good condition.

The size of the storage room is 143.5 m^2 (Figure 54) and it is next to the collection manager's office. The room is sealed with a metal safety door, which helps to keep the temperature and humidity at suitable levels. The insides of the windows are covered with rolled thick white curtains, so as to avoid UV deterioration. Artificial lighting is used only when the room is in use, and is provided by normal lamps. The colour of the walls is white and the floor is covered with white tiles. Considering the storage room and the number of collection items, there is very little space.

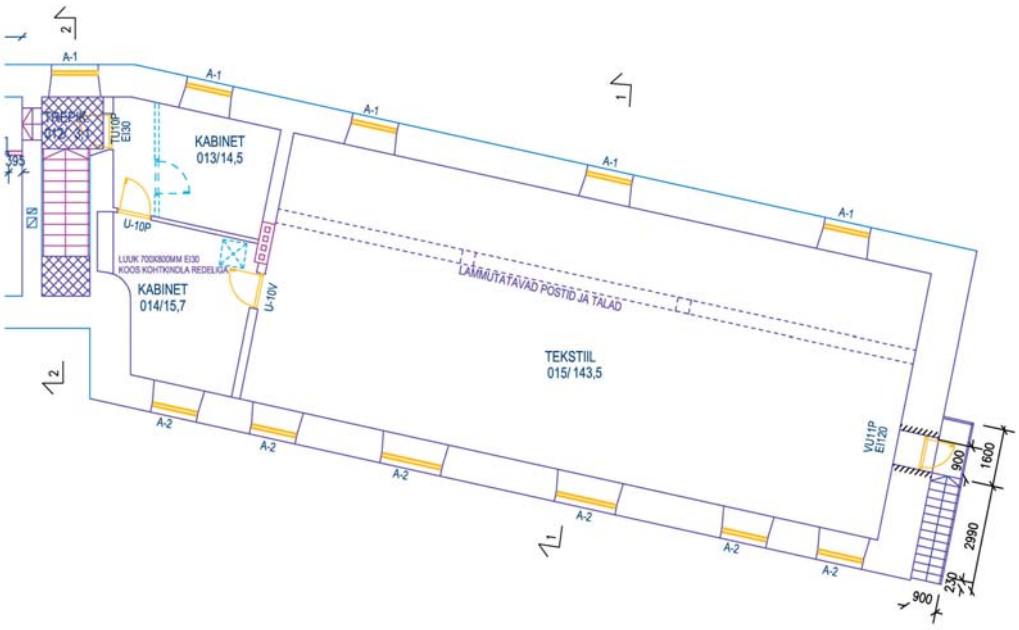

Figure 54: Architectural plan of the textile depository facility.

The anti-fire system that is used for fire suppression is an Argonite system[109], which uses Nitrogen and Argon and suppresses fire extension (Figure 55). This system is not harmful to both the personnel and the items. Gases are released from the holes that are in the wall. In terms of dealing with floods, the water-pipes and the outside of the building are checked often. They avoid storing items on the floor.

Figure 55: Anti-fire system Argonite.

As for the RH and T, in winter the relative humidity is around 34%-38% and the temperature is around 10°C. In summer, the RH is around 50%-55% and the T around 20-28°C. Figure 56 shows the average of 12 months; the climate data for October and November 2009 are missing. Table 11 shows the biggest deviation in the monthly average. For the measurement of RH and T, HOBO TEMPERATURE, RH (C) 1996 ONSET loggers are used.

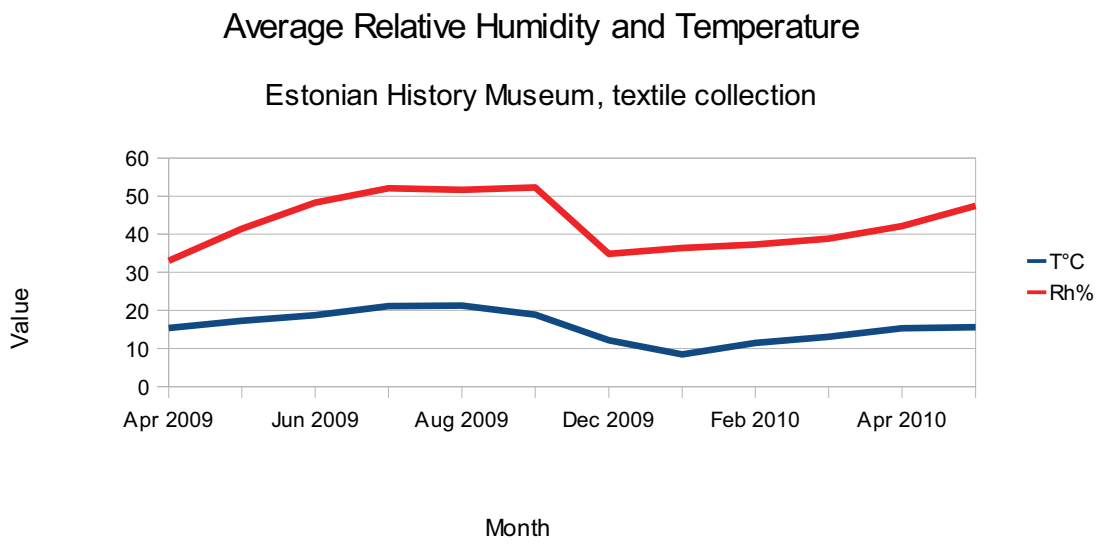

Figure 56: Graphic of average relative humidity and temperature.

109 GUNNEBO®, *Argonite System*, n.d. http://www.gunnebo.com/id/products/FireSystems/FireSuppressionSystem/Pages/ArgoniteSystem.aspx, 23 Sept.2011.

Table 11: Biggest deviation in monthly average Temperature & Relative humidity.

Month	Average		Biggest deviation	
	T ° C	RH%	T ° C	RH%
April 2009	15.4	33	17.4	42.4
May 2009	17.3	41.4	19.4	28.9
June 2009	18.7	48.3	21.7	60.4
July 2009	21.1	52	19.4	39
Aug 2009	21.3	51.7	25.17	38.8
Sept 2009	18.9	52.3	22	67.3
Dec 2009	12.1	34.9	17.9	46.7
Jan 2009	8.5	36.4	20.95	24.2
Feb 2009	11.5	37.2	18.28	23.4
March 2009	13.1	38.8	22.09	24.1
April 2009	15.3	42.2	21.71	45.7
May 2009	15.6	48.5	19.04	41.9

Generally, comparing Figure 56 with Table 11, it is noticeable that the RH and T showed no big fluctuations during the year, with some exceptions in RH in summer. The values of T remained at normal levels.

The equipment used and measurements taken to stabilise temperature in winter are electrical radiators and relative humidity; when RH drops under 25%, long wet textile strips are used on the floor. The depository facility has a proper ventilation system.

The control for insects and pests is done by visual observation of the whole textile collection two times a year. Due to holes in the walls from the anti-fire system, the use of insect traps is avoided, in order to minimise the risk of attracting insects (Figure 57).

Figure 57: Holes in the wall for the anti-fire system.

The cleaning measures include the use of shoe covers and gloves. The room is cleaned quite often with a vacuum cleaner.

3.2.3 Materials and method of storage

The storage equipment includes closed wooden units (cupboards, drawers, shelves and places for rolled items). Also boxes are used, which are mainly made of acid-free cardboard. The items are stored depending on their type.

Three-dimensional objects are stored in cupboards, drawers and boxes and on shelves. Costumes are mainly hung in cupboards, if their condition allows (Figure 58). Mostly wooden hangers are used, although there are some metal and plastic hangers. Most hangers are non-padded. The items are packed and sometimes come in contact with the wood or with items that are stored in the lower part of the cupboard. No acid-free materials are used to separate items from the wood surfaces. Costumes whose condition prevents them from being hung are stored horizontally, using “sausages” of acid-free paper to fill them (e.g. a brocade priest's robe from the 16th century). With some three-dimensional items stored in boxes, a model is used (Figure 59). Boxes are stored either in cupboards (if there is space) or at the top of cupboards. Also some fans are stored in envelopes made of acid-free cardboard, as their condition is rather poor.

Figure 58: Costumes stored hung in cupboards.

Figure 59: Three-dimensional item stored on a mounting.

Flat objects are rolled and stored in drawers. The long items are stored folded with buffered acid-free paper to minimise wrinkling. Moreover, some fragments and samples are stored in acid-free cardboard envelopes. Laces, small scarves and other small items are stored separately in non-acid-free boxes.

Some long flat items, such as carpets, flags and banners, are stored rolled in acid-free cardboard tubes and are stored on stands with wooden bars. The items are covered with cotton textiles, in order to protect them from dust (Figure 60).

Figure 60: Rolled long flats items

The storage equipment is wooden and this creates some problems: the cupboard doors do not close tightly (hermetically), and the drawers are difficult to open. The storage unit with the drawers is difficult to access if items are stored in the top drawers; the same is true of the boxes that are stored at the top of cupboards.

3.2.4 Method of labelling

The labelling system is the same as at the EOAM. Every item has its own museum number. The old system of cataloguing was to write on cards the item's number, material and a small description of it. The cards were kept in numerical order. Nowadays, the cataloguing is done on MUIS. The cataloguing number contains the museum's name, the collection, the archiving number of the object and the storage location.

The numbers are written on the items on textile ribbon and sewed on at a place that is visible. The exception are the shoes, where the number is written or glued on the sole. For the items that are store in boxes, in envelopes and rolled, the number is also written on the outside. The storage units are numbered and have labels giving the types of items stored inside the unit.

3.2.5 Condition of items

The researched items were chosen randomly with the help of the museum collection manager by different types and materials; 28 items were observed. Mainly, there were three-dimensional objects and some two-dimensional. The types and the materials of the objects are presented below (Table 12).

Table 12: Researched items during the condition assessment.

Item	**Material**	**Number of items**
Uniforms	Wool, cotton	2
Coats	Synthetic leather and synthetic silk, cotton, wool, linen	4
Rain coat	Nylon	1
Dresses	Viscose, nylon, silk, synthetic silk, cotton and elastic, poly-amid	10
Skirt	Viscose	1
Fans	Silk	3
Child's shoes	Cotton,linen,leather	1
Rain shoes	Waxed cotton	1
Umbrella	Silk, combination wool and silk, poly amid, cotton	4
Embroidery	Brocade (silk, metal threads, cotton)	1

The condition assessment of the researched objects is shown in Figure 61.

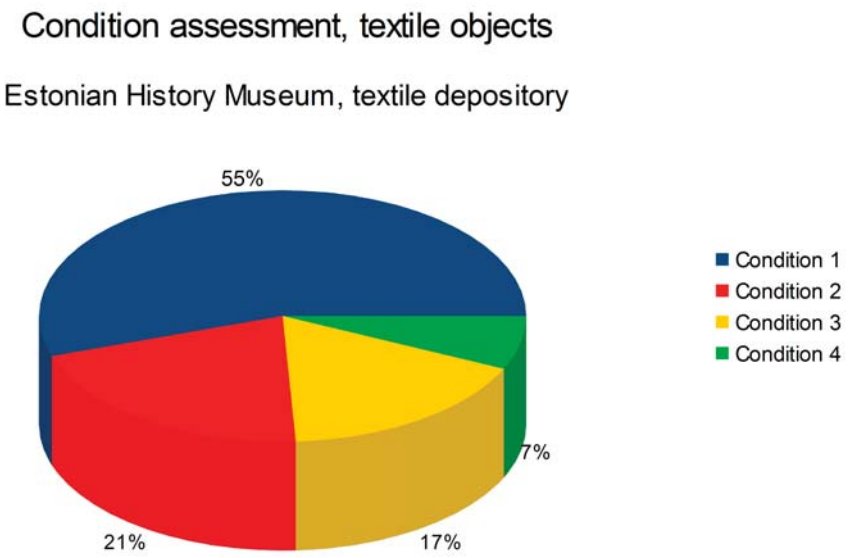

Figure 61: Graphic of items' condition.

55.2% of the items were in Very Good condition, especially items made of man-made threads, as the main types of damage identified were deformation, some holes and tears and old poor quality repairs. 20.7% of the items were rated as in Good condition and 17.2% in Bad condition. 6.9% were rated as Very Bad: usually these were silk objects.

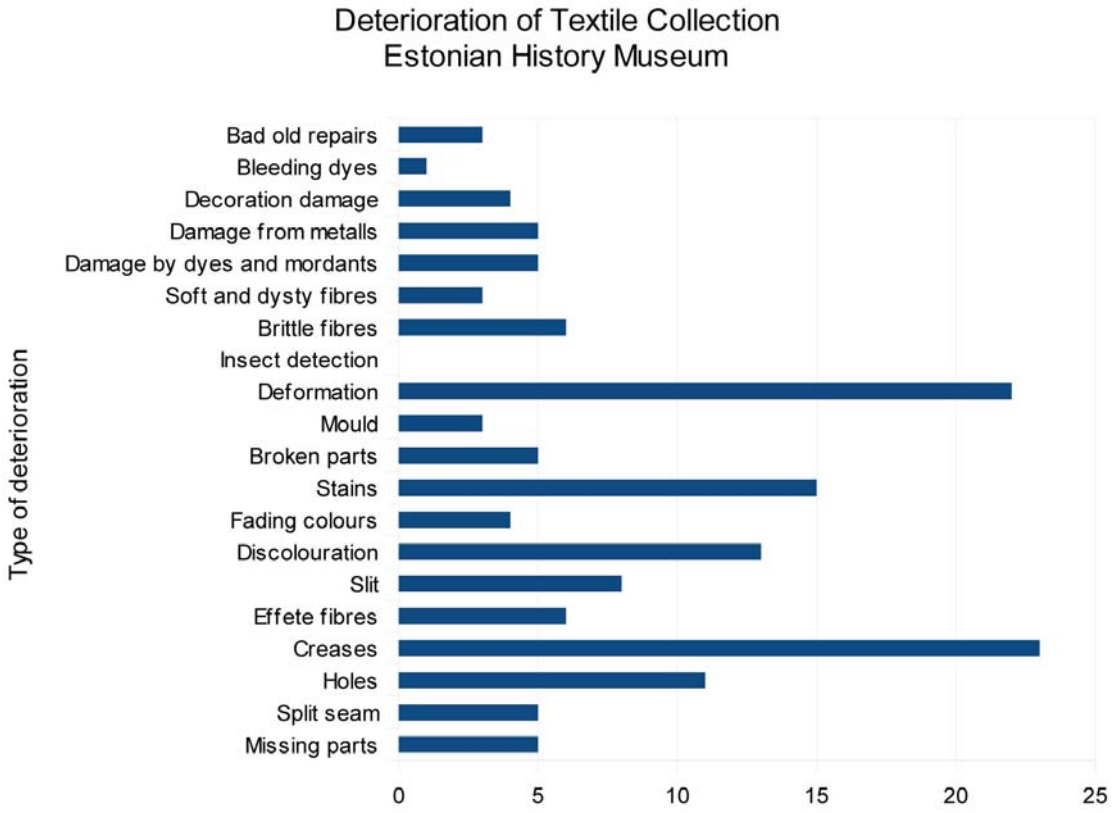

Figure 62: Deterioration of textile items.

Figure 62 shows that the main types of damage to the collection are deformation and a big amount of wrinkling, both caused by the method of storage and the lack of storage equipment. The items don't have a necessary appropriate space to preserve their condition. Stains and discolouration are damages that probably came from the use of the items, but also from their contact with wood surfaces. Also, the fact that closets do not close hermetically and dust particles enter may result in discolouration. The existence of mould on a few objects was also created by their use, as with umbrellas, rain coats and rain shoes mould has created black stains on the items.

3.2.6 Conclusion

The condition of the outside of the depository facility does not lead to changes in RH and T and does not further influence the condition of the stored collection. Several preventive actions have been taken to secure the storage

environment against physical hazards. The preservation plan and measurements correspond to the museums' general economic condition.

Due to the lack of space and storage equipment, all the necessary storage procedures cannot be properly followed. Items are packed and stored together tightly and the space in the storage equipment is being used beyond its capacity.

The use of wooden storage equipment and wooden unpadded hangers increases the possibility of item deterioration. High storage units of drawers create a problem in collection accessibility and also risk movement of items. To sum up, the possible risks that the textile collection face are:

- deformation;
- discolouration;
- increase in mechanical damage;
- problems with the accessibility of the storage collection.

3.3 Tallinn City Museum

The building of the Tallinn City Museum is a medieval building that dates back to the 14th century. It is located in the Old Town of Tallinn, in Vene Street. Over time, the purpose and owners of the building changed, until in 1963 it became a museum.

The purpose of the museum is historical and it contains items dating back to the prehistoric period. There are three depository rooms in the building, in the basement (mostly stored glass items), on the ground floor and on the fourth floor, where the textile collection is stored.

3.3.1 Items

The textile items' types that the museum owns are three-dimensional, flat textiles and two-dimensional items. The number of textile items is around 1575. The oldest is from the 16th century (Tallinn's Town Hall tapestry) and the newest from the 21st century. The textile items consist of different materials made of natural and man-made threads. The textiles are shown more precisely in Table 13:

Table 13: General amount of textile collection.

Type of textile collection				
				Number
Three dimensional	Costumes	Folk	√	10
		19th century	√	21
		20th century	√	285
		21st century	√	2
		uniforms	√	
		theatrical		
		priest's clothes		
		underweras	√	144
		ritual clothes	√	22
		dolls	√	12
Costumes' accessories	gloves		√	55
	bags		√	18
	fans		√	7
	sun's umbrella		√	15
	umbrellas		√	7
	hats		√	115
	eyeglasses' case		√	3
	bonet		√	10
	scarfs		√	21
	belts		√	22
	socks		√	7
	tights		√	18
	textile shoes		√	
	hairdressers			
	lips		√	10
	wallets		√	
	muff		√	2
	pins			
	other type			
Flat dimensional	carpets		√	35
	church furnishing		√	17
	flags		√	97
	blankets		√	28
	towels		√	62
	curtains		√	22
	sheets			
	table clothes		√	92
	pillows		√	30
	decorative home textiles		√	90
	handkerchief		√	17
	headscarf		√	130
Two dimensional	tapestries		√	1
	small tapestries		√	14
	ribbons		√	37
	length of textile		√	97
	fabric samples			
	archeological			
	other type			

The textile collection is stored in ground and fourth floor store rooms, and the glass collection is also stored in the same store rooms.

3.3.2 Condition of the depository facilities and measurement equipment

The general construction of the building is of stone. After the renovation of 2000, a new storage room was built on the fourth floor. Before that, items were stored only on the ground floor and in the basement storage room. The building is connected with two other medieval houses and has an inner courtyard. The outside of the building seems to be in good shape, as the gutters are in good condition, the roof does not seem to have problems and the outside walls have no signs of algae.

The whole building is protected by anti-fire and anti-theft alarms. In the storage rooms, there are smoke detectors and also fire extinguishers. As a preventive action in the case of flood, nothing is stored on the floor and there are regular checks of water pipes. Visits to the store rooms can be organised only through arrangements with the collection manager.

Fourth Floor Store Room

The size of the storage room is 66 m^2, it is located under the roof, and its highest part is 2.20 m (Figure 63). Because there are no separate plans for the storage rooms and due to security reasons, the original architectural plan cannot be presented. The ceiling material used is plasterboard. This choice has created some problems in the maintenance of proper environmental conditions, as the material doesn't protect the building from outdoor conditions. The colour on the walls and ceiling is white and the floor is covered with dark grey and white tiles. The storage equipment includes closed units and there is a space for easy access to the store room. In the same store room, the collections manager's office is located, so the area is in use every work day.

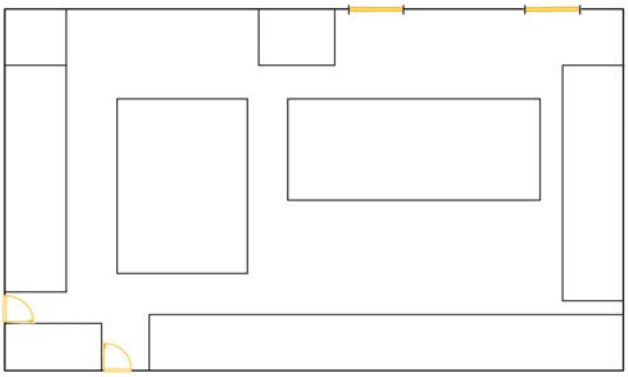

Figure 63: Plan of the fourth floor store room.

The lighting is artificial and natural, as there are windows, although they are covered with white rolled curtains, letting some light enter. The artificial lighting is separated into sections and the lights close to the manager's desk and glass collection are used every day. The tubes and bulbs in use are covered, although there was not enough information about the type of covering. The light lux level is around 45-65 l.

The measurement of RH and T is done with electronic loggers and the results are saved on a computer. The level of RH in summer is around 45%-55% and T is around 25°C; in winter RH is around 25%-35% and T is around 15°C. Figure 64 presents the monthly average of RH and T for five months. Due to missing data, only five months are presented instead of one year.

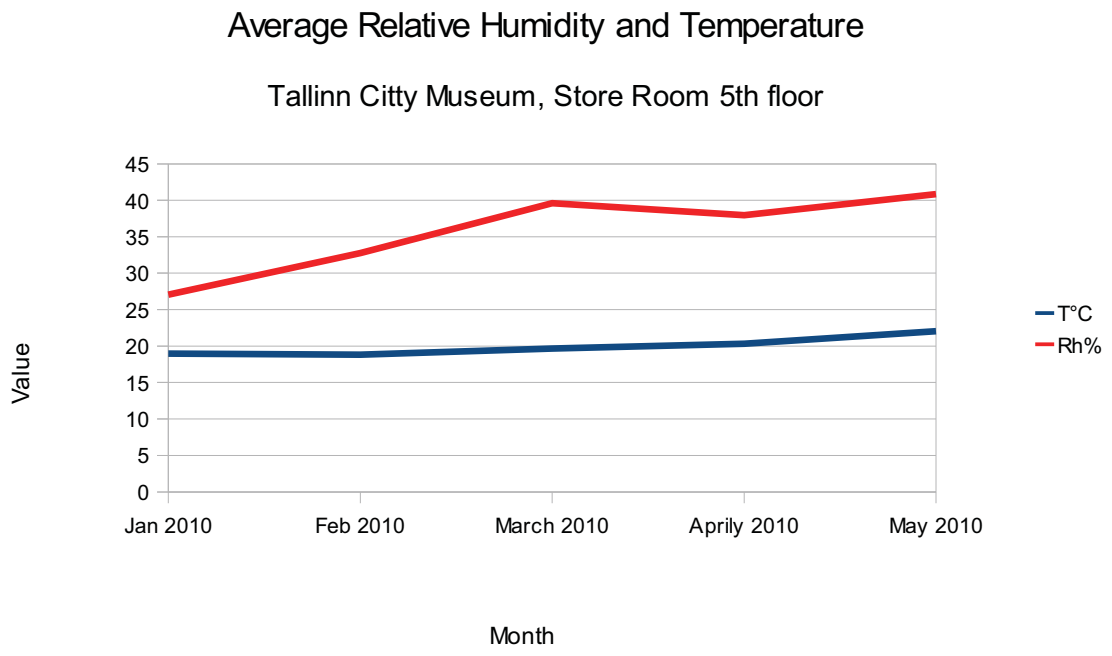

Figure 64: Graphic of average relative humidity and temperature.

Table 14 shows the biggest deviation in monthly average.

Table 14: Biggest deviation in monthly average Temperature & Relative humidity.

Month	**Average**		**Biggest deviation**	
	T °C	**RH%**	**T °C**	**RH%**
Jan 2010	18.9	27.1	20.1	33.9
Feb 2010	18.1	32.8	17.9	42
March 2010	19.7	39.6	21.1	25
April 2010	20.3	37.9	18.3	50.1
May 2010	22	40.8	18.5	55

T mostly remains at normal values, around 20° C. However, RH shows bigger fluctuations, which may be the influence of outdoor climate and also due to the everyday use of the room.

In order to stabilise RH and T, there are a ventilation system, dehumidifier and radiators in use (Figure 65).

Preventive steps against insects include the use of insect traps, which are checked every season. If an insect is found, it is observed with a microscope, in order to identify it. In terms of the cleanliness of the storage room, shoe covers are required, although hats and coats are not used. However, when items are opened (unpacked), cotton gloves are used. The area is regularly cleaned with a vacuum cleaner.

Figure 65: Dehumidifier and radiator

Ground Floor Store Room

The size of the room is 23 m^2, the colour of the walls are white and the floor is covered with light grey tiles. The room is heavily furnished with storage equipment, which covers most of the space, and accessibility is difficult (Figure 66).

Figure 66: Plan of the ground floor store room.

The room lighting is artificial. There is a big window, which is not covered

with curtains. The type of the lamps in use cannot be specified as they are covered; the light lux level is 45-65 l.

RH and T are measured with electronic loggers and the data are saved on a computer. Figure 67 presents the five months' average. T is around 15° C to 20° C and in February it seems to be around 15° C. The values of RH show big fluctuations. In winter the humidity is quite low, around 25% to 30%, and from April it starts to increase to normal values (40%-45%).

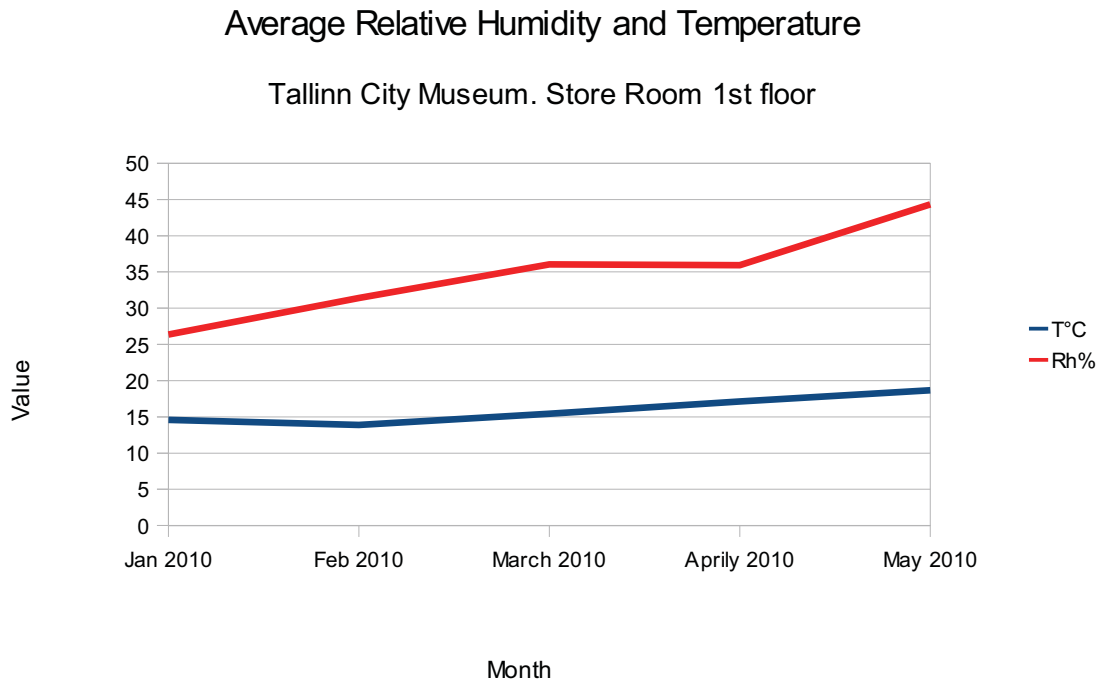

Figure 67: Graphic of average relative humidity and temperature.

Table 15 shows the biggest deviation in the monthly average.

Table 15: Biggest deviation in monthly average Temperature & Relative humidity.

Month	**Average**		**Biggest Deviations**	
	T° C	**RH%**	**T° C**	**RH%**
Jan 2010	14.6	26.4	11.9	15
Feb 2010	13.9	31.4	15.5	42
March 2010	15.4	36.1	16.8	26
April 2010	17.1	35.9	16.8	47
May 2010	18.7	44.3	16.7	62

T does not show big monthly fluctuations, mostly remaining at the same level. RH, on the other hand, seems to show big fluctuations, with the biggest in May, when the month average is 44.33% and the biggest deviation 62%. One possible reason is the big window, which may influence the stability of the environmental conditions.

The equipment that is used for the stabilisation of RH and T are radiators and de-humidifiers, which are used only when necessary.

The prevention actions against insects and dust are the same as in the storage room on the fourth floor (Figure 68).

Figure 68: Use of insect traps.

3.3.3 Materials and method of storage

The equipment that is used for the storage of the items includes mostly wooden, closed storage units, such as cupboards, drawers and shelves, and an open wooden storage shelf in the fourth floor storage room. In order to provide proper storage of textile items, there are also acid-free cardboard boxes and such materials as buffered acid-free tissues, cotton textiles, plexi-glass for the storage of glass items, glass, polyester and Tyvek.

The storage of the items depends on type, dimension and condition. The method of storage is the same in both storage rooms. There is enough storage

space in the fourth floor storage room – items are not packed tightly together, unlike in the ground floor room, where there is limited space. Efforts are made in both storage rooms to prevent items from coming into contact with the wooden surfaces or with each other by the use of buffered acid-free layers.

The costumes are hung in the cupboard, mostly with padded hangers (in the ground floor storage room there are unpadded hangers) (Figure 69). The most fragile costumes are stored horizontally, in drawers, but because of their low depth the objects are not filled with acid-free “sausages”, which prevent abrasion and further mechanical damage (Figure 70). In some cases, such as with children's ritual clothes, items are stored together and in this case filling with “sausages” is not possible. Some children's clothes are stored in acid-free cardboard boxes, which are put in drawers.

Figure 69: Costumes stored in cupboard,(fourth floor store room

Figure 70: Costume stored horizontally in drawer, (fourth floor store room).

The other three-dimensional items, such as costume accessories, are stored in boxes, in drawers and on cupboard shelves. Hats and shoes are kept in boxes, which are put on shelves (Figure 71), and some hats are mounted on models. Fans are stored in boxes and with items they are connected with (e.g. dresses), and are placed in drawers. Umbrellas are stored on cupboard shelves

and they are packed with acid-free tissues. Gloves are usually kept in drawers, except for gloves connected with costumes, which are stored together. The other three-dimensional objects are stored in drawers.

Figure 71: Three-dimensional items stored on shelves and in boxes, (fourth floor store room).

Small flat objects are stored horizontally on cupboard shelves or in drawers. Acid-free paper is placed between them. Small banners are stored on shelves and are rolled with acid-free tissues. Long flat items are rolled and stored in drawers (fourth floor storage room) (Figure 72) or in special design cupboards (in the ground floor store room) (Figure 73). They are rolled in tubes, acid-free tissues are used during the rolling procession and they are covered with cotton textiles.

Figure 72: Rolled stored items, (ground floor store room).

Figure 73: Rolled stored items, (fourth floor storage room).

Long two-dimensional objects, such as tapestries, are kept rolled in specially designed cupboards (in the ground floor storage room).

The cupboards that are used in the fourth floor storage room close with savers. The doors close and open well, and thus protect the stored objects from dust, light and insect deterioration. However, the cupboards in the ground floor storage room do not close as well. Opening the drawers is slightly difficult, as is moving items.

3.3.4 Method of labelling

The labelling system of the museum is the same as in the other museums. Every item has its own museum number, which indicates the storage location, the collection and the counting number. The number is written on a ribbon and then sewed on the item. The museum number is written on the outside of the boxes and on the left side of the drawers (Figure 74).

Figure 74: Labelling system of the drawers.

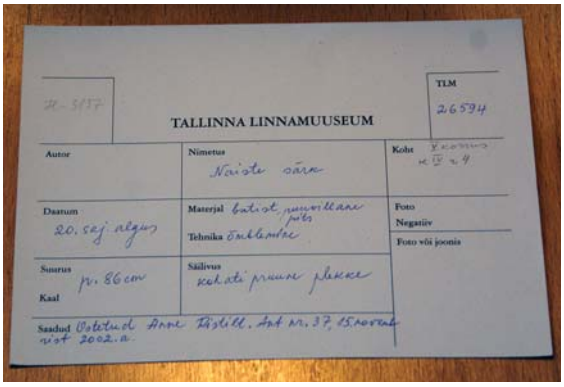

Figure 75: Old cataloguing system.

The old cataloguing system involved writing on cards the items' numbers, types, origins, materials and small descriptions of them (Figure 75). These cards were separated into groups. Nowadays, all the information is entered on MUIS.

3.3.5 Condition of items

The researched items were chosen randomly, with the help of the museum collection manager, by different types and materials. The items that were observed were mostly from the ground floor storage room. Six items were observed, four from the ground floor storage room and two from the fourth floor (Table 16).

Table 16: Researched items during the condition assessment.

Item	Material	Number of items
Bonnet	Cotton, wool	1
Dress	Silk, chiffon,	1
Blouse	Silk, cotton	1
Blackheads' Uniform	Wool	1
Trousers	Wool	1
Tapestry	Wool	1

Figure 76 presents the condition assessment for objects in both storage rooms.

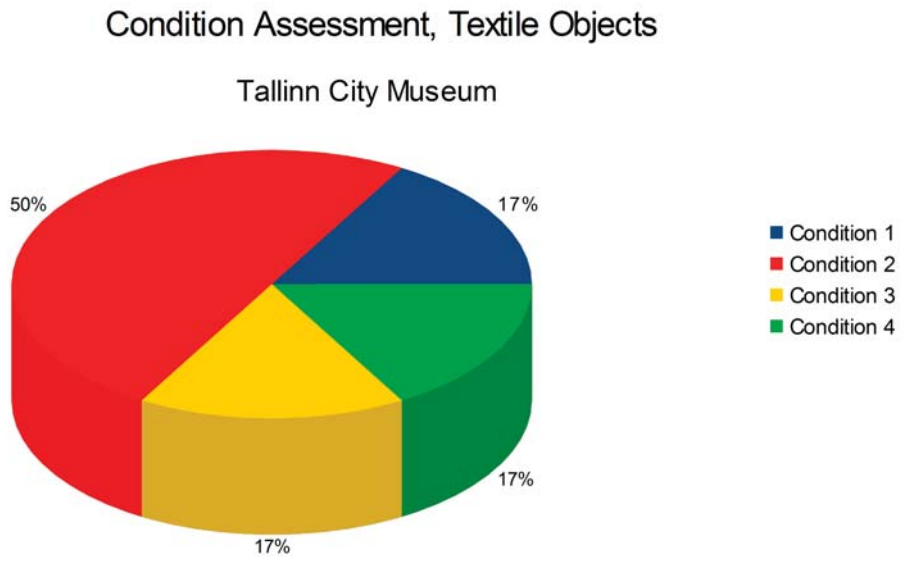

Figure 76: Graphic of items' condition.

Most of the researched objects (50%) were found in Good Condition, although there was some damage, but not enough to influence the items' condition very much. 16.67% were in Very Good condition, 16.7% in Bad and 16.7% in Very Bad condition. The tapestry was found to be in Very Bad condition, even though one part of it had been conserved. Figure 77 shows the most common types of damage that were found in the objects.

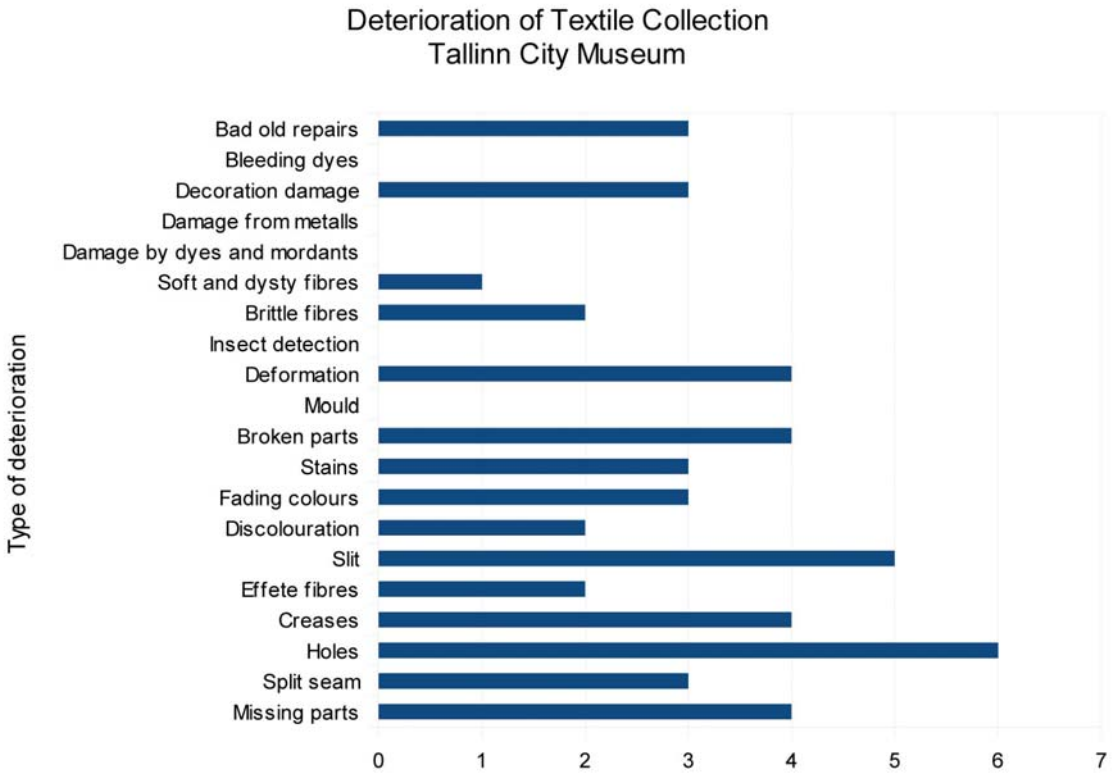

Figure 77: Deterioration of textile items.

The main type of deterioration that was found in the objects was mechanical damage, such as holes and slits, deformations and wrinkles.

3.3.6 Conclusion

The Tallinn City Museum has a valuable collection of textile items. The items do not come in contact with wood and, although the space of the depository is small, the objects are not packed tightly but have suitable space, except in some cases in the ground floor storage room.

The location of the collection manager's office in the storage room creates some advantages and disadvantages. The advantages are that the collection is always under control and, if something unexpected happens, then the reaction time is quicker. On the other hand, the everyday use of the room creates fluctuations in RH, and dust and organic particles (skin flakes) that can possibly attract insects and pests enter the room more easily. Although items are stored in

closed units, the everyday use of light can still influence the items. The inappropriate building materials that were used for the ceiling do not stabilise the environmental conditions; the same problem was observed in the ground floor storage room.

The use of wooden storage equipment creates problems in opening and closing cupboard doors and drawers (in the ground floor storage room).

To sum up, the possible risks that textile collection can face are:

- deformation of the objects, especially those that are stored on the ground floor;
- chemical deterioration from dust and light;
- weakened and brittle threads due to the fluctuation of RH;
- biological deterioration.

3.4 Museum of Harju County

The Harju County museum is located in the river-park of Keila, and since 1988 has operated at the Keila manor house. The museum collects items from the history of the county.

3.4.1 Items

The depository facility of the museum has two storage rooms. In the first one, textile items are stored and, in the second, there are mainly wooden and metal items.

The museum has all the textile item types, from three-dimensional to flat items. The number of the items could not be precisely determined. The items are mostly from the 20th century, but some are from the end of the 19th. There aren't any original folk costumes in the museum's collection, only copies. Mostly the costumes are urban clothes, uniforms (military, school and doctor's) and theatrical, and there are also many accessories: hats, gloves, scarves etc. The flat objects are mostly home textiles (curtains, blankets, towels etc.) and the two-dimensional

items are tapestries and laces.

The items' materials are made of natural and man-made threads. Details are shown in Table 17.

Table 17: Textile collection.

Type of textile collection

Three dimensional	Costumes	Folk	
		18th -19th century	
		20th century	√
		Modern	
		Military uniforms	√
		school uniforms	√
		doctor uniforms	√
		theatrical(bee costume)	√
		priest's clothes	
		copies of national costumes	√
		dolls	√
Costumes' accessories	gloves		√
	bags		√
	fans		
	umbrellas		√
	hats		√
	scarfs		√
	belts		√
	shocks		√
	textile shoes		√
	hairdressers		
	pins		
	other type		
Flat dimensional	carpets		√
	church furnishing		
	flags		√
	banners		√
	blankets		√
	towels		√
	curtains		√
	sheets		√
	table clothes		√
	decorative home textiles		√
	other type		√
Two dimensional	tapestries		√
	ribbons		
	length of textile		
	fabric samples		
	archeological		
	other type	lace	√

3.4.2 Condition of the depository facility and measurement equipment

The storage room is located on the ground floor of the museum and its size is 31.8m^2. The plan (Figure 78) is from before the renovation of the building in 2000.

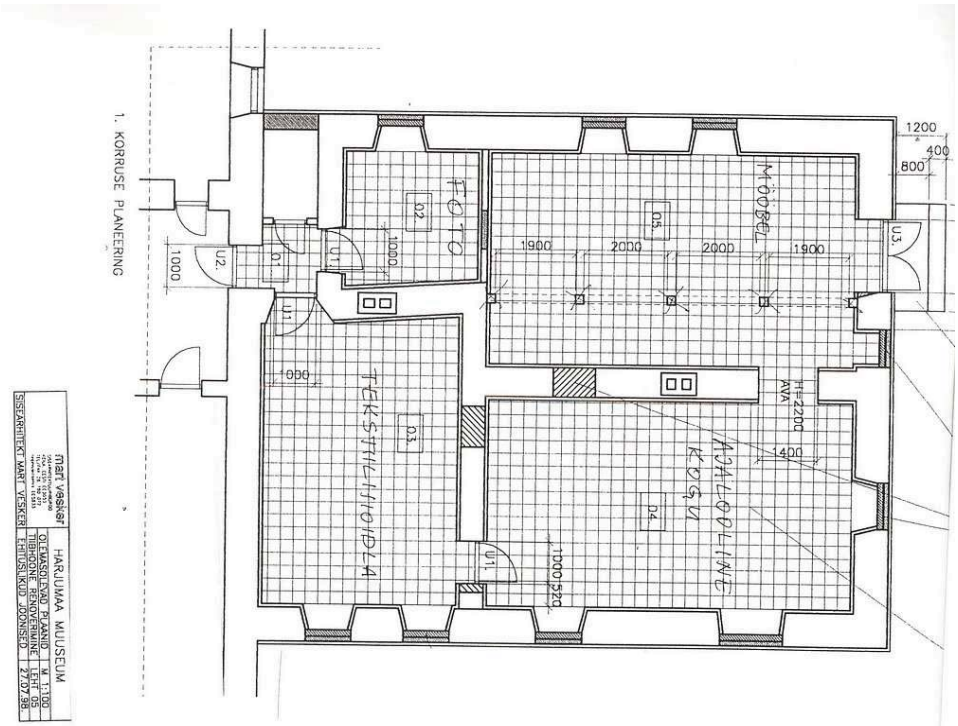

Figure 78: Plan of store room before the renovation.

The walls of the building are solid, made of stone and generally the outside of the building is in very good condition. The colour of the storage room's walls is light ochre. The floor is covered with light grey tiles. Outdoors, the gutters are in good condition and they do not leak; there is no sign of a mould problem.

The building is protected by an anti-theft alarm. Visits to the storage house are allowed only under arrangement with the collection manager. The lighting of the room is artificial and after the renovation windows were put in. The lamps used are fluorescent and are turned on only when the room is in use. Every room has an independent lighting system. In case of fire, there is a fire detector and extinguisher in both of the store rooms (Figure 79).

The level of RH is 50%-60% and T is 18° C. Loggers and an electronic thermohygrometer are used for measurement; unfortunately, the museum doesn't

keep the results. For the stabilisation of RH, a dehumidifier is used (Figure 80) and, for T, there is a heating system under the floor. Checks on the situation and equipment functioning are made every time the store room is visited.

Figure 79: Fire extinguisher

Figure 80: Dehumidifier.

In order to prevent dust and dirt in the room, plastic shoe covers and cotton gloves are used. The cleaning of the area is done with a vacuum cleaner once a year. Regarding insects and pests, the personnel check the objects once a year. Insect traps are not used. Also the outside of the building does not allow the entrance of pests.

3.4.3 Materials and method of storage

The storage equipment includes closed storage units, such as cupboards, drawers and shelves. Together with textiles, archaeological items and other artefacts are stored in the same room. Because of the lack of storage equipment, home cupboards are used (Figure 81). Additional equipment that is used includes boxes made from acid-free and non acid-free materials, and also from wood. Other materials that are used for storage are wood, paper, cardboard, acid-free cardboard, textiles and Tyvek.

Figure 81: Storage equipment.

Figure 82: Costumes stored in a cupboard.

The costumes are hung on unpadded hangers in the cupboard; the space between them is small, so the items are packed tightly. Most of the objects come in contact with the wood surfaces, although some are covered with Tyvek sheets (Figure 82). In the lower part of some cupboards normal boxes are kept, and they also come in contact with the items, e.g. a doctor's uniform and bee costume are stored folded on a cupboard shelf covered with acid-free tissue, in order to protect them from the wood. The blouses are stored in drawers and are filled with acid-free tissues.

The hats and bags are generally kept on cupboard shelves and are separated from the wood (Figure 83). In order to preserve hats' shape, they have been filled with acid-free tissue; also there are hats that are kept in boxes. Most of the boxes are made from acid-free cardboard and are kept at the top of cupboards (Figure 84). Also, umbrellas are stored in boxes and placed on cupboard shelves. The other costumes' accessories (gloves, scarves, socks etc.) are kept in drawers. A small collection of dolls and shoes are also kept in a drawer; there is usually more than one pair of shoes in each drawer.

Figure 83: Stored hats on shelves.

Figure 84: Hats stored in boxes.

Most of the flat items are stored folded in drawers (Figure 85). Because there is little space in drawers, there is more than one object inside. Small tapestries are stored folded in drawers. Flags and some banners are rolled on tubes and covered with cotton textiles. These are stored in the upper part of cupboards (Figure 86).

Figure 85: Flat items stored in drawers.

Figure 86: Flat items stored rolled.

3.4.4 Method of labelling

Every item is given its own museum number when it comes to the museum. The system is the same as in the other museums. The number is written on a piece of textile that is then sewed on the item. The items that are in boxes have their codes written on the outside of the boxes.

In addition, every item has its own card on which is written the code, the name, type, material and origin of the item. The cards are kept in the storage room

in numbered drawers. All of the information is in the process of being transferred to the database MUIS.

3.4.5 Condition of items

The observed items were chosen randomly, according to different types and materials, with the help of the museum collection manager. Eleven items were observed (Table 18). It should be stressed that the items' condition assessment was made before the museum collection's organising and cleaning project, undertaken as a cooperative effort of the Harju County Museum and the Society of Estonian Conservators, which occurred in August 2011. The objects observed were:

Table 18: Researched items during the condition assessment.

Items	**Material**	**Number of items**
Coat	Cotton	1
Men's costume (3 parts)	Wool, cotton, linen	1
Traditional bouse	Linen	1
Woman's shirt	Silk, cotton	1
Baptism dress	Silk, cotton	1
Gloves	nylon	2
Scarf	Crepe fibres	1
Carpet	Wool	1

The condition assessment is presented in Figure 87. 46.2% of the items were rated in Good condition and 30.8% in Very Good condition. The rest were rated in Bad condition, and no items were found to be in Very Bad condition. At the first level were items made of nylon and silk, as silk is a sensitive material. Figure 88 presents the types of deterioration of the objects.

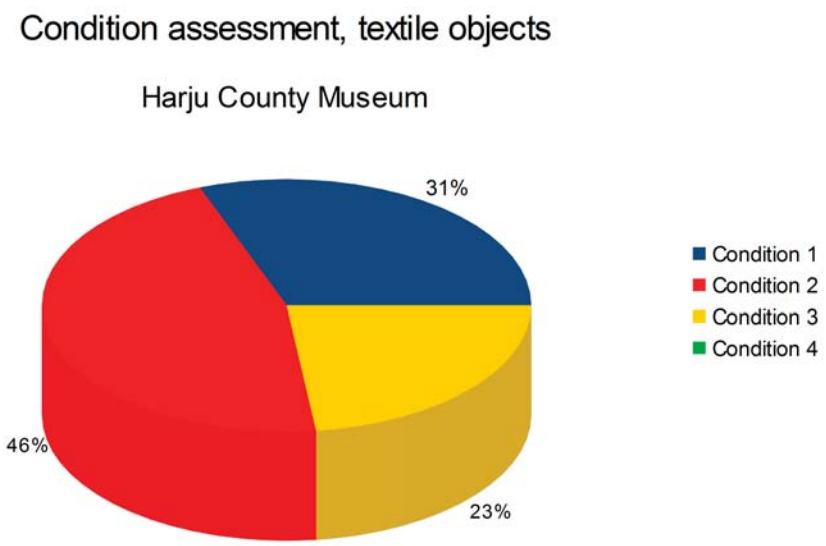

Figure 87: Graphic of item condition.

The main types of damage that the textile collection faces (Figure 88) are deformation and a big amount of wrinkling. This shows the main problem of the museum: the items are stored very tightly together and don't have the necessary space. A quite large number of the objects seem to have discolouration problems which could be from their use, and the problem may have been increased because of contact with some of the equipment. There were a considerable number of objects with mechanical damage, which was created by the use of the items and may have been increased by inappropriate storage equipment or the method of storage.

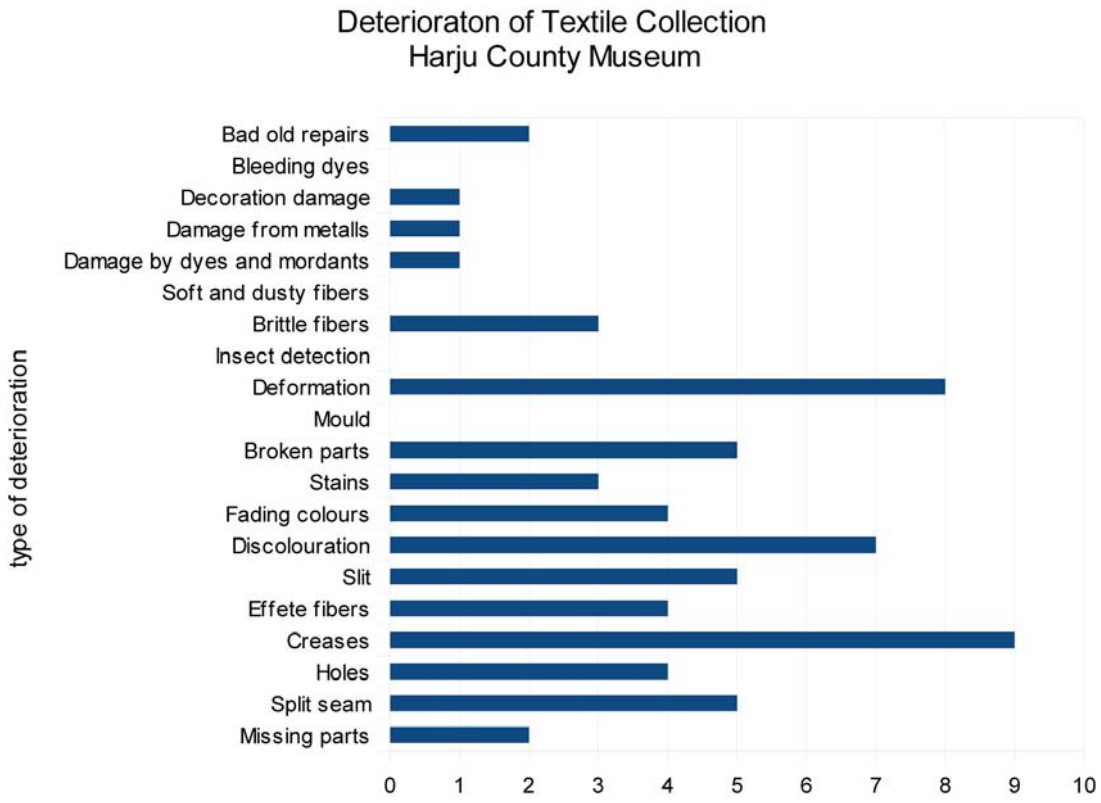

Figure 88: Deterioration of textile items.

3.4.6 Conclusion

The Museum of Harju County has a small collection of textile items, most of them from the 20th century. The building is in good condition and this is beneficial to the good maintenance of environmental conditions. However, the missing information of RH and T measurements creates a problem in the continuous observation of environmental conditions and in action that should be taken in order to improve the situation.

The lack of facilities and space are the main problems. Old cupboards are used, they do not close tightly and the space is small, so the items are packed together. The drawers open with difficulty and this increases the movement of the items. Additionally, the long textiles, such as carpets and curtains, are stored folded in drawers, instead of being rolled, because there is a lack of space. The

rolled items are kept at the top of a cupboard one above another and accessibility is rather difficult. Shoes are stored in drawers on top of each other, which affects their shape and can cause mechanical damage (Figure 89).

Furthermore, most of the hangers are not padded and the costumes come in contact with the surface of the wood, as nothing is used to separate them. The boxes are stored on top of each other at the top of cupboard and are very difficult to reach.

Figure 89: Shoes stored in drawers.

To sum up, the possible risks that the textile collection faces are:

- severe deformation of the textiles;
- increase in mechanical damage;
- damaged fibres;
- discolouration;
- lack of space and equipment.

4 Suggestions based on the survey

The problems that museum depository facilities are facing are universal. An international storage report of 2011 by ICCROM and UNESCO showed that one quarter of museums have difficulties and problems in correctly housing their items[110].

Through the research work of this Master's thesis, necessary information about the condition of four Estonian museums' depository facilities and their collections has been collected. All the museums face similar problems and therefore a shared depository facility is one option for improving the conditions of the collections and the preservation of cultural heritage. This could be achieved by the cooperation of museum collection managers, conservators, architects and engineers.

The main problem of the museums' depository facilities is connected with inappropriate depository buildings. Even though at some museums the buildings provide good environmental conditions, there is always a problem with space and accessibility. Museum collections are growing continuously and the existing depository facilities don't have enough space to store items properly. The main problems of the five researched Estonian museums' depository facilities are:

- 5 of 5 have a lack of storage facilities;
- 4 of 5 have overcrowded storage units;
- 2 of 5 have totally unsuitable buildings;
- 4 of 5 have difficulties in preservation plan usability;
- 2 of 5 have difficulties in the proper recording of climate data;
- 2 to 5 have difficulties in mapping the number of items;
- 4 of 5 have a lack of additional storage materials;

110 ICCROM-UNESCO,*International Storage Survey 2011,* http://www.iccrom.org/eng/news_en/2011_en/various_en/10_21StorageSurveyResults_en.pdf, 08 Nov.,2011.

•1 of 5 has unsecured doors and windows;

•3 of 5 have a lack of staff;

The results of the item condition assessment are:

•at 3 of 5 depositories the majority of researched items are in good condition;

•at 4 of 5 depositories there are items in very bad condition;

•at 5 of 5 depositories the main type of damage is holes;

•at 3 of 5 depositories there was mould damage;

•at 4 of 5 depositories there were deformed items;

•at 3 of 5 depositories there was discolouration of items.

In order to have a shared depository facility, some actions are necessary: first, choosing a suitable method and, second, the mapping and evaluation of all of the objects. The evaluation is necessary to maintain the historic importance, artistic and social value and possibly also the value of the objects. The mapping of objects will give a clear idea of the space necessary and the type and amount of storage equipment needed.

Item-condition assessment is necessary, with as many items as possible, in order to categorise the types of damage to textiles, and the possible risks. This gives a realistic picture of the situation and it helps to make necessary decisions for the preventive actions that should be taken. The condition assessment, along with the evaluation, provides important information about which items are most endangered and should be stored in better conditions immediately.

The location of the depository facility should not have a negative impact on the indoor environment and should make it easily accessible by the museums' staff. The building materials should provide stable environmental conditions, protection from climate hazards, should not allow pest and insect deterioration and should ensure the protection of the collection from vandalism, theft, flood and fire. As shown in the depository facilities of EOAM and the Tallinn City Museum, wood and plasterboard are totally inappropriate building materials for depositories. The

use of suitable building materials would help to create better conditions and to lower energy consumption. The cooperation of engineers and architects is necessary in decisions about planning, location and materials.

Internally, the depository facility should be separated into adjustable sections according to the number of items, and the nature of the museums and collections, in order to identify the location of the items and also control the collections. Storage rooms should be secure but easily accessible and, depending on the building size, a cargo lift should be included. In the depository facility, it is advisable to have, in addition to storage rooms, work rooms for the preparation of items (storage preparation and minimal conservation work) and a studio for digitisation.

Storage equipment should be closed metal units, movable and customizable for items that may be added to the depository facility. All the additional storage materials should be chemically inert. The moving of items should be done following safety and security regulations.

The number of items shouldn't be limited – a shared depository facility could be expandable. The labelling system should provide easy and quick access to the collections. A possible solution for the control of collections and items is the use of a machine-readable labelling system (e.g. RFID tags), connected directly to the national museum information system MUIS[111].

The need of storage management is vital for the correct working of the depository facility. A well equipped and fine building is not enough if there is no specific plan of management regarding the responsibilities of personnel and the actions that should be taken. A detailed plan should be drawn up for the frequency of maintenance of systems, storage rooms and the control of collections. The preservation plan of the textile collections should be clear and understandable to museum staff and the staff of the depository facility. The depository facility should be equipped with reliable and tested devices. The use of electronic loggers for the measurement of RH, T and light has worked well in museums so far. The control of RH and T can be done by controlled devices, such as a humidistat and a

111 Musuems Public Portal, http://www.muis.ee, 30.Nov. 2011.

ventilation system, which should be controlled by a central management controlling system. The establishment of a proper heating system is a challenge in which engineers can provide the best modern solutions. The lighting should be controlled (artificial) and used only when necessary; the use of flicker-free lamps is suggested.

Preventive conservation and collection management deals with the organisation of storage facilities and eliminates the possibility of damages. The depository facility should be prepared and organised for any disaster so as to preserve the stored objects and to avoid endangering the personnel. Disaster plans should be created appropriate to the facility and its characteristics. For example, in Estonia the probability of hurricanes and earthquakes is rather low but a rain- or snow storm occurs often. In such conditions, the depository facility should be able to work properly even for several days without human control on site, i.e. it should be able to operate automatically or everything could be managed through the Internet. It is necessary to eliminate/minimise technical mistakes, such as a fire starting due to faulty wiring. The proper operation of anti-theft and anti-fire systems and flood detection should be well organised by experts in order to mitigate any possible damage.

The depository facility should have a stable energy source with a reliable back-up system.

Because such a shared depository facility would take a huge risk in having many collections from several museums, it would be vulnerable and, considering this heavy responsibility, every step and possibility should be considered well, and personnel should be well trained.

Summary

The purpose of museum depositories is to properly preserve collections. The incorrect maintenance of items can lead to irreversible damages. Preventive conservation is less expensive than normal conservation and can be handled by most museums if there is correct organisation and the proper facilities. In the current thesis, an attempt has been made to present the theoretical framework of the proper functioning of the depository facility. It presents the importance of a preservation plan at depository facilities and how it can be achieved.

The practical section presents some of the conditions of Estonian museums' depository facilities. Through the survey report and the item-condition assessment, the main problems that museums face has been presented. The inability of museums to carry through properly on the preservation plans is connected with the inappropriate conditions in depository facilities, the lack of proper storage equipment and devices, the minimal personnel available in many fields and the funding problems of museums.

Some museums' depository facilities face important problems related to building construction (e.g. EOAM). Even if the museum has a proper preservation plan, it might not be accomplished if the outside of the building is unsuitable for maintaining necessary environmental conditions; problems with the outside of the building may increase biological development and increase the risk of several other hazards. The creation of a depository facility with a building that can support its function properly is beneficial to the suitable preservation of the collection, lowers the energy needed for environmental stabilisation and is more economical.

Storage equipment should prevent the further deterioration of the collection. It should be noted that the storage equipment of museums is usually made of wood and wood products, which can influence the condition of items, even if items have been separated from wood surfaces. The theoretical section of the Master's thesis has presented the disadvantages of wooden storage equipment. Metal storage equipment provides a more secure and reliable method of storage, as it is usually chemically inert. The types and sizes of storage equipment should be

compatible with the sizes and types of the collections.

The equipment of depository facilities with suitable devices supports the proper functioning of the building. The equipment should be reliable, accurate, easily used by the personnel and, if possible, use less energy. The choice of the equipment should meet the museum's needs. There should be a preservation plan and cooperation with experts is necessary. It should be stressed that devices should be regularly checked and properly calibrated. Collection managers should provide regular training on the proper functioning of the equipment.

The labelling systems of museums lack machine-readable interfaces. Labelling systems are not flexible and do not provide easy access to items, thus increasing the possibility of confusion; they also lead to difficulty in controlling the amount of movement of items. The use of MUIS (database) by museums supports collection cataloguing.

The proper functioning of the depository facility and the proper implementation of a preservation plan can be successfully achieved with the cooperation of well-trained personnel and with suitable equipment. At the present time, expert staff often need to deal with several other museum tasks, so the responsibilities for the care of collection are neglected.

The proper implementation of a preservation plan depends on the museums' funding. A museum's funding problem directly affects the functioning of the preservation plan and the depository facility. The museum usually tries to find cheaper solutions and methods (e.g. the use of wooden storage equipment), in order to create feasible solutions.

The preservation plan is connected with the proper functioning of the museum. The proper organisation and control of depository facilities can lead to the preservation of cultural heritage. Cooperation between different fields can lead to desired results. It is understandable that the ideal functioning of a depository facility can not be achieved, as always there is the possibility of human error. However, the attempt to reach the ideal can lead to beneficial results for the preservation of cultural heritage.

Finally, I would like to thank the museum collection managers and conservators who agreed to cooperate in order to collect the necessary information. Their expertise and suggestions were always welcome and helpful.

Kokkuvõte

Tekstiiliesemed kuuluvad muuseumides säilitatavate objektide seas ühtede tundlikumate hulka. Keskkonnatingimustele tundlike tekstiilide sobimatutes tingimustes hoiustamine võib põhjustada nende hävimist ja seega tekitada kultuuripärandile korvamatut kahju. Tekstiilide säilitamine on keerukas ja paljusid tegevusi hõlmav valdkond. Tegemist on protsessiga, mille eesmärgiks on teadlikult ja süstemaatiliselt ennetada võimalikke tekstiilesemete kahjustusi ja tagada sel viisil nende kestmine.

Ennetuskavade rakendamine muuseumides vähendab konserveerimist vajavate esemete hulka ja aitab luua võimalikult sobivaid säilitustingimusi. Tekstiilesemete korrektne hoiustamine on saavutatav süstemaatilise planeerimise, nende säilituskeskkonna seire, muuseumikogude hindamise ja neile ligipääsu parandamise abil. Säilitamise kavandamine tõstatab küsimuse ühtsest muuseumipoliitikast, selle lühi- ja pikaajaliste eesmärkide püstitamisest ning kõikidele muuseumidele ühtsetest tööjuhenditest.

Käesoleva magistritöö „Keskkonnatingimused tekstiilide säilitamiseks ja muuseumikogude ühishoidla rajamiseks vajalikud ressursid“ eesmärk on tekstiilesemetele keskendudes esitada teoreetiline raamistik ja pakkuda välja praktilisi lahendusi võimaliku muuseumite ühishoidla kavandamiseks.

Magistritöö annab ülevaate tekstiilmaterjalide haldamise, hooldamise, seisundi ja säilitamise hetkeolukorrast neljas Eesti muuseumis: Eesti Vabaõhumuuseumis, Eesti Ajaloomuuseumis, Tallinna Linnamuuseumis ja Harjumaa muuseumis. Tihedas koostöös nimetatud muuseumitega on läbi viidud hoidlate uuring, seisukorra kaardistamine ning tekstiilesemete seisundi analüüs.

Kuna tekstiilesemete säilitamise juures on olulised nii nende materjal, kui ka valmistamise viis, siis magistritöö teoreetilises osas on lühidalt esitatud ülevaade tekstiilide materjalidest ning neid mõjutavatest keskkonnatingimustest. Samuti antakse põgus ajalooline ülevaade tekstiili kasutamise traditsioonidest Eestis.

Eesti aladel on tekstiiltoodete kasutamisel traditsioon pikk. Varaseimad

arheoloogilised tekstiililеiud pärinevad 11.-13. sajandist. Peamised Eesti aladel kasutusel olnud tekstiilmaterjalid olid kuni 20. sajandi alguseni vill, lina, nõges ja siid, kangaid neist valmistati enamasti käsitööna.

Kangaste toonimisel kasutatud värvained olid kuni 19. sajandi teise pooleni looduslikud. Valdavalt kodus valmistatud kangastele värvi andmiseks kasutati puukoort, erinevaid seeni ja taimi, taimede juuri, õisi ja marju, aga ka imporditud indigot.

Sõltuvalt kasutatud kiududest ja tehnoloogiatest ning säilitustingimustest on tekstiilesemete kahjustused erinevad. Tselluloosikiud, näiteks puuvill ja lina on tundlikud hapete ja biokahjustajate (mikroseened) suhtes. Valgulised kiud, nagu vill ja siid on aga tundlikud aluste ja oksüdeerivate ainete suhtes, samuti kahjustavad neid enam putukad.

Tekstiilide kahjustused võivad olla mehaanilised, keemilised, füüsikalised ja bioloogilised. Enamike tekstiilikahjustuste peapõhjuseks on keskkond, kus neid esemeid hoiustatakse. Peamisteks kahjustusi mõjutavateks keskkonnateguriteks on õhu temperatuur ja suhteline niiskus, valgus ja tolm.

Hoiustamine tähendab teavikutele võimalikult sobivate säilitustingimuste loomist, et aeglustada materjalide vananemist, kaitsta neid rikkumiste ja varguste eest ning tagada nende laialdane kättesaadavus ning kasutatavus. Hoiutingimuste tagamine algab alati keskkonnatingimuste analüüsist. Keskkonnatingmiuste analüüsi esimeseks probleemiks on antud hoidlates säilitatavate materjalide kaardistamien ja neile sobivaimate tingimuste määratlemine. Tekstiilikogusid tuleb säilitada tingimustes, kus suhteline niiskus on 45 +/- 5% ja temperatuur 25 +/- 5 °C. Hoidlaruumides peaks valitsema pimedus ning näitustel peaks valguse intensiivsus olema alla 50 lx ning ultraviolettkiirguse tase alla 30µW/lm.

Igasugune säilitamine eeldabki ennekõikeobjektidele sobivate keskkonnatingimuste loomist. Temperatuuri ja õhuniiskuse kontroll eeldab esmasena sisekliimatingimuste seiret. Tuginedes hoone vaatlusele ja sisekliimaandmetele saab hakata tegema ettepanekuid sisekliima stabiliseerimsieks ja parandamiseks. Tekstiilihoidlate valgustatuse tase peaks olema nii minimaalne kui võimalik. Vähendades valgustuse taset hoidlates ning

näituseruumides kulutatakse vähem energiat, eraldub vähem soojust ning valgustundlikud esemed (nagu tekstiilid) on hoiustatud senisest sobilikumas keskkonnas.

Soovitatav on hoidla valgustus jaotada sektoriteks, kontrollida valgustatuse taset ja kasutada valgusteid, mis ei kiirga ultraviolettkiirgust. Haruldased ja haprad tekstiilid ei tohiks olla ekspositsioonis üle 3–6 kuu. Kahjustamata tekstiile võib eksponeerida 6–9 kuud. Pikaajalised ekspositsioonid tuleb kavandada sellisel viisil, et objekte saaks vahetada.

Hoidlat peab süstemaatiliselt kontrollima ja puhastama tolmust. Tolm soodustab värvide tuhmumist, metalli korrosiooni jne. Konkreetsed meetmed ja lahendused on tolmu pääsu piiramine hoiuruumidesse (uksematid, ukse all olevad harjad, filtreeritud õhk, hoidlasse sisenemisel kasutada Tyvek'ist valmistatud kitleid vms).

Saasteainete sattumine nii sise- kui välistingimustest otse hoidlasse tuleks viia miinimumini. Väliste saastajate alla kuuluvad kütte-, ventilatsiooni- ja konditsioneerisüsteemi välisseadmed, millest väljuv õhk võib sattuda taas ventilatsioonisüsteemi.

Kindlasti peaks vältima hoidlates ja näituseruumides avatud aknaid ja uksi, et mitte suurendada vääveldioksiidi, lämmastikoksiidide ja osooni hulka. Ruumide sisetingimustest lähtuv saaste sõltub muuseumihoone ja -hoidlate inventarist ning selle ehitusel kasutatud materjalidest ja tehnoloogiatest.

Sisetingimustest tulenevat saastet võivad põhjustada aga ka hoiustatud tekstiilesemed ise, mille materjal või detailid võivad sisaldada degradeerunud kummi, metalli või tselluloosnitraati.

Parema säilituskeskkonna saavutamiseks tuleks hoidla ventilatsioonisüsteemis kasutada aktiivsöe filtreid või õhupuhasteid. Uue hoidla puhul peaks enne esemete hoiustamist läbi viima "Oddy"- testi saastetaseme kontrollimiseks. Hoidlate süsteemne säilitamiskeskonna kava ja selle meetmed peavad välistama võimaluse, et tekstiilesemed võiksid saada bioloogilisi kahjustusi.

Enne, kui hakata tegelema hoidla tingimuste stabiliseerimisega, on oluline hinnata hoidla seisundit. Sobiliku hoidla planeerimine vajab erinevate ekspertide (arhitektid, insenerid, konservaatorid, peavara- ja koguhoidjad jt) koostööd.

Hoone asukoht ja selle arhitektuur ei tohiks minna vastuollu muuseumihoidlale lubatud keskkonnatingimuste määradega. Ehituslikud tingimused peaksid minimaliseerima võimalused bioloogiliste kahjustuste tekkeks ning välistama vandalismi. Hoidla disain peaks pakkuma võimalikult ideaalseid tingimusi tekstiilesemete säilitamiseks ja neile ligipääsuks.

Muuseumihoidlates ei saa alahinnata ka automaatse tuletõrjesüsteemi tähtsust, mis kaitseb nii hoiustatud esemeid kui ka hoidla töötajad. Üleujutuste või veekahjustuste vastu peab tegema regulaarset vett kasutavate süsteemide kontrolli.

Hoidla turvasüsteem peab olema kaasaegne, sellega tuleb viia miinimumini esemete varastamise võimalus. Kõik hoone sissepääsud peaks olema kontrollitavad ning hoidlate külastamine peab lähtuma kindlast regulatsioonist.

Pidev säilitustingimuste täpne järgimine, vajadusel hoiustatud tekstiilide hooldus ja nende säilitamiseks mõeldud nõuetekohane inventar (kapid, riiulid, kummutid) on samuti oluline osa säilitamisest.

Tekstiilesemete hoiustamiseks on sobilik suletav inventar, mida on võimalik vastavalt vajadusele ümber korraldada. Kindlasti peavad hoiuruumid olema varustatud vahenditega, mis võimaldavad esemetele paremat juurdepääsu (tõstelavad). Tagatud peab olema võimalus esemeid vajadusel ohutult transportida (hoidlale sobilikud redelid ja kärud).

Materjalid, mida kasutatakse hoiustamiseks ning millest on valmistatud hoidla inventar, peavad olema stabiilsed (ei tohi kiiresti vananeda) ja inertsed (ei tohi põhjustada tekstiilides muutusi).

Tavaliselt kasutatakse hoidlainventari materjalidena puitu ja puidutooted. Uuringute ja testide põhjal on leitud, et enamik puiduliike ja puidust valmistatud tooteid on tekstiili hoiustamiseks sobimatud, kuna need pole keemiliselt inertsed ja võivad eraldada happeid.

Teine hoidlas laialdaselt kasutatud materjal on metall, millel on mitmeid eeliseid, kuid konkreetne otsus, mis tüüpi metalle kasutada, tuleks teha hoolikalt (mõnede metallide puhul võib esineda keemilisi muutusi). Hoiustamisel kasutatavad lisamaterjalid (nt pakkematerjalid) peavad olema happevabad ja keemiliselt inertsed.

Sõltuvad tekstiili tüübist (lame, kahe- või kolmemõõtmeline ese) on säilitamise viisid erinevad: rullis, riputatud, horisontaalselt sahtlis või kastides/karpides. Eseme hoiustamine tuleb teostada hoolikalt, võttes arvesse iga konkreetse eseme seisundit.

Juurdepääsu kogule on võimalus parandada kasutades sobilikku märgistamist. Tavapärasel esemete märgistamisel on mitmeid puudusi – pole võimalik saada lihtsalt ja kiirelt informatsiooni eseme või kollektsiooni seisundist, võimalikust eksponeerimisest näitusel või vajadusest seda eset konserveerida.

Uued tehnoloogia võimaluste ja tehniliste abivahenditega on kogude kaardistamine oluliselt hõlpsam ega ole nii ajamahukas.

Kogu või kollektsiooni kaardistamine on üks esimesi tegevusi, mida peaks teostama, et saavutada sobilikud hoiustamise tingimused. Koos esemete seisundi hindamisega aitab see planeerida ja saavutada paremat säilitamise korraldamist hoidlas, sh ka tekstiili säilitamise (esma)vajaduste ja võimalike ohtude määratlemist.

Töö praktilises osas annab magistritöö ülevaate tekstiilikogude kaardistamise metoodikast ja selle rakendamisest neljas Eesti muuseumis. Magistritöö raames töötati välja metoodika tekstiilesemete kahjustuste kirjeldamiseks ja nende seisundi määratlemiseks. Selline süstemaatiline metoodika varem puudus. Kasutades eelnevalt välja töötatud metoodikat kaardistati töö praktilises osas nelja muusemi tekstiilikogud lähtudes alljärgnevast:

1. esemete seisundi hindamine;
2. esemete märgistamine;
3. kogude haldamine;
4. hoidlad ning nende seisund;

5. säilitamise süsteemse kava olemasolu ning selle rakendamine;

6. säilitamisel tekkinud probleemide ja raskuste kirjeldamine.

Kogutud informatsiooni ja vaatlusandmete põhjal valmisid graafikute ja foto-dokumentatsiooniga varustatud aruanded. Esemete seisund määratleti eksperthinnangute abil valitud esemetel vaatlusaluste muuseumide kogudest.

Magistritöös pakutakse lahendusi ja ettepanekuid nelja muuseumi olemasolevate hoidlate säilitustingimuste parandamiseks ning uue nõuetekohase tekstiilitoodetele keskendunud ühishoidla loomiseks. Antud informatsiooni kasutades oleks võimalik luua kultuuriväärtuslike tekstiilesemete säilitamiseks oluliselt turvalisemad ja soodsamad hoiutingimused kui seni.

Käesolevas magistritöös jõuti järeldusele, et kõikides uuritud muuseumide tekstiilikogudes valitseb ruumi- ja inventari puudus. Paljudel juhtudel kasutati ebasobivat inventari ning mõnel juhul olid hoidlaruumid tekstiilide säilitamiseks täiesti sobimatud. Säilituskavade rakendamine muuseumides sõltub suuresti kasutada olevatest ruumidest ja muuseumide üldisest majanduslikust olukorrast.

Kindlasti tasuks mõelda riiklikult ja heaperemehelikult teostatud regulaarsetele uuringutele ja analüüsidele eri muuseumide kogude ja nendes esinevate materjalide kohta. See on vajalik arvestades muuseumide kogudes esinevat ruumipuudust, sellest lähtuvaid riske, vajakajäämisi kaasaegsetes säilitustingimustes. Võimaliku uue muuseumite ühishoidla loomine eeldaks ka süsteemsete säilitustingimuste väljatöötamist.

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Appendices

APPENDIX 1. Mapping of museum textile collection

Museum name
Address
Museum type
Collection
Type of textile collection

				No	Materials
Three dimensional	Costumes	Folk			
		18th -19th century			
		20th century			
		Modern			
		Military uniforms			
		school uniforms			
		doctor uniforms			
		theatrical(bee costume)			
		priest's clothes			
		copies of national costumes			
		dolls			
	blouses				
	shirts				
	trousers				
	skirts				
Costumes' accessories	gloves				
	bags				
	fans				
	umbrellas				
	hats				
	scarfs				
	belts				
	shocks				
	textile shoes				
	hairdressers				
	pins				
	other type				
Flat dimensional	carpets				
	church furnishing				
	flags				
	banners				
	blankets				
	towels				
	curtains				
	sheets				
	table clothes				
	decorative home textiles				
	other type				
Two dimensional	tapestries				
	ribbons				
	length of textile				
	fabric samples				
	archeological				
	other type				

APPENDIX 2. Depository house survey report

Depository house:
Location:
Rooms' number:
Type of items that are stored:
Space:

Storage facilities	
	cupboards
	drawer
	bars
	hungers
	boxes
	shelves
	lockers

Materials that are used for the storage	wood
	metal
	carton
	acid free carton
	paper
	acid free papers
	textile
	plastic
	plexiglass
	glass
	melinex
	polyester
	Tyvek 1422A

Equipment for control of conditions:

Light
Humidity
Temperature
Dust
Insects
Pollutants
Physical disasters
Anti-theft system

Frequency and method of environmental control:

Comments:

APPENDIX 3. Survey report about items' condition assessment

Collections' condition

Item: **Date:**
Survey code: **Museum:**
Material: **Depository:**
Collection:

No	Type of deterioration	Level of deterioration			
		1	2	3	4
1	**Missing parts**	non	A few small missing parts	Moderately-missing parts affects 10-30% of object	Numerous Large missing parts (more than a couple of cm) Affects more than 30% of object
2	**Split seam**	non	A few	Moderately 10-30% of seams are split	Lot of, more than 30% of seams are split
3	**Holes**	non	A few	Moderately, 10-30% of object is affected	Lot of, more than 30% of object is affected
4	**Creases**	non	A few	Moderately creased, 10-30% of object is affected	Badly creased, more than 30% of object is affected
5	**Effete fibres**	non	A few is affected no more than 10% of object	Moderately affected 10–30% of the object	Severe, more than 30% of object is affected
6	**Slit**	non	A few small (a few cm) slits. Affected no more than 10% of object	Moderately-Small tears, affected 10–30% of the object	Big slit (more than 30% of object length)-A lot of little slits which affect more than 30% of object
7	**Discoloration (yellowing, brown colour)**	Discolouration is not identifiable	Slight yellowness -affects less than 10% of object	Severe yellowness on 10–30% of the object	Very severe brownish yellow tone on more than 30% of the object
8	**Fading of colours**	Fading is not identifiable	Slight fading affects less than 10% of object	Severe fading affects 10–30% of the object	Original color is completely faded
9	**Soiling, stains**	non	Small stains (0.5 cm)- less than 10% of the object are stained	Staining and soiling affects 10-30% of the object, stains are not very large	Staining and soiling affects more than 30% of object, large stains (also individual), stained and soiled areas
10	**Broken parts**	non	Slightly, less than 10% of object	Moderately, 10 – 30% of objects is affected	Severely, more than 30% of object is affected
11	**Mold damage**	non	Single colonies, material is not visibly affected	Colonies affect 10 – 30% of object, material is slightly damaged	Big colonies, whole object is affected, material is severely damaged
12	**Deformation/Disfigurement/Loose of shape**	good maintenance of its shape	Slight deformation, affects less than 10% of object good maintenance of its shape	Severe-Deformation affects 10–30% of the object partially lost shape	The whole object is badly deformed-completely lose of shape
13	**Insect damage**	yes	Identification:		
		no			
14	**Fibers are brittle**	yes			
		no			
15	**Fibers are soft and dusty**	yes			
		no			
16	**Damage by dyes and mordants**	yes			
		no			
17	**Damage due influence of metals**	yes			
		no			
18	**Surface decorations damaged**	yes			
		no			
19	**Bleeding dyes**	yes			
		no			
20	**Bad old repairs**	yes			
		no			

Condition of the object

Condition 1: Very good	• Number 1, 2, 3, 6, 9, 11 is 1 • Number 4, 5, 7, 8, 10, 12 is 1 or 2	No existence of any type of deterioration, good maintenance of its shape, colour, and strength of textile, does not need conservation.
Condition 2: Good	• Number 1, 2, 3, 6, 9, 11 is 2 • Number 16,17,18 is yes	Existence of some deterioration's type that don't influence its condition (dust, small mechanical damages, like small splits) , good maintenance of its shape, colour and strength of textile, does not need extent conservation treatment except slight cleaning procession and repair of the splits.
Condition 3: Bad	• Number 1, 2, 3, 6, 9, 11 is 3 • Number 4, 5, 7, 8, 10, 12 is 3 • Number 13, 17, 20 is yes	There are considerable deteriorations like big splits, dirt and dust, slight discolouration, lost of its shape, appearance of mold and/or insects. Need conservation.
Condition 3: Very bad	• Number 1, 2, 3, 6, 9, 11 is 4 • Number 4, 5, 7, 8, 10, 12 is 4 • Number 14,15 is yes • Number 16,18,19 is yes	There are important deteriorations, lost of its shape, discolouration and lost of textile strength. Its need for conservation is vital

APPENDIX 4. Photographic documentation

Estonian Open Air Museum

First depository facility

Photo 1: Storage of costumes.

Photo 2: Flat items fold and stored on shelves Tyvek.

Photo 3: Flat items fold and stored on shelves.

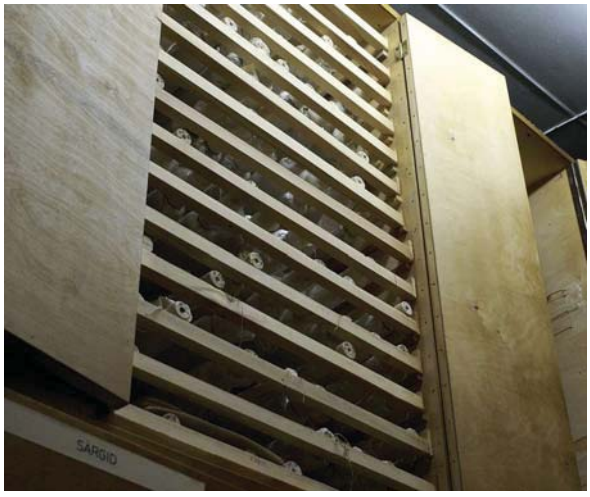

Photo 4: Rolled items stored horizontally.

Photo 5: Dolls stored horizontally on shelves and storage of three dimensional items in boxes

Photo 6: Humidity and mould problem (ground floor).

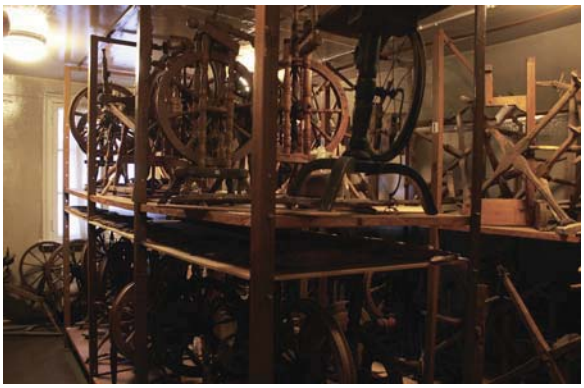

Photo 7: Storage of wooden collection (first floor).

Photo 8: Items stored in the cupboard of the corridor, (ground floor).

Photo 9: Use of dehumidifier to clean the air at the store room with mould problem.

Photo 10: Narrow corridors that make difficult the access in the store rooms.

Photo 11: Discolouration and metallic stains at girl's dress, (Items Condition Assessment).

Photo 12: Discolouration, brownish stain and deformation of girls cotton dress,(Items Condition Assessment).

Photo 13: Slits and effete fibres at silken black scarf stored rolled and vertically to cupboard, (Items Condition Assessment).

Photo 14: Deformation, effete fibres and metallic stains from the metallic decoration of the silk bag, (Items Condition Assessment).

Photo 15: Deformation, discolouration and mould stains on silk bag,(Items Condition Assessment).

Photo 16: Discolouration of the lining of the silk back, (Items Condition Assessment).

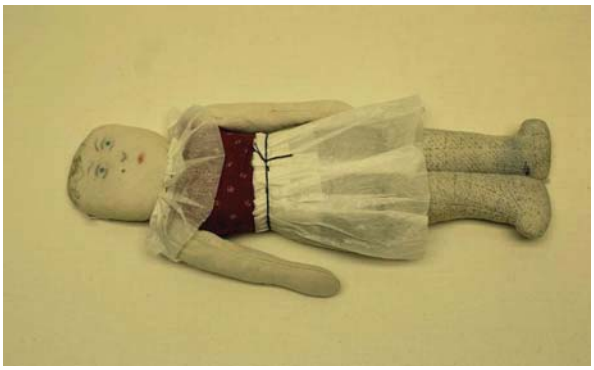

Photo 17: Doll that its clothes are missing, (Items Condition Assessment).

Photo 18: Slightly deformed doll with discolouration problem, (Items Condition Assessment).

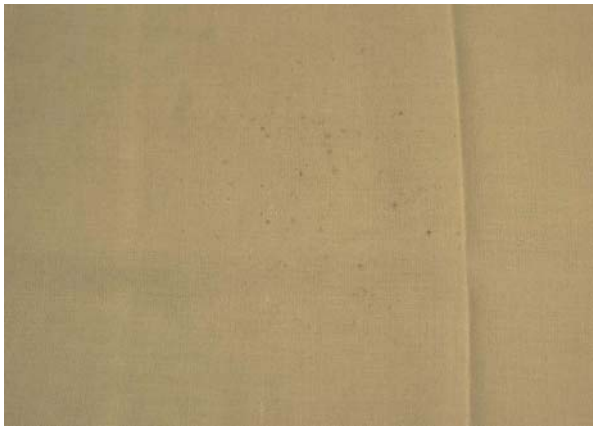

Photo 19: Mould stains at linen & cotton decorative textile, (Items Condition Assessment).

Photo 20: Severe deformation and discolouration of cotton decorative textile that is stored folded, (Items Condition Assessment).

Second depository facility

Photo 21: Humidity problem and algae growing on the outside of the building.

Photo 22: Humidity problem on the back side of the building.

Photo 23: Possible mould problem

Photo 24: Ventilation system.

Photo 25: Combination of open and closed storage units.

Photo 26: Flat items stored rolled on wooden stands.

Photo 27: Flat items stored rolled in drawers.

Photo 28: Horizontal storage of belts in drawers.

Photo 29: Horizontal storage of costumes accessories in drawers.

Photo 30: Horizontal storage of hats in drawers.

Photo 31: Hats stored in designed cases in drawer.

Photo 32: Effete fibres and discolouration problem of silk pot hat, (Items Condition Assessment).

Photo 33: Severe effete fibres of silken pot hat, (Items Condition Assessment).

Photo 34: Discolouration, slight deformation and big brownish stain of cotton& silken skirt, (Items Condition Assessment).

Photo 35: Effete fibres of cotton shirt that is stored horizontally in drawer, (Items Condition Assessment).

Photo 36: Cotton shirt that is stored horizontally as is very fragile, (Items Condition Assessment).

Estonian History Museum

Photo 37: Storage equipment of closed wooden units

Photo 38: Drawers units that outside is written the type of stored items.

Photo 39: Uniforms stored horizontally in drawers.

Photo 40: Costumes hung in cupboard.

Photo 41: Storage of different textile and rubber items,as well in boxes.

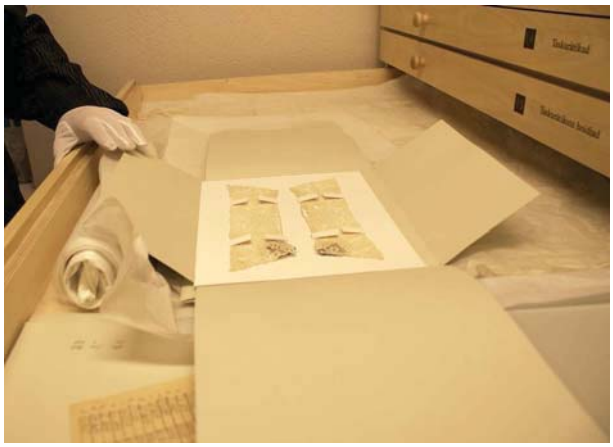

Photo 42: Storage of textile fragments in acid-free envelope.

Photo 43: Deformation and mould deterioration of nylon rain coat(Items Condition Assessment).

Photo 44: Slightly deformed nylon dress, (Items Condition Assessment).

Photo 45: Severe deformation and mould deterioration of cotton umbrella, (Items Condition Assessment).

Photo 46: Slightly deformed brocade dress, (Items Condition Assessment).

Tallinn City Museum

Photo 47: Items stored in boxes on shelves.

Photo 48: Small flat items stored in boxes.

Photo 49: Flat items stored rolled in drawers.

Photo 50: Small banners stored on shelve.

Photo 51: Old cataloguing system

Photo 52: Mechanical damage of silk blouse (Items Condition Assessment).

Photo 53: Deformation and mechanical damages on Blackheads' wool uniform (Items Condition Assessment).

Photo 54 Mechanical damages on silk griffon (Items Condition Assessment).

Photo 55: Effete and brittle fibres of the Town Hall woollen tapestry (Items Condition Assessment).

Photo 56: Discolouration and deformation (Items Condition Assessment).

Harju County Museum

Photo 57: Wooden cupboards drawers and shelves.

Photo 58: Storage of the boxes at the top of cupboards.

Photo 59: Costumes hung in cupboards. Under them are stored non acid-free boxes.

Photo 60: Dolls stored horizontally in drawers.

Photo 61: Woollen carpet that has effete fibres (Items Condition Assessment).

Photo 62: Discolouration and deformation of cotton blouse (Items Condition Assessment).

Photo 63: Mechanical damages, discolouration and deformation of linen blouse (Items Condition Assessment).

Photo 64: Discolouration and deformation of nylon glove (Items Condition Assessment).