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An Investigation into whether the Compressive Forces Exerted on a Textile Artefact Suspended in a Magnetic Display System Cause Damage to the Objects Fibres and/or Weave

By

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Abstract

Through review of the relevant literature and through data collected via a questionnaire, this dissertation highlights that magnets are widely utilised within conservation, both as a treatment tool and as a method of display. There is however little published research available into the potentially damaging effects of compression on artefacts held under the exerted force of a magnet.

This research project begins to bridge this gap in knowledge by analysing the effects of a magnetic display system on the fibres and weave of four textile samples and one textile artefact suspended in magnetic display systems over set periods of time.

The textile types and method of magnetic display chosen were based on those found to be most commonly cited in the qualitative data collected.

Methods of analysis conducted for the purpose of this research included: simple visual analysis, stereomicroscopy, and scanning electron microscopy.

Through the analysis carried out no damage to the textiles was observed as a result of compression by the magnetic display systems. More research is however required i.e. analysis of textile artefacts mounted with magnets for longer periods of time and by pursuing other analytical techniques such as tensile strength testing to assess whether damage is occurring as a result of compression that is not detectible via visual analysis methods.

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This is, in the opinion of the author, the most important page in this dissertation, as without the following people this research project would not have been possible:

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Contents

List of Appendices

List of Figures

List of Tables

Magnets within the Museum – a Brief History

It may be difficult to spot them (given their ability to be camouflaged) but magnets are everywhere: Used as a method for securing an object onto a display mount within a gallery setting or as a treatment tool behind the scenes in the conservation studio.
Literature shows that since entering the museum in the late 1980s[1] magnets have become an increasingly popular method of display for both inorganic and organic heritage material such as metal, paper, textile and leather artefacts (see information highlighted in red in figure 1).
This increase in the use of magnets as a method of display can be understood by A) consulting magnetic theory texts which show when certain magnets first became available (information highlighted in green and yellow - figure 1) and B) through comparison with traditional mounting techniques as explained in the textile conservation paper; 'An Alternative to Velcro? Upper edge hanging methods using rare earth magnets'[2]. Through review of the latter literature mentioned it is possible to see the appeal of magnets for the display of textile artefacts: They offer a less interventive method of mounting than stitching, are less time consuming and require fewer skills to utilise.

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[1] Karen Potje, "A Travelling Exhibition of Oversized Drawings," (paper presented at The Book

[2] Gwen Spicer, "An Alternative to Velcro? Upper edge hanging methods using rare earth magnets", *WAAC Newsletter,* vol. 35, 3 (2013): 20-25.

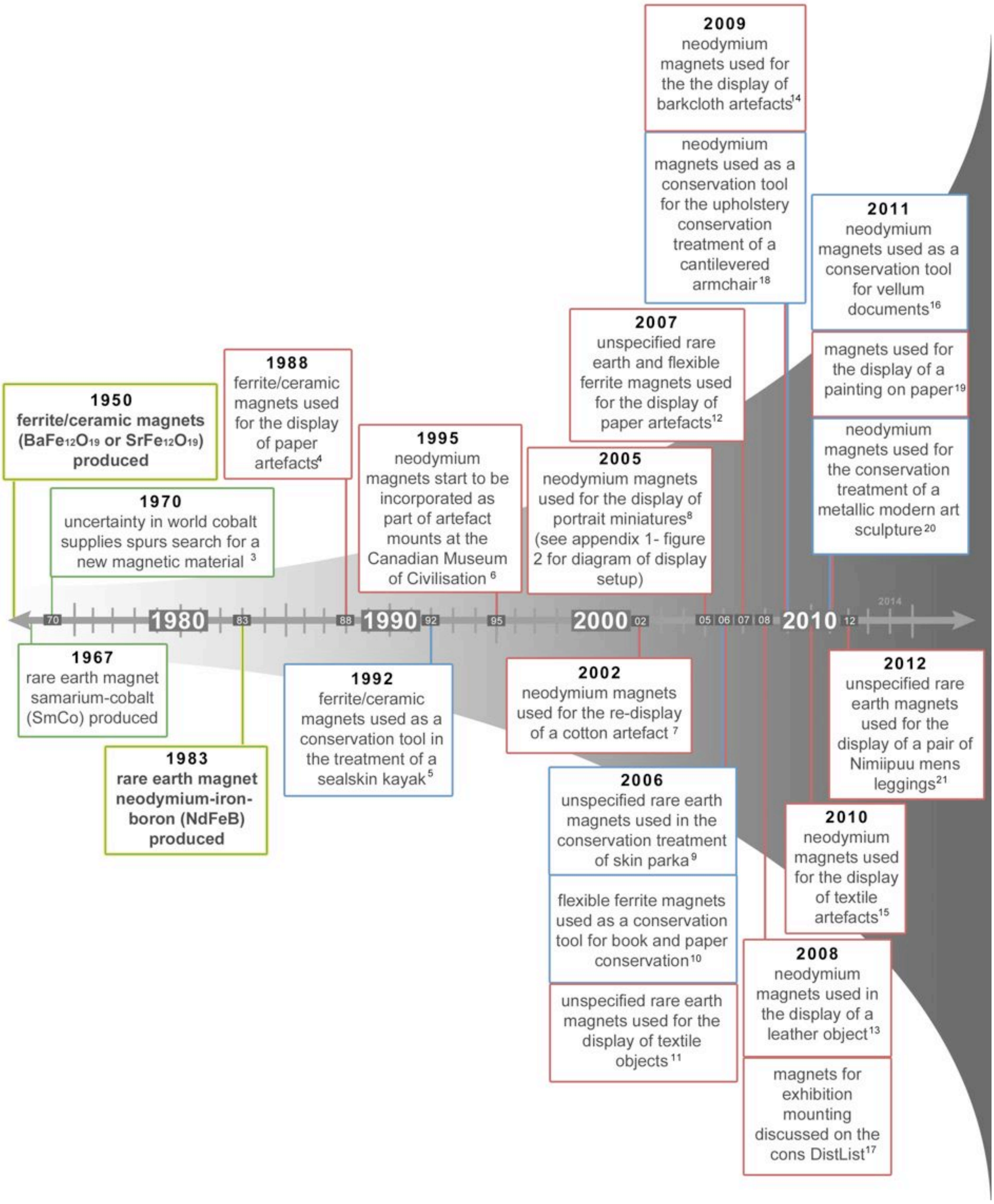

Figure 1: Timeline showing an increase in the use of magnets within museums

[3] J.M.D. Coey, "Preface," in *Rare-Earth Iron Permanent Magnets*, ed. J.M.D. Coey, (Oxford: Clarendon Press, 1996), vii – xii.

[4] Karen Potje, "A Travelling Exhibition of Oversized Drawings," (paper presented at The Book and Paper Group Annual 16, Vancouver, British Columbia, June 1-5, 1988).

[5] Carol Dignard, "Tear Repair of Skins with Minimal Access to their Back: the Treatment of a Kayak," *Leather Conservation News* Volume 7, Number 2 (1992): 1-8.

[6] Julie Hughes and Paul Vardy, "20 Years of Innovation and Development: Costume Support at the Canadian Museum of Civilization," in *Forum of the ICON Textile Group post prints*, ed. Rebecca Bissonnet and Elizabeth-Anne Haldane, 42-44 (London: ICON, 2007).

[7] F Verberne-Khurshid et al., "The Attraction of Magnets as a Conservation Tool," in *ICOM CC 13th Triennial Conference 2002 Preprints*, ed. Roy Vontobel, 363-369 (Rio de Janeiro: The Getty Conservation Institute, 2002).

[8] Alan Derbyshire and Timea Tallian, "The New Miniatures Gallery", *V&A Conservation Journal*, no. 51 (2005): 3-6, http://www.vam.ac.uk/content/journals/conservation-journal/issue-51/the-new-miniatures-gallery.

[9] Heather Dumka,"The Re-treatment of an Inuit Beaded Skin Parka, *"Journal of the Canadian Association for Conservation*, no.31 (2006): 23-32.

[10] Linda Blaser and Susan Peckham, "Archives Conservators Discussion Group 2006: Overall and Local Humidification and Flattening Tips and Tricks," (paper presented at The Book and Paper Group Annual 25, Washington D.C., 2006).

[11] Megan Dean-Jones, "Development of a Magnetic Vertical Display System for Bark Cloth Artifacts," *AICCM National Newsletter*, no.111 (2009): 27.

[12] "How the DAM Uses Rare-Earth Magnets with Art Installations," Denver Art Museum, http://www.denverartmuseum.org/article/staff-blogs/how-dam-uses-magnets-art-installations (accessed July 11, 2014).

[13] Tammy Jordan, "Using Magnets as a Conservation Tool: A New Look at Tension Drying Damaged Vellum Documents," (paper presented at The Book and Paper Group Annual 30, Washington D.C., 2011).

[14] "Magnets for exhibition mounting," Cons DistList, http://cool.conservation-us.org/byform/mailing-lists/cdl/2008/1185.html (accessed July 18, 2014).

[15] Gwen Spicer, "Conservation Treatment of a Hunzinger Cantilevered Armchair Including the use of Magnets to create Tufting," *Journal of the American Institute for Conservation* 52, no.2 (2013): 107-122.

[16] "Magnet Mounts," American Institute for Conservation of Historic and Artistic Works, http://www.conservation-wiki.com/wiki/Magnet_Mounts (accessed October 20, 2013).

[17] Kristen Watson Adsit, "An Attractive Alternative: The Use of Magnets to Conserve *Homer*," *WAAC Newsletter*, Volume 33, Number 2 (2011): 16-21.

[18] Deanna Hovey, "Short Communication: Simple and Invisible Solutions Using Rare Earth Disc Magnets in Mount making", *Journal of the American Institute for Conservation* 51, no.2, (2012): 51-58.

A Note on Flexible Ferrite and Neodymium Magnets

As seen in figure one, magnets commonly used within heritage conservation and display include flexible ferrite and neodymium rare earth magnets.

Flexible ferrite magnets (figure 2), familiar to most as fridge magnet material, are composed of powdered ferrite, also known as ceramic, magnet[19] ($BaFe_{12}O_{19}$ or $SrFe_{12}O_{19}$) [20] incorporated into a flexible binder[21].

The rare earth magnet neodymium iron boron ($Nd_2Fe_{14}B$) (figure 3), which was introduced in the 1980s as a cheaper and more readily available alternative to the other rare earth magnet samarium-cobalt (Sm_2Co_{17})[22], is a permanent magnet[23] like the flexible ferrite but possess a far stronger magnetic force.

Applications of both magnets within conservation are shown briefly in figure one and in more detail in tables 1, 2, and 3.

Images © www.first4magnets.com

Figure 2: Flexible ferrite magnet **Figure 3:** Neodymium magnets

[19] David Jiles, *Introduction to Magnetism and Magnetic Materials,* (London: Chapman & Hall, 1998), 103.

[20] J.M.D. Coey, "Preface," in *Rare-Earth Iron Permanent Magnets*, ed. J.M.D. Coey, (Oxford: Clarendon Press, 1996), vii.

[21] "Types of Magnets," How Magnets Work, http://www.howmagnetswork.com/types.html (accessed June 21, 2014).

[22] William D Callister Jr, "Magnetic Properties", in *Materials Science and Engineering an Introduction*, ed. Wayne Anderson and Ken Santor, 693 (New York: John Wiley & Sons Inc., 2003).

[23] "Permanent and Temporary Magnets," How Stuff Works, http://science.howstuffworks.com/magnetism-info2.htm (accessed June 20, 2014).

Chapter 1. Introduction and Project Outline

1.1 Introduction to the Research Project

For the author of this dissertation, whose background included experience of museum/art gallery exhibition display and who has recently graduated as a textile conservator, the topic of this research project was an obvious choice.

Since witnessing a growing trend in the use of magnets for the display of textile artefacts the author by way of this research project sets out to discover if magnets offer a non-invasive answer for the display of cultural heritage material or could potentially become a conservation concern of the future.

Magnets are a moderately new presence within the field of heritage conservation (see figure 1), and as it would undoubtedly take a length of time for any damage to occur as a result of the compression of a magnet, it is likely that little is currently known as to the effects of a magnet on a mounted textile. Therefore given their recent rise in popularity (figure 1) research into the effects of magnets on heritage material is considered an essential requirement.

1.2 The Research Aim

The primary aim of this research project is to establish whether magnets form a safe method of display for textile artefacts by discovering whether the compressive forces exerted on a textile artefact suspended in a magnetic display system cause damage to the objects fibres and/or weave.

1.3 The Research Objectives

Although time is limited, it is hoped that some understanding of the effects of a magnetic display system on a textile artefact can be gained through following the proposed route of research:

Objective 1:

- Establish what research has previously been undertaken regarding the effects of a magnetic display system on mounted textile artefacts.

Objective 2:

- Discover what methods of magnetic display are most commonly being utilised within the museum and for what type of textiles, via conducting a thorough review of the currently available literature and through circulating a questionnaire throughout the textile conservation community.

Objective 3:

- Use the information gained from the literature review and questionnaire to inform the design and manufacture of 'typical' magnetic display systems, which will hold samples of the textile types cited as being most commonly displayed using magnets for set periods of time.

Objective 4:

- Conduct an experiment to quantify the total compressive force of the 'typical' magnetic display systems created

Objective 5

- Once the textile samples have been demounted carry out visual analysis i.e. simple unaided visual examination, stereomicroscopy, and scanning electron microscopy to ascertain whether any damage has occurred as a result of the textiles being mounted using magnets.

Objective 6:

- Recommendations can then be made based on the findings of the research i.e. suitable timespans for magnets to be in contact with textile artefacts or alternative methods of display.

1.4 Project Outline

Chapter 2 – Reviews four areas of available literature:

- Magnetic theory texts
- Conservation case studies describing the use of magnets as a conservation treatment tool.
- Conservation case studies describing the use of magnets as a method of display.
- Published conservation research into the effects of magnets on mounted textiles.

Chapter 3 – Discusses the results of a questionnaire designed, and circulated throughout the textile conservation community.

Chapter 4 – Information gathered through the literature review and questionnaire is collated to inform the design and manufacture of three 'typical' magnetic display systems in order to achieve relevant results during the experimental stages of the research.

Chapter 5 – Study one – A Tension Compression Machine is used to quantify the total compressive force of a ‘typical’ magnetic display system on a textile sample.

Chapter 6 – Study two – Visual analysis (simple unaided visual examination, stereomicroscopy, and scanning electron microscopy) is carried out on textile samples previously mounted with magnets to assess if any damage has occurred as a result of the compressive forces exerted by the magnetic display system.

Chapter 7– The findings from the entire research project are summarised, followed by an evaluation of the aims and objectives of the dissertation and the prospect of further research is discussed.

Chapter 2. Literature Review

2.1 Introduction, Aims and Objectives

In this chapter the author will explore and review the current literature available on magnetic theory and on the use of magnets for the treatment and display of cultural heritage material.
The overarching aims of this literature review are to:

- Identify gaps in the published research that relate specifically to magnetic display.
- Discover the most common textile types mounted using magnets along with the most frequently cited magnetic display system(s), in order to inform the experimental methodology of the dissertation.

Subsequent aims are that the literature review should act as a resource for further research and provide evidence of how this Master's thesis builds upon the body of knowledge currently available to the conservation community.
The objectives of this literature review are to:

- Establish where a basic understanding of magnetic theory can be gained.
- Summarise the various uses of magnets in the context of both conservation treatment and museum display[24].
- Create a comprehensive resource of illustrations of the magnetic display systems described in the literature, to act as a timesaving device in the problem-solving process of exhibition installation.

2.2 Magnetic Theory – Understanding the Basics

In order to be able to interpret the terminology used when magnets are discussed within the context of conservation, and prior to using magnets in contact with heritage objects, it is necessary to gain a basic understanding of magnetic theory.
As would be expected, and contrary to the conservation literature currently available, educational texts detailing the physical science of magnetism are widespread, spanning from primary to postgraduate level readings. The former; primary teaching aids, such as BBC learning zone videos[25], provide a good rudimentary understanding of the key principles of magnetism, while more specific information can be found in specialist or postgraduate level

[24] Please note the term 'museum display' is used throughout the dissertation to mean the display of cultural heritage objects within a museum, art gallery or other heritage institution.

[25] "Magnets," BBC Search, http://search.bbc.co.uk/search?scope=all%3Alearning&search_form=in-page-search-form&q=magnets (accessed June 13, 2014).

textbooks such as Material Science and Engineering an Introduction by William D. Callister Jnr[26] and Physics Technology Update by James S. Walker[27].

By linking these two areas of knowledge 'the properties and mechanisms that explain the magnetic phenomenon which are often subtle and complex'[28] can be understood. For instance the more basic of the literature can be used to help decipher the less familiar terminology found in advanced physics books, enabling information relevant to specific conservation tasks to be extracted.

2.3 Magnetic Theory in Conservation

The chapter entitled Magnetic Properties in the textbook Material Science and Engineering, an introduction describes, for example, 'the influence of temperature on magnetic behaviour', valuable information for those intending to implement magnets in the context of museum display i.e. adhering magnets inside mount forms using a hot-melt glue gun.

Callister calls upon the basic principles of kinetic theory to describe how a rise in temperature causes the thermal vibrations of atoms within a magnet, which randomizes the directions of any magnetic moments that may be aligned, hence diminishing the magnetic force of the magnet.

The point at which magnetization is completely diminished is known as the Curie Temperature (Tc)[29], the Tc for Neodymium magnets, the type of magnet cited as being most commonly used both as a conservation tool and within museum display (see tables 1 and 2), being 310°c[30].

As hot-melt glue guns typically operate at around 190°c[31], 120° below the Tc of neodymium magnets it could be assumed, if consulting magnetic theory texts in isolation of conservation

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[26] William Callister D Jr, *Materials Science and Engineering an Introduction,* (New York: John Wiley & Sons Inc., 2003), 673-706.

[27] James. S Walker, *Physics: Technology Update, Fourth Edition*, (Glenview: Pearson, 2013), 765.

[28] William Callister D Jr, *Materials Science and Engineering an Introduction,* (New York: John Wiley & Sons Inc., 2003), 674.

[29] William Callister D Jr, *Materials Science and Engineering an Introduction,* (New York: John Wiley & Sons Inc., 2003), 686.

[30] Gwen Spicer, "Defying Gravity with Magnetism," *AIC News*, Vol. 35, No. 6 (2010): 1-5.

[31] "Hot-melt adhesive," Wikipedia, http://en.wikipedia.org/wiki/Hot-melt_adhesive (accessed August 22, 2014).

case studies (which offer context through purveying the individuals experience), that hot-melt glue offers a safe and effective method for adhering magnets into a display mount.

New York based objects conservator Gwen Spicer, who has published widely on the topic of magnets in conservation, highlights the value of understanding magnetic theory and interpreting the literature when applied to conservation by challenging this assumption in her published case studies. 'Conservation Treatment of a Hunzinger Cantilevered Armchair Including the use of Magnets to Create Tufting' discusses Spicer's experience of a loss of magnetism when using 'hot-melt glue to mount magnets onto a display'[32].

When questioned about this by the author, Spicer demonstrated both experience of using magnets within conservation and an awareness of magnetic theory by maintaining: "*as the temperature increases the strength of the magnetic force decreases, so there is a working temperature and a point of irreversibly i.e. no turning back. Therefore beyond 150°c the magnet is really threatened*."[33]

Spicer's conservation case studies, such as: 'Creating Mounts with Magnets for 'Uncommon Threads''[34] and 'The Upholstery Treatment of the Hunzinger Chair,'[35]highlight how conservators are critically engaging with magnetic theory in order to inform and justify their decision to use magnets either for the display or conservation of cultural heritage artefacts.

2.4 Magnets as a Conservation Tool

Although this dissertation focuses on the use of magnets as a method of display, it is important to acknowledge the other ways in which magnets come in contact with textile artefacts i.e. during their treatment in the conservation studio.

Typically used as a conservation tool to secure an object whilst an adhesive dries, or to prevent the return of creasing to a drying humidified object, both neodymium and flexible ferrite magnets are becoming an increasingly common feature within the cultural heritage conservator's toolbox.

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[32] Gwen Spicer, "Conservation Treatment of a Hunzinger Cantilevered Armchair Including the use of Magnets to create Tufting," *Journal of the American Institute for Conservation* 52, no.2 (2013): 107-122.

[33] Personal communication 4th of August 2012 20:04.

[34] Gwen Spicer, "Creating mounts with magnets for 'Uncommon Threads'," *Inside the Conservators Studio: An Art Conservator's Journal*, (2013), http://insidetheconservatorsstudio.blogspot.co.uk/2013/01/creating-mounts-with-magnets-for.html (accessed August 20, 2014).

[35] "Upholstery Project for the Munson Williams Proctor Arts Institute," Spicer Art Conservation, LLC, http://www.spicerart.com/portfolio/page40/page30/page30.html (accessed August 20, 2014).

Spicer, by way of collating information derived from the currently available literature, offers a useful, albeit brief, paragraph in the 2010 AIC News article: 'Defying Gravity with Magnetism'[36] which summarises the various uses of magnets as a conservation tool. Throughout such case studies as mentioned by Spicer, which span object, paper and textile conservation, magnets are cited as having offered an innovative solution to conservators when challenged by a lack of access to an object and in some instances offering an effective substitute to weights.

Linda Blaser et al describe the preference of flexible magnets over weights for the mending and light humidification of torn paper in bound volumes. When making a comparison with weights Blaser describes magnets as being user friendly, enabling a light weight force, and offering portability whilst requiring little room in storage[37].

As well as books and paper magnets are a commonly cited conservation tool in the treatment of skin or leather objects: Tammy Jordan of Etherington Conservation Services describes the use of rare earth magnets for the humidification and tension drying of severely cockled vellum documents.[38] While Carole Dignard, in an article from the leather conservation news published in 1992, discusses the use of magnets as a treatment solution in the tear repair of a sealskin kayak[39].

An additional innovative use of magnets as a treatment solution can be found in; 'An Attractive Alternative: The Use of Magnets to Conserve *Homer*', which describes the use of magnets in the conservation treatment of 'Homer' a metallic sculpture by John Chamberlain. The magnetic nature of the work, being composed of tin-plated steel, allowed for magnets to be used as an adhesive in place of original soldered joins, which had begun to fail, providing the artefact with 'renewed structural strength and stability'.[40]

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[36] Gwen Spicer, "Defying Gravity with Magnetism, " *AIC News*, Vol. 35, No. 6 (2010): 1-5.

[37] Linda Blaser and Susan Peckham, "Archives Conservators Discussion Group 2006: Overall and Local Humidification and Flattening Tips and Tricks," (paper presented at The Book and Paper Group Annual 25, Washington D.C., 2006).

[38] Tammy Jordan, "Using Magnets as a Conservation Tool: A New Look at Tension Drying Damaged Vellum Documents," (paper presented at The Book and Paper Group Annual 30, Washington D.C., 2011).

[39] Carol Dignard, "Tear Repair of Skins with Minimal Access to their Back: the Treatment of a Kayak," *Leather Conservation News* Volume 7, Number 2 (1992): 1-8.

[40] Kristen Watson Adsit, "An Attractive Alternative: The Use of Magnets to Conserve *Homer*," *WAAC Newsletter*, Volume 33, Number 2 (2011): 16-21.

The four diverse examples of magnets as a conservation treatment tool that have been discussed are included in table one below. The table collates information from across six conservation case studies to demonstrate the various materials being conserved using magnets and the types of magnets and methods being utilised.

Literature	Material Type	Conservation Treatment	Magnet Type
1) Linda Blaser and Susan Peckham 'Overall and Local Humidification and Flattening: Tips and Tricks'[41]	paper in bound volumes	aligning separated tears and clamping materials whilst an adhesive dries, as well as local humidification and flattening of paper documents	flexible ferrite magnets covered with blotter and spun polyester (Hollytex®), Tyvek® or Gore-tex®
2) Tammy Jordan 'A New Look at Tension Drying Damaged Vellum Documents'[42]	vellum document	drying object under tension after humidification treatment	neodymium magnets covered with spun polyester (Hollytex®)
3) Carol Dignard 'Tear Repair of Skins with Minimal Access to their Backs'[43]	sealskin kayak	aligning separated tears and clamping materials whilst an adhesive dries	ferrite (ceramic) magnets covered with jersey in conjunction with a tin-plated spatula
4) Heather Dumka 'The Retreatment of a Beaded Skin Parka'[44]	caribou skin parka	magnets used to hold patches in place prior to being heat set	unspecified rare earth magnets (either neodymium or samarium-

[41] Linda Blaser and Susan Peckham, "Archives Conservators Discussion Group 2006: Overall and Local Humidification and Flattening Tips and Tricks," (paper presented at The Book and Paper Group Annual 25, Washington D.C., 2006).

[42] Tammy Jordan, "Using Magnets as a Conservation Tool: A New Look at Tension Drying Damaged Vellum Documents," (paper presented at The Book and Paper Group Annual 30, Washington D.C., 2011).

[43] Carol Dignard, "Tear Repair of Skins with Minimal Access to their Back: the Treatment of a Kayak," *Leather Conservation News* Volume 7, Number 2 (1992): 1-8.

[44] Heather Dumka,"The Re-treatment of an Inuit Beaded Skin Parka," *Journal of the Canadian Association for Conservation*, no.31 (2006): 23-32.

			cobalt)
5) Gwen Spicer 'Upholstery Conservation Treatment of a Hunzinger Chair'[45]	unspecified fabric	Returning the chair seat to its original profile: '*In order not to disturb the original lasing ties and springs rare earth magnets were used in replacement of the buttons'*	neodymium magnets
6) Kristen Watson Adsit 'The use of Magnets to Conserve Homer by John Chamberlain'[46]	tin-plated steel sculpture	long term joining method	neodymium magnets covered with a rubberized coating

Table 1: Review of conservation case studies: Assessment of the types of materials being conserved using magnets and the typical magnets and methods utilised

It was decided to study magnets within the context of display as opposed to conservation treatment as, with the exception of the artwork described above (no. 6 in table 1), the period of interaction between object and magnet is likely to be significantly less during treatment and therefore the risk of possible damage caused by compression is considerably reduced.

2.5 Magnets as a Method of Display

With the exception of one scientific research article all conservation literature currently published on the topic of magnetic display depicts case study scenarios where magnets have been employed as the mounting solution for a particular object or group of objects within a heritage institution.

The conservator's experience of using magnets as a method of display is, like with the use of magnets as a conservation tool, expressed through a variety of knowledge sharing formats, including: conference papers, websites and both print and electronic journals.

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[45] Gwen Spicer, "Conservation Treatment of a Hunzinger Cantilevered Armchair Including the use of Magnets to create Tufting," *Journal of the American Institute for Conservation* 52, no.2 (2013): 107-122.

[46] Kristen Watson Adsit, "An Attractive Alternative: The Use of Magnets to Conserve *Homer*," *WAAC Newsletter*, Volume 33, Number 2 (2011): 16-21.

Case studies from across all disciplines of cultural heritage conservation, with paper and textiles being the most commonly cited mediums; describe magnets used as a mounting solution for a broad range of museum objects, such as:

- Costume and two-dimensional textiles that cannot be mounted via other means i.e. sewn or pinned into due to the inherent instability[47] or condition of the material[48] or surface decoration[49].
- Paper objects that necessitate a visually unobtrusive method of hanging in response to the artist's intent. [50]
- Objects subjected to repeated display, i.e. popular items or artefacts incorporated in travelling exhibitions, which as a result require a non-invasive alternative to other more potentially damaging display methods.[51]

The case studies reviewed on the subject of magnetic display are presented in table 2 below. The information (on the types of textiles mounted using magnets and the typical magnetic display systems used) gathered from the literature is presented in this format in order to allow ease of access for the reader and to enable the viewing of information from multiple sources at one time to inform the experimental methodology of the research project.

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47 "How the DAM Uses Rare-Earth Magnets with Art Installations," Denver Art Museum, http://www.denverartmuseum.org/article/staff-blogs/how-dam-uses-magnets-art-installations (accessed July 11, 2014).

48 F Verberne-Khurshid et al., "The Attraction of Magnets as a Conservation Tool," in *ICOM CC 13th Triennial Conference 2002 Preprints*, ed. Roy Vontobel, 363-369 (Rio de Janeiro: The Getty Conservation Institute, 2002).

49 Julie Hughes and Paul Vardy, "20 Years of Innovation and Development: Costume Support at the Canadian Museum of Civilisation," in *Forum of the ICON Textile Group post prints*, ed. By Rebecca Bissonnet and Elizabeth-Anne Haldane (London: ICON, 2007): 42-44.

50 Daria Keynan, Julie Barten and Elizabeth Estabrook, "Installation Methods for Robert Ryman's Wall-mounted Works," *The Paper Conservator*, no.31 (2007): 7.

51 Karen Potje, "A Travelling Exhibition of Oversized Drawings," (paper presented at The Book and Paper Group Annual 16, Vancouver, British Columbia, June 1-5, 1988).

Literature	Textile Type	Magnet Type	Other Materials
1) Asian Art Museum Website Page (date unknown)[52]	**Case Study 1:** unspecified (‘*Burmese court costume made of fragile fabric encrusted with heavy metal and glass ornaments’*)	**Case Study 1:** unspecified (‘*magnetic buttons’)* - thought by the author to be rare earth magnets (neodymium or samarium-cobalt)	none stated
	Case Study 2: unspecified (batik)	**Case Study 2:** ‘*bendable refrigerator magnets’* (thought by the author to be flexible ferrite magnets) and rare earth magnets (neodymium or samarium-cobalt)	archival museum board, steel sheeting (to attract the magnets) ‘*covered with a protective flannel layer and finish fabric’*
2) Denver Art Museum Staff Blog 2012[53]	**Case Study 3:** caribou skin (Innu (Naskapi) woman’s dress and child’s coat)	neodymium magnets were used in all three case studies	none stated
	Case Study 4: silk (Chinese hangings)		‘steel slat’ to attract the magnets
	Case Study 5: unspecified (embroidered rank badges)		none stated
3) ‘Inside the Conservator’s Studio’ Gwen Spicer Blog 2013[54]	**Case Study 6:** unspecified	rare earth magnets (neodymium or samarium-cobalt)	Dibond®, 1” thick Ehafoam®, two layers of ¼” thick Volara®, galvanized fender washers (to attract the magnet), blue board and Mylar®

[52] “Preventative Conservation: Magnet Mounts,” Asian Art, http://www.asianart.org/collections/magnet-mounts (accessed April 20, 2014).

[53] “How the DAM Uses Rare-Earth Magnets with Art Installations,” Denver Art Museum, http://www.denverartmuseum.org/article/staff-blogs/how-dam-uses-magnets-art-installations (accessed July 11, 2014).

[54] Gwen Spicer, “Creating mounts with magnets for ‘Uncommon Threads’,” *Inside the Conservators Studio: An Art Conservator’s Journal*, (2013), http://insidetheconservatorsstudio.blogspot.co.uk/2013/01/creating-mounts-with-magnets-for.html (accessed August 20, 2014).

Literature	Textile Type	Magnet Type	Other Materials
4) Cons DistList Conversation 2008 (Victoria Gill in correspondence with Metta Jorgensen)	**Case Study 7:** unspecified textiles and basketry	not stated	Mylar®
5) Cons DistList Conversation 2008 (Shirley Ellis in correspondence with Metta Jorgensen)	**Case Study 8:** unspecified textiles	rare earth (neodymium or samarium-cobalt)	acid free card, felt and metallic panel (to attract the magnets)
6) Cons DistList Conversation 2008 (Helena Jaeschke, in correspondence with Metta Jorgensen)[55]	**Case Study 9:** unspecified textiles and bark cloth	neodymium	small polythene foam pads and metal plates (to attract the magnets)
7) AICCM National Newsletter Article 2009[56] (see appendix 1 - figure 3 for diagram of display set-up)	**Case Study 10:** bark cloth	neodymium	plywood, Marvelseal®, self-adhesive flexible magnet (to attract the magnets), Mylar® and calico
8) ICOM CC 13th Triennial Conference 2002 Preprints (see appendix 1 - figure 1 for	**Case Study 11:** cotton	neodymium	wooden stretcher, metallic cups (to attract the magnets), velvet, felt, and metallic rings (to enclose

[55] "Magnets for exhibition mounting," Cons DistList, http://cool.conservation-us.org/byform/mailing-lists/cdl/2008/1185.html (accessed July 18, 2014).

[56] Megan Dean-Jones, "Development of a Magnetic Vertical Display System for Bark Cloth Artefacts," *AICCM National Newsletter*, no.111 (2009): 27.

diagram of display setup)[57]			magnetic fields)
Literature	**Textile Type**	**Magnet Type**	**Other Materials**
9) ICOM CC 15th Triennial Conference 2008 Preprints[58]	**Case Study 12:** leather	neodymium	Honeycomb aluminium structure laminated with polycarbonate sheets, strip of synthetic textile with iron bar inside (to attract the magnets) Teflon® slide, aluminium track, springs and ferromagnetic material (also to attract magnets)
10) JAIC Vol.51 Article 2012[59]	**Case Study 13:** native tanned hide (‘*Nimiipuu men’s leggings*’)	rare earth (neodymium or samarium-cobalt)	archival corrugated board, gummed linen tape, 1.9cm birch plywood, Marvelseal®, 16-gauge steel sheet (to attract the magnets) and finish fabric
11) ICON Textile Group forum Paper 2007[60]	**Case Study 14:** unspecified (‘*1760s dress*’)	neodymium magnets were used in all three case studies	Ultrasuede® buffer, ‘*mate magnets*’ (to attract the magnets)
	Case Study 15: unspecified (‘*moccasins with fragile*		Ultrasuede® buffer, Polyethylene foam,

[57] F Verberne-Khurshid et al., ‘The Attraction of Magnets as a Conservation Tool,’ in *ICOM CC 13th Triennial Conference 2002 Preprints,* ed. Roy Vontobel, (Rio de Janeiro: The Getty Conservation Institute, 2002): 363-369.

[58] Mariabianca Paris et al., “The Restoration of a gilt Leather portière of the 16th century: study of a magnet-based support structure,” in *15th Triennial Conference New Delhi, 22-26 September 2008, Preprints Volume I*, ed. ICOM Committee for Conservation, 211-216 (New Delhi: Allied Publishers Pvt Ltf, 2008).

[59] Deanna Hovey “Short Communication: Simple and Invisible Solutions Using Rare Earth Disc Magnets in Mountmaking,” *Journal of the American Institute for Conservation* 51, no.2 (2012): 51-58.

[60] Julie Hughes and Paul Vardy, “20 Years of Innovation and Development: Costume Support at the Canadian Museum of Civilisation,” in *Forum of the ICON Textile Group post prints*, ed. Rebecca Bissonnet and Elizabeth-Anne Haldane, (London: ICON, 2007).

	quill or beadwork') thought by the author to be composed of leather		fibrefil, cotton jersey, thin-gauge stainless steel plates (to attract the magnets),
	Case Study 16: unspecified ('*brittle World War One protective coat with hand painted camouflage*')		1"and 2½" thick polyethylene foam planks, cotton jersey, Gatorboard®, fibrefil, mate magnets (to attract the magnets)

Table 2: Review of textile conservation case studies: Assessment of the types of textiles mounted using magnet and the typical magnetic display systems utilised

Through review of the current conservation literature available on the subject of magnetic display, magnets appear to offer the perfect solution when challenged with how to exhibit a vast variety of complex heritage objects: 'They are easy to use requiring minimal skill, they are discreet and can be camouflaged so as to become visually unobtrusive when viewing an artefact[61] and most importantly; they are seemingly non-invasive to the object to which they are providing support'[62]

Figure 4 below shows collated the most frequently cited magnetic display system[63] components described in the literature detailed in table two. This information has been brought together in a diagram to show A) the most common combination of components found in a magnetic display system setup and to B) dictate the materials chosen for the experimental phase of the research.

[61] "Preventative Conservation: Magnet Mounts," Asian Art, http://www.asianart.org/collections/magnet-mounts (accessed April 20, 2014).

[62] Rosie Chamberlin, "Conservation in Practice Literature Review: Methods of Mounting with Magnets with a Focus on Vertical Display," (Textile Conservation MPhil, Glasgow University, 2013).

[63] Please note: the term 'magnetic display system' used in the context of this dissertation means the whole display set up used, i.e. everything depicted in figure 4: The backing board with magnetic material to attract the magnets, and all incorporated materials including the magnets placed on the surface of the mounted artefact.

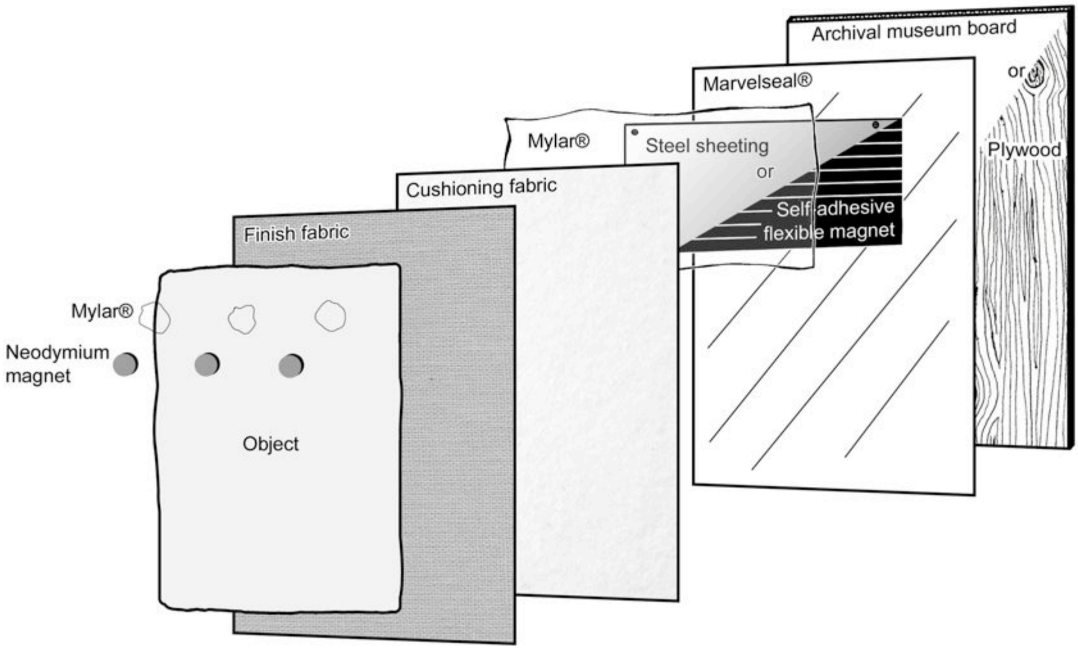

Figure 4: A 'typical' magnetic display system (as based on information derived from textile conservation case studies)

2.6 Published Research

Although it is evident from reviewing the literature that magnets are widely used, little appears to have been done in regards to scientific research into the effects of magnets on cultural heritage material.

This gap in published research could be explained by the fact that magnets are a relatively new tool within conservation (see figure 1) or that, while mock-up display systems may be set up within conservation studios to test the mounting methods suitability on certain material types, institutions may not possess sufficient funding or the facilities required to carry out analysis. Additional reasons for the lack of research could be that the possible risk of damage via compression is seen as unimportant when considering other factors such as the time restraints involved in setting up an exhibition, or it could be assumed that magnets pose less risk to a historic artefact when compared to seemingly more invasive measures such as stitching.

Whatever the reasoning there is nonetheless one research article which was published in the AICCM National Newsletter in 2009 that describes analytical studies carried out in order to develop to a safe method of display for bark cloth artefacts using magnets[64].

[64] Megan Dean-Jones, "Development of a Magnetic Vertical Display System for Bark Cloth Artefacts," *AICCM National Newsletter*, no.111 (2009): 27.

The author Megan Dean-Jones describes three tests carried out on a magnetic display system in order to A) 'Determine how many magnets would be needed to hold up a given area of bark cloth' (see appendix 1 - figure 4 for illustration of test), B) 'Examine whether magnets compress bark cloth fibres' and C) 'Calculate the compressive force of a magnet'. These latter two tests carried out will form a platform for the further research carried out in this research project.

2.7 Summary of Results

To summarise the results from the twenty-two conservation case studies reviewed; neodymium magnets are cited as being the most widely used magnet in the context of both conservation treatment and exhibition display. While leather was found to be the most common material to be both conserved and displayed using magnets, with the predominant treatment application being magnets used to clamp an object while an adhesive dries. Bark cloth, cotton, and silk artefacts were also cited as being displayed using magnets. Many of the authors of the case studies reviewed describe their decision to use magnets for a particular treatment or display method as being modelled on or influenced by earlier published literature. This is typical of the knowledge sharing prevalent in the conservation community and it was therefore expected that a common trend would be found in the materials cited.

2.8 Conclusion

Through review of the current conservation literature it has been observed that, while magnets are extensively cited as being used for both the treatment and display of cultural heritage artefacts, surprisingly little published research is available into the effects of magnets on the clamped or mounted material.

In order to bridge this gap in knowledge, information has been collated from the available literature to gain an insight into the typical type of textiles being mounted with magnets and the typical magnetic display systems being utilised (tables 1, 2 and figure 4). Together with the qualitative questionnaire data collected this information will go on to inform the experimental methodology of the research project. It is hoped that the questionnaire responses will perhaps shed light on unpublished research involving magnetic display and discuss aspects not referred to in the literature such as environmental conditions that will go on to inform the experimental phase of the research.

Chapter 3. Qualitative Research

3.1 Aim of the Research

A questionnaire was developed with the principal aim of gaining further insight into the current practice of magnets as a method of display for textile artefacts.
Together with the data collected through the literature review, the responses from the questionnaire would provide an understanding of A) the most common textile types being mounted with magnets and B) the most popular magnetic display systems currently in use. This information would then go on to dictate the materials used in the experimental phase of the research in order to produce results that would be relevant for those using or intending to use magnets for the mounting and display of cultural heritage material.

3.2 The Questionnaire

An online questionnaire composed of ten questions was designed and sent out via email to 23 textile conservators working either in an institution, in private practice, or on a freelance basis in the UK[65].
Previous published surveys were referred to when writing the questionnaire[66][67] and questions were chosen in the hope that the responses would add to the information previously gathered from the literature review conducted. For example as no reference was made to the environmental conditions throughout the case studies reviewed, the questionnaire participants were asked to 'provide an indication of the typical environmental conditions that objects mounted with magnets were displayed in'. This information would enable the author to replicate the most common environmental conditions cited during the experimental phase of the research, ensuring relevancy in the results produced.
Having conducted a review of the literature pertinent to the subject area, informed choices could be made as to the questions asked and the range of answer options given. Each question was kept short and to the point using tick box or short answer choices with the intention of making the questionnaire as quick and as easily accessible as possible.
Online survey software was used to create the questionnaire in order to avoid formatting issues and to enable compatibility with a wide range of operating systems. The software

[65] Please note: the author is awaiting the questionnaire to be posted on an international conservation forum.

[66] Camille Myers Breeze, *A Survey of American Tapestry Conservation Techniques*, (Lowell, MA: American Textile History Museum, 2000), 16-38.

[67] "Introduction to Survey on the use of Magnets in Conservation," Survey Monkey, http://www.surveymonkey.com/r/?sm=%2bl0eJ4KGkJJdoiduNm2g%2fQ%3d%3d (accessed June 14, 2014).

used allowed the questionnaire to be sent as a link as opposed to a large attachment and was found to be effective in giving the document a professional appearance (see appendix 2 for the questionnaire).

3.3 The Results

There were not a high amount of responses from the participants contacted (8 out of 23 filled out the questionnaire) however out of the 8 responses received 4 had encountered the use of magnets for the display of textile artefacts and provided useful feedback relating to their individual experiences (see table 3).

A number of reasons were thought of as to why responses to the questionnaire were so few i.e. it being the time of year that people are away on leave etc. But through looking back at the literature reviewed it was observed that only four out of twenty two case studies reviewed were from the UK, while fifteen were from the US and the remaining three from Europe, Canada, and Australia. It is most likely therefore that while the use of magnets for the conservation and display of heritage artefacts is known of, few textile conservators in the UK have yet to experience magnets in the context of exhibition display for themselves.

As there were not many participants involved in the questionnaire the data is insufficient to be representative of the use of magnets for display by textile conservators as a whole. The four participants that did take part however were from a breadth of different working environments and coupled with the information gathered from the literature review a picture can begin to be built of the type of magnetic display system needed to be manufactured for the experimental phase of the research to ensure the relevancy of the results.

3.3.1 The Participants

Participant one and four work as freelance textile conservators while participant two runs a private textile conservation practice and participant three is based in the textile conservation department of a large institution. All four participants are UK based. Participant answers are organised in the order that the responses were received with 'participant one' being the earliest response and 'participant four' being the most recent.

The questionnaire commenced by asking participants to provide their name, position, and place of work. They were then asked whether they used magnets for the mounting/display of textile artefacts. Those who answered yes moved onto the questions listed in table three below.

3.3.2 Participant Answers

Please note: The questions have been reordered in table three. For the original document sent to participants see appendix two or follow the link[68] footnoted below.

Question 1 What kind of textile artefacts have you displayed using magnets?	
Participant	Answer
1 (Freelance)	Thangkas
2 (Private practice)	Flat textiles
3 (Institution based)	Flat textiles, two and three dimensional costume and bark cloth
4 (Freelance)	Flat textiles, three dimensional costume and large banners
Question 2 What are the textile artefacts you have mounted with magnets composed of?	
Participant	Answer
1	Cotton and silk
2	Cotton
3	Cotton, silk, synthetics and bark cloth
4	Cotton, silk and linen
Question 3 Please give an indication of the largest kind of object displayed using magnets.	
Participant	Answer
1	1-1.3 m x 50-80 cm
2	80cm x 60cm
3	We used magnets to secure Chinese robes onto slanted mounts and to mount contemporary quilts vertically on walls.
4	Largest is several metres in width - 5m
Question 4 What type of magnet do you typically use for mounting textile artifacts?	
Participant	Answer
1	Rare earth - neodymium
2	Neodymium (typically 2mm thick disc magnets at about 1cm diameter)
3	Rare earth magnets
4	Small solid metal discs and flexible lengths of magnetic material (for continuous hanging I have used covered magnet strips along the top edge in lieu of Velcro)
Question 5 Is the type, size or amount of magnet(s) used changed depending on the suspended object?	
Participant	Answer
1	Yes
2	Yes
3	Yes
4	Yes

[68] "Magnets Within Museum Display Questionnaire," Survey Gizmo, http://www.surveygizmo.com/s3/1666107/Magnets-Within-Museum-Display (accessed June 14, 2014).

Participant	Answer
Question 6 Please give an indication of the typical environmental conditions during this time.	
Participant	Answer
1	Controlled
2	Not sure of the conditions within galleries
3	Uncontrolled
4	Controlled
Question 7 Are magnets used temporarily or for long-term display?	
Participant	Answer
1	12 month rotation
2	Long term and temporary
3	Both. It's more frequent in temporary displays - especially for textiles, but I know that some small objects are permanently mounted with magnets.
4	Temporary display and long-term storage -stored flat on mount
Question 8 Why did you decide to use magnets for displaying textile artefacts?	
Participant	Answer
1	As sacred objects a non-invasive method was chosen that would also allow the Thangka to be displayed, as they would have been hung in a temple setting.
2	Economical yet effective method for mounting
3	The quilts were made with complex mixed materials that could not be sewn through for Velcro. It's usually because the textile is painted or of a paper-like quality and cannot be punctured.
4	Textile could not withstand stitching. For storage they are a means to hold the textile in place on the board.
Question 9 Are they found to be effective?	
Participant	Answer
1	Yes, very, but they must have the correct thickness barrier layer between the object and the magnet to prevent any indentation or compression.
2	Yes
3	Yes
4	Very
Question 10 Have any adverse effects been noticed on the magnetically mounted textiles?	
Participant	Answer
1	None
2	Not that we know of as yet
3	No
4	No

Table 3: Questionnaire responses

3.4 Conclusion

As seen in table three and also in appendix four (where a table of summarised results from the qualitative research carried out can be found), the questionnaire responses describe flat textiles composed of cotton or silk as the most common type of artefact to be mounted using magnets. The most usual magnet for displaying the described textiles is cited as being neodymium ($Nd_2Fe_{14}B$), while a mixed response was received to the environmental conditions question (table 3 - question 6). The environmental conditions during the period of testing will therefore, where possible, be monitored and documented in order to make the tests carried out replicable for further research.

In retrospect it would have been desirable to circulate the questionnaire more broadly i.e. internationally, as this is where much of the literature detailing the use of magnets for the display of textile artefacts was found to have originated. However the data collected through the literature review and the survey results combined provides an adequate enough depiction of the typical method of magnetic display and typical textile types mounted using magnets to enable the replication of an accurate display set-up in order to produce results relevant to the conservation community.

When comparing the questionnaire responses to the data extracted from the literature reviewed (see summary of findings – appendix 4) a common theme is evident. It can be seen in figure 5 below that, through the conservation case studies and the questionnaire responses, cotton is found to be the most commonly mounted textile using magnets, followed by silk, leather and bark cloth. While the most commonly used magnet type is the rare earth magnet neodymium (see figure 6). Other materials found to be typically included within a magnetic display system are included in figure 4 and appendix 4.

The common theme running through the literature and the questionnaire responses can be found explained in the references given in each text; with each newly published case study citing that which came before it. This discovery is demonstrative of the practice of the sharing of knowledge of a recent development within the discipline of heritage conservation.

The information derived from the literature review and the questionnaire regarding the two key components (the type of textiles being displayed using magnets and the choice of magnetic display system used) that would inform the material choices in the experimental methodology were organised into a bar chart format (see figure 5 and 6 below).

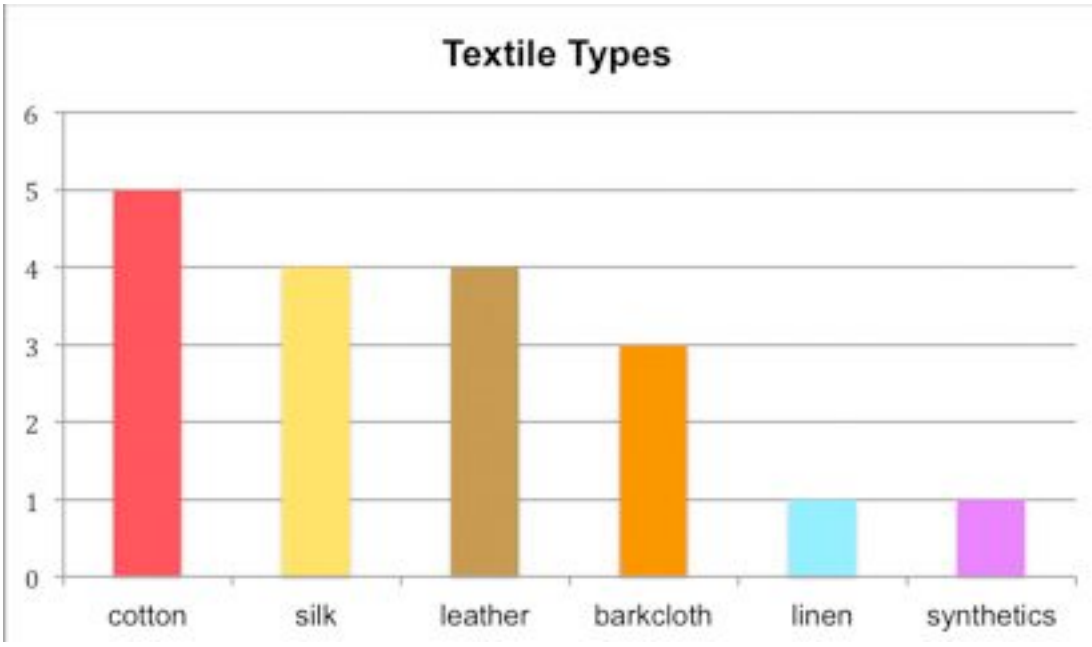

Figure 5: Bar chart 1: Common textile types mounted using magnets

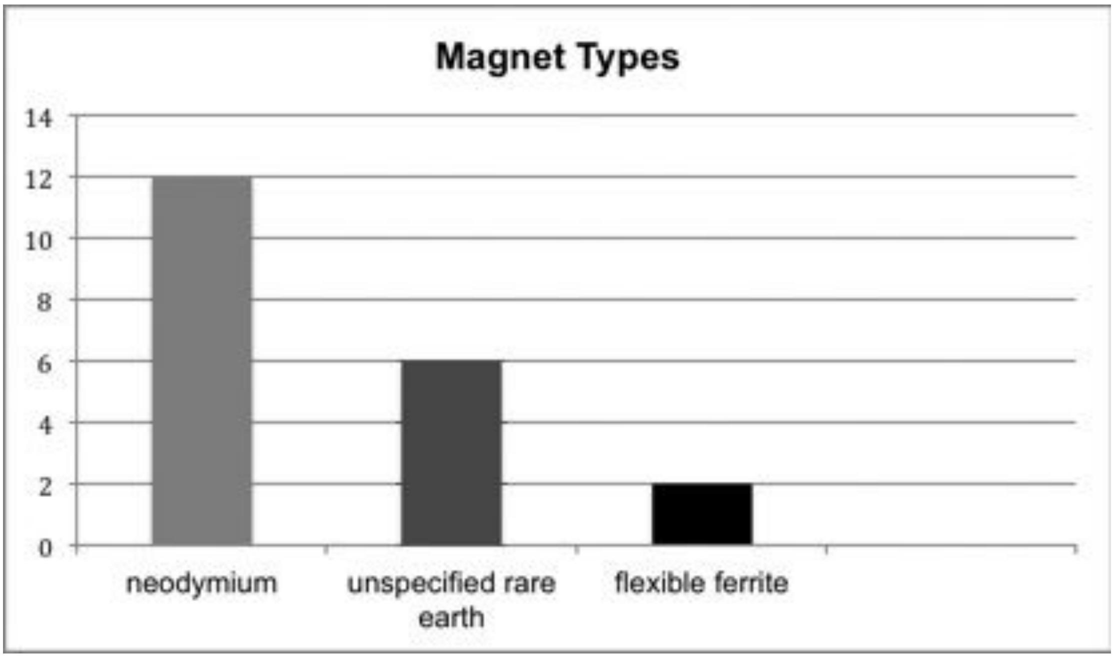

Figure 6: Bar chart 2: Common magnet types used for mounting textiles

The data presented in both figure 5 and figure 6 was collated from both the literature reviewed and the questionnaire feedback - see appendix 4

Chapter 4. Magnetic Display Systems: Design and Manufacture

4.1 Magnetic Display Systems for Visual Analysis

Based on the information gathered through the literature review and questionnaire, two 'typical' magnetic display systems were designed (see figure 7) and manufactured (see appendix 5 and 6), which would hold samples of the most commonly cited textile types to be mounted using magnets. After a period of time had elapsed the samples would be removed from the systems and the effects of the force of the magnetic display system on the samples would be analysed via visual analysis methods.

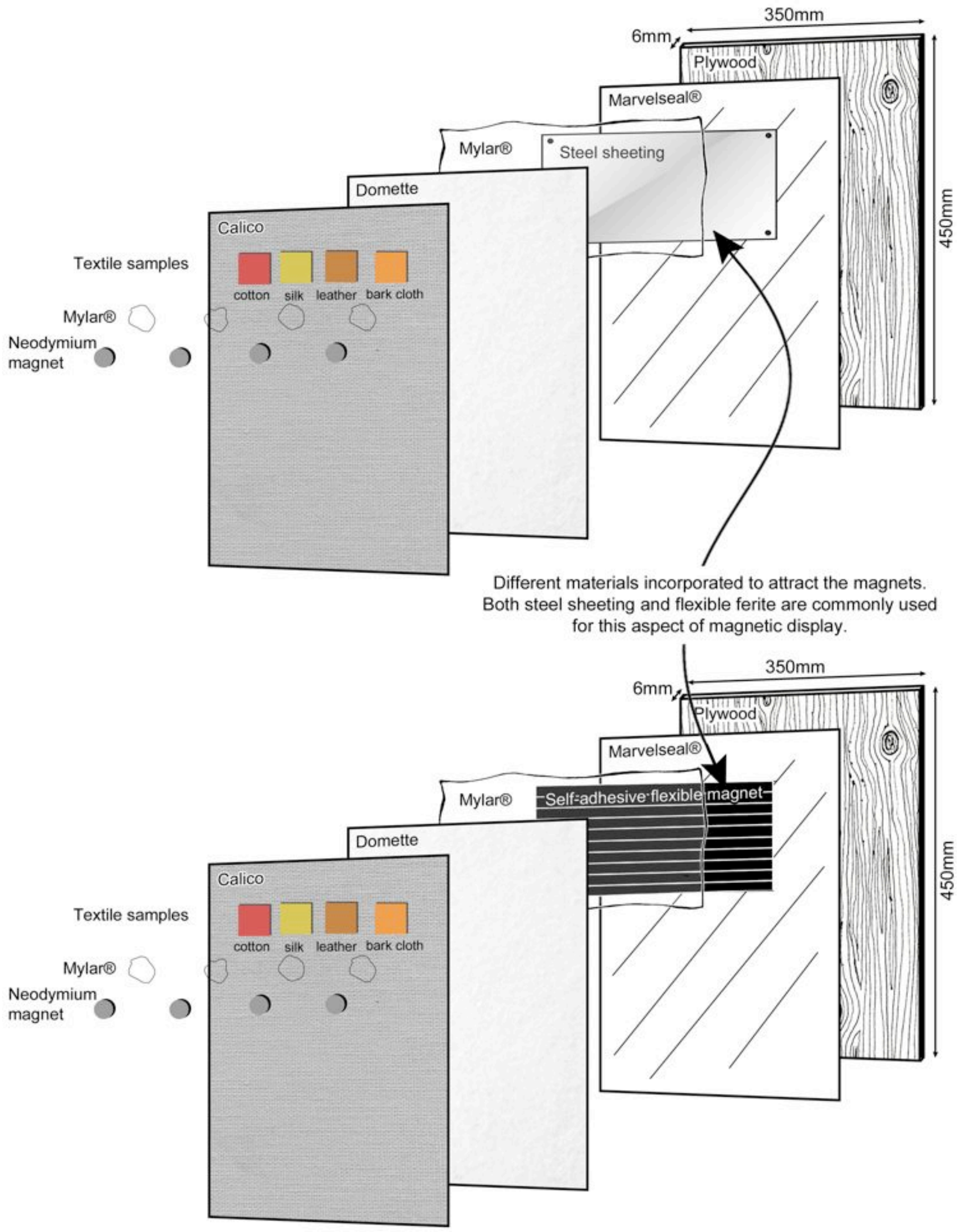

Figure 7: Magnetic display systems designed for visual analysis, from the collated literature and questionnaire data (see chapter 5)

4.2 Magnetic Display Systems for Quantifying Compressive Force

A small mock-up version of the magnetic display system described above was designed (see figure 8) and then manufactured (figure 9) to function as both a trial run of the construction of the system and as a model for which to test the compressive force of the magnetic display system on mounted textile samples. In order to achieve a relevant range of results the mock-up board was split into four areas each simulating a 'typical' magnetic display system (figure 8).

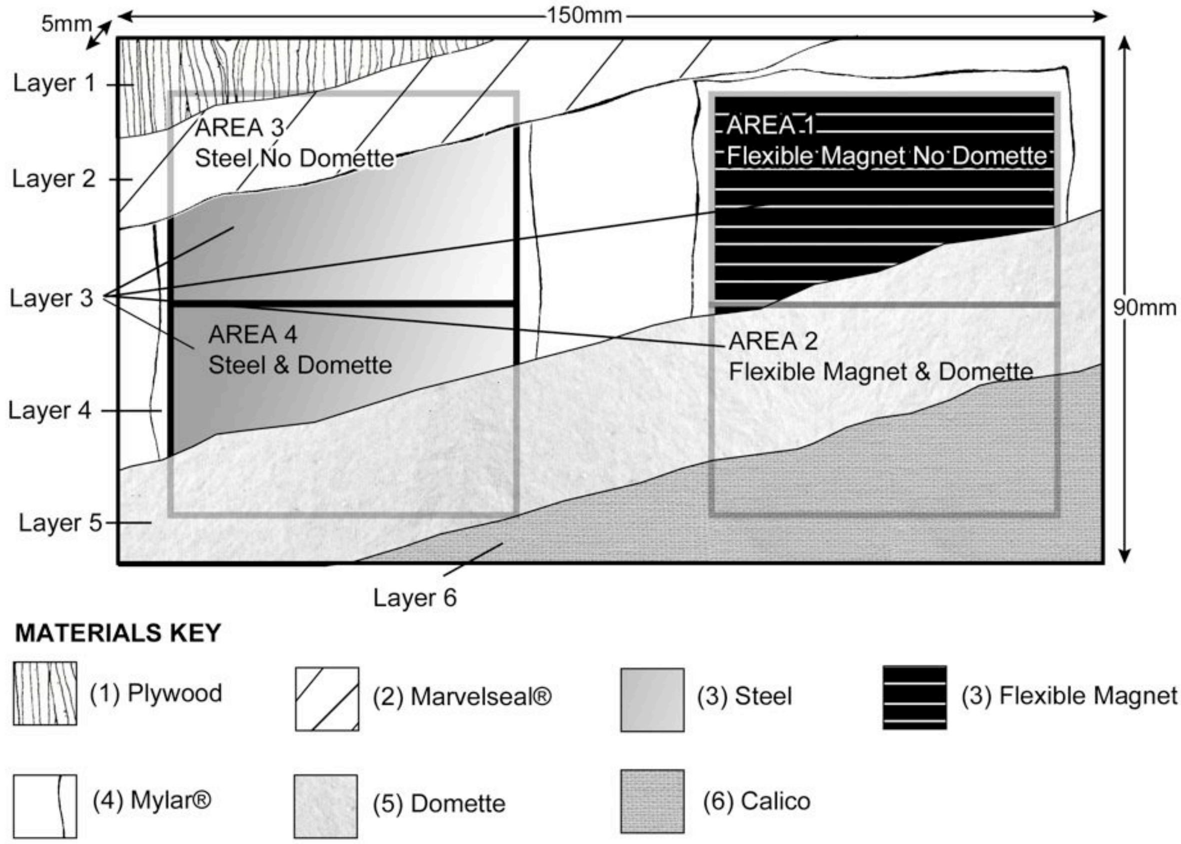

Figure 8: Mock-up magnetic display system for quantifying compressive force – design

Figure 9: Mock-up magnetic display system for quantifying compressive force - manufacture

Description of Images in Figure 9

1. The plywood backing board was cut to size.
2. The edges were sanded smooth.
3. Double-sided tape was applied to the reverse of the plywood.
4. A Marvelseal® barrier layer was wrapped around the plywood. Marvelseal® is commonly used to protect mounted artefacts from off-gassing wood[69].
5. Materials to attract the neodymium magnets (strips of self-adhesive flexible magnet and a piece of steel sheeting - 430 stainless steel, 0.9mm thick[70]) were secured onto the board. Double-sided tape was used for attaching the steel sheeting.
6. A cushioning layer of cotton domette was secured (using shallow staples) over half of the self-adhesive flexible magnet and steel sheeting.
7. Double-sided tape was applied to the reverse of the board.
8. Calico 'finish fabric' was positioned using the double-sided tape.
9. The calico was secured into position using shallow staples.
10. Masking tape was applied to the reverse of the board.
11. The board was marked in pencil – where each of the four testing areas were situated i.e. Steel sheeting with domette, steel sheeting with no domette etc.

Images 12 – 15 show araldite adhesive being applied to a neodymium magnet and a purpose shaped wire being attached. This was done in order for the tension compression machine to be able to grip the magnet when pulling it away from the sample and the rest of the system.

String was later added, as the wire did not allow sufficient contact between the magnet and the magnetic board when held by the tension compression machine. The additional string allowed the magnet to self-centre and lay flat against the board (see chapter 5).

4.3 The Magnets

Neodymium magnets were chosen to be incorporated in all systems described as they are cited as being the most predominant magnet to be used to secure a textile artefact to a magnetic display system.

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[69] "Marvelseal," PEL, https://www.preservationequipment.com/Store/Products/Conservation-Materials/Other-Materials/Marvelseal (accessed July 13, 2014).

[70] "Stainless Steel Magnetic Boards," The Metal Store, http://www.themetalstore.co.uk/products/stainless-steel-magnetic-boards (accessed July 10, 2014).

As the size and resulting strength of magnets used in the context of cultural heritage display was not often discussed in the data collected, a range of sizes, strengths, and shapes of neodymium magnets were selected for the purpose of this research. Each of the magnets chosen were composed of neodymium Iron Boron (NdFeB), were NiCuNi plated to protect against corrosion, and were purchased from e magnets UK.

Chosen Magnets

- Magnet 1: rectangular shape with a 22mm length x 11mm width x 2mm depth and a stated pull force of 2.2kg (pull kg)[71]
- Magnet 2: large circular disc with a 20mm diameter x 5mm depth and a stated pull force of 6.40kg (pull kg)[72]
- Magnet 3: small circular disc with a 8mm diameter x 1mm depth and a stated pull force of 0.40kg (pull kg)[73]

The supplier (e magnets UK) states the pull force (pull kg) of each magnet purchased.
As the purpose of this research was to test the total force of the display system this information was dismissed but included in the dissertation as product information to allow reproducibility of the tests carried out.
When questioned about what the pull force of the neodymium magnets purchased were measured against, e magnets UK stated, “The pull force is the force required to get a degree of movement away from thick mild steel.” Therefore some similarities may be observed between the figures provided by the supplier and the results from the Tension Compression Machine in the areas of the manufactured magnetic display system that include steel sheeting I.e. areas 3 and 4 (figure 8).

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71 “Rectangular Magnets - 22mm x 11mm x 2mmA depth, N42 - NiCuNi plated, 2.2kg, Pack of 10 Magnets,” E-magnets UK, http://e-magnetsuk.com/magnet_products/neodymium_magnets/rectangular_magnets.aspx?Keyword=EP280 (accessed July 10, 2014).

72 “Circular Disc Magnets - 20mm diameter x 5mmA depth, N42 - NiCuNi plated, 6.40kg, Pack of 2 Magnets,” E-magnets UK, http://e-magnetsuk.com/magnet_products/neodymium_magnets/circular_disc_magnets.aspx?Keyword=EP336 (accessed July 10, 2014).

73 “Circular Disc Magnets - 8mm diameter x 1mmA depth, N42 - NiCuNi plated, 0.40kg, Pack of 25 Magnets,” E-magnets UK, http://e-magnetsuk.com/magnet_products/neodymium_magnets/circular_disc_magnets.aspx?Keyword=EP32 (accessed July 10, 2014).

4.4 The Textile Samples

The textile samples chosen to be incorporated in both the visual analysis and the compression test were based on those commonly found to be displayed using magnets I.e. cotton, silk, leather and bark cloth.

It should be noted that as leather (which is studied in the visual analysis phase of the research but was not obtainable for including in the compression test) is thicker, less force would presumably be required to separate the magnet from the display system:

I.e. as materials situated between two magnets compress the attracted magnets become closer and as they become closer they compress the materials even more and so on[74], therefore the thicker the textile type mounted in a magnetic display system the further away the magnetic materials are from one another and therefore less force is applied to the mounted object.

[74] "Super-strong neodymium magnets crushing a man's hand," YouTube, https://www.youtube.com/watch?v=0t8yDnyOaQ8&list=TLK7nmTXy72F9TCyZl6BtMbn5E8D1LTAfD (accessed July 20, 2014).

Chapter 5. Quantifying the Compressive Force of a Magnetic Display System

5.1 Introduction

When visually assessing the effects of a magnet on a textiles surface it is necessary to be able to quantify what we are seeing. For this purpose it was proposed (following communications with biomedical engineering Professor Liz Tanner and engineering technician John Davidson, of the University of Glasgow) that a Tension Compression Machine would be used to establish the amount of force that a typical magnetic display system exerts on a mounted textile.

5.2 Motivation for the Research

This phase of the research project was instigated by Dean Jones's 'experiment to calculate the compressive force of a magnet' as described in 'Development of a Magnetic Vertical Display System for Bark Cloth Artefacts' discussed, which was in the literature review chapter.

Dean Jones describes a magnetic display system composed of a board clamped in a horizontal position, and three neodymium magnets, each with a calico bag attached to it, into which lead shot was added in 5g increments until the magnets were pulled from the board. The weight at which the magnets came free from the board indicated the total compressive force of the system.

This test carried out by Dean Jones is invaluable in its rarity as published research on the subject of magnetic display. However seemingly fundamental factors such as the weight of the bag attached to the magnets was not taken into account or given in the text.

A Tension Compression Machine was therefore chosen for quantifying the compressive force of the mock-up 'typical' magnetic display system (figure 8), as it appeared to offer accurate results via a reproducible method, with less variables than offered by Dean Jones's technique.

5.3 The Tension Compression Machine

The Tension Compression Machine Zwick / Roell Z2.0, situated in the School of Engineering Materials Testing Workroom at the University of Glasgow is typically used for testing the tensile stress and compressive strength of materials used within engineering. For the purpose of this research project however it was decided to use the machine to measure the amount of force required to remove a magnet from the designed system depicted in figure eight.

5.3.1 Adapting the Tension Compression Machine for Inclusion of Magnetic Materials

Given that the Tension Compression Machine Zwick/Roell Z2.0 was not typically used for experiments involving magnetic materials some minor adjustments had to be made in order to proceed with the study. Firstly the base plate of the Tension Compression Machine was made of magnetic steel, attracting the magnets through the non-magnetic (middle) section of the prepared 'mock-up' board (figure 8). Secondly the clamps used to hold down the magnetic-board element of the system were also magnetic and therefore attracted the magnets as soon as they became free from the board (see figure 10). Both of these complications had to be resolved in order to avoid interference with the results. This was achieved by adding layers of non-magnetic aluminium material and wooden panels below the board until no magnetic pull was felt between the magnet and base plate of the machine. A section of aluminium was also used to extend the clamp to prevent the magnet being attracted towards it once it was separated from the system (see figure 11).

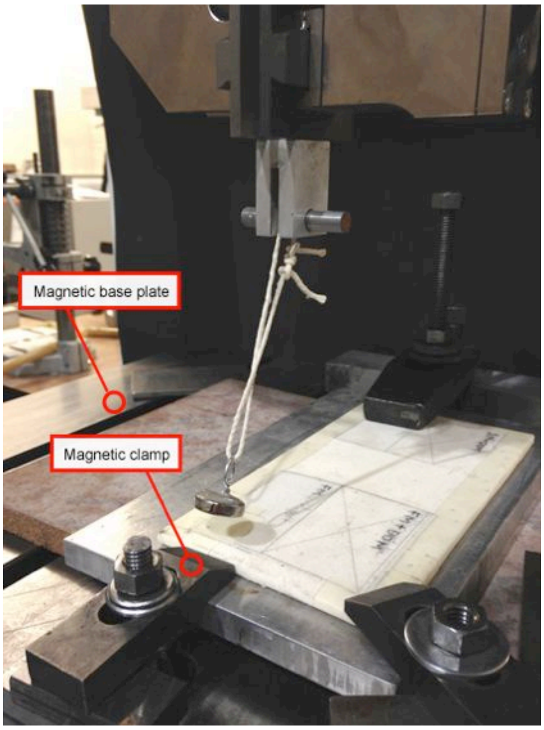


Figure 10: Large disc magnet being attracted towards the magnetic clamp

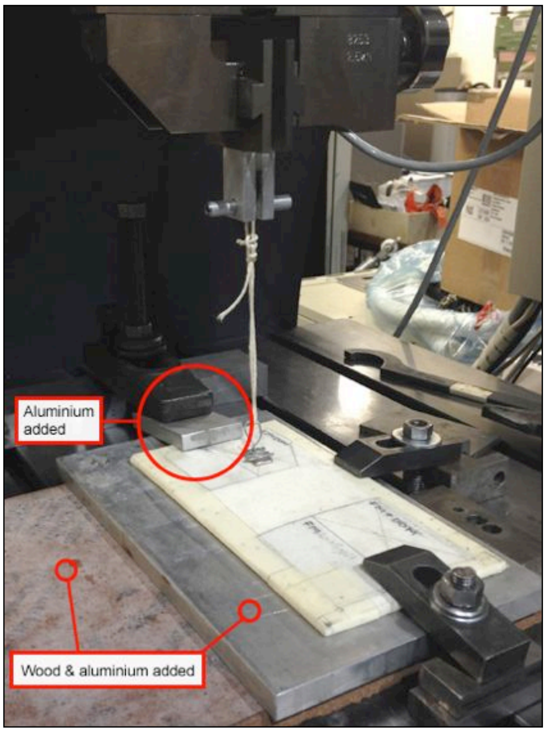


Figure 11: materials put in place to prevent interference with the test results

5.3.2 Operating The Tension Compression Machine

Once the magnetic display system was secured to the base plate the neodymium magnet on the surface of the prepared board was gripped by the machine through the previously attached string which, when the machine was operated, pulled the magnet vertically from the board at a speed of 5mm per minute. The Newton (N) measurement of force at which the magnet was pulled free from magnetic board indicated the total compressive force of that particular system (I.e. board area plus surface magnet and incorporated materials) on a suspended artefact.

Figure 12: Operating the Tension Compression Machine Zwick/Roell Z2.0

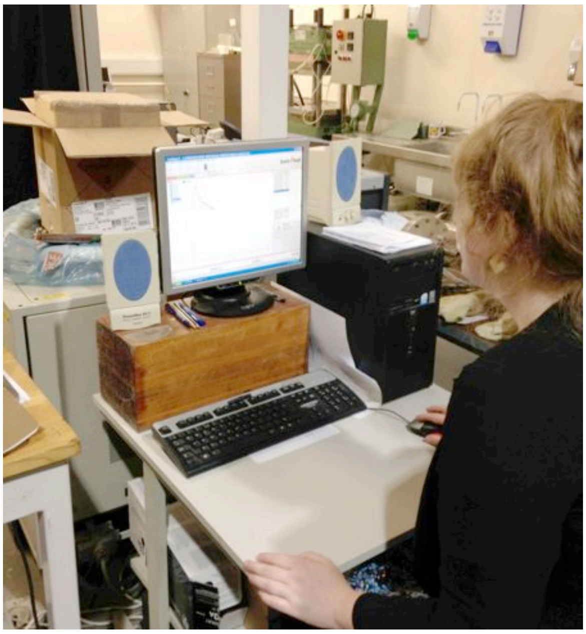


Figure 13: Analysing the results

Each of the chosen neodymium magnets; rectangular, large circular and small circular were tested in each of the four magnetic display areas of the board; area 1: flexible ferrite with domette, area 2: flexible ferrite no domette, area 3: steel sheeting with domette, area 4: steel sheeting with no domette (see figure 8) using the Tension Compression Machine (see figure 12) and the data was collected and analysed on the connected PC by which the machine was operated (figure 13).
In total fourteen tests were carried out; three magnets in each of the four board areas plus two extra tests including bark cloth in areas 2 and 4 (the areas including domette).
It was decided to test the removal of a magnet from the system with the thickest possible specimen i.e. bark cloth included in the areas of the board that include a cushioning layer of domette. This was done to see if there was any difference in the force required to remove the magnet from the magnetic board. It was predicted that with the domette and bark cloth situated between the magnet and the magnetic board less force would be required to remove the magnet from the system as the attracting forces were further apart.

Although textiles which possess more bulk would experience less compressive force within a magnetic display system, due to the attracting forces being at a greater distance from one another, textiles such as leather or bark cloth which have a thicker depth of fibre are more likely to bear visual marks from compression than thinner more two dimensional textiles see figure 15 below.

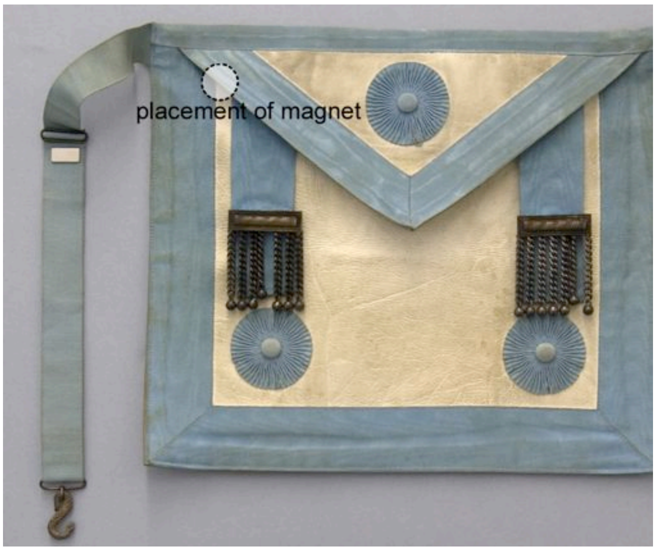


Figure 14: Leather bag displayed using magnets

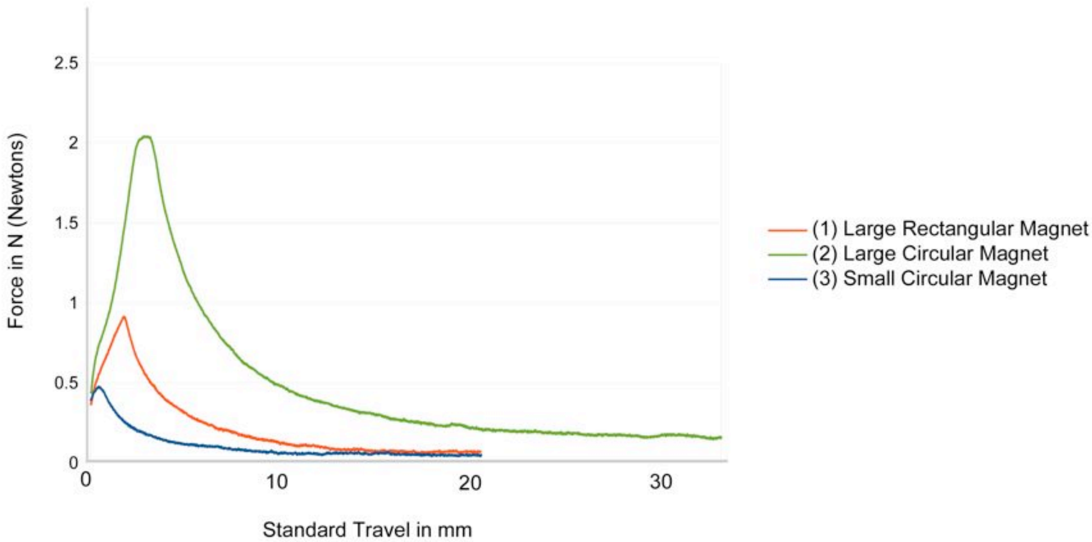
Figure 15: Compression mark left on leather bag from magnetic display

5.4 The Tension Compression Machine Results

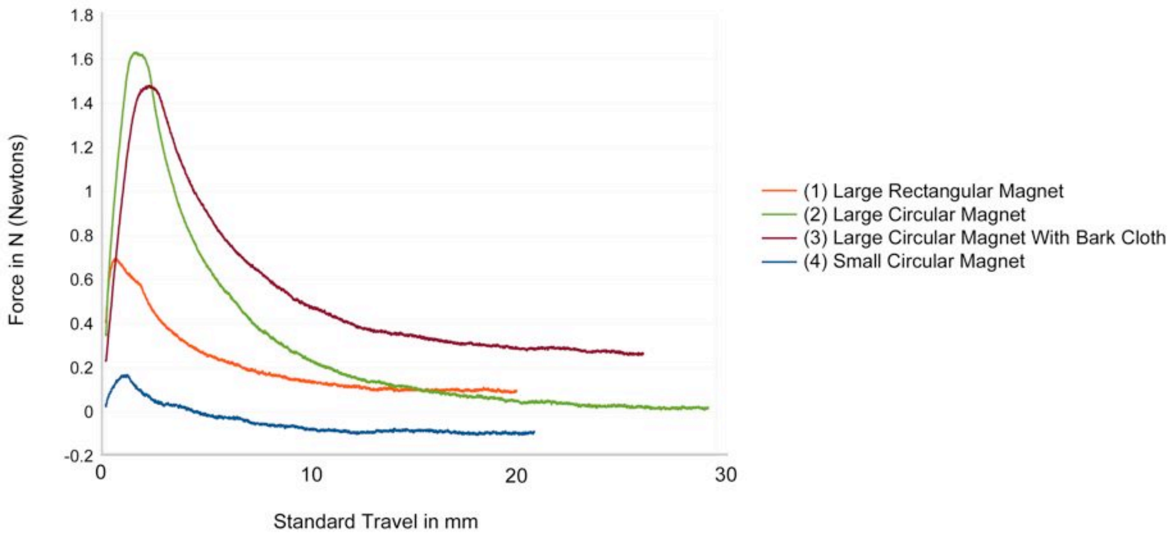
The results in table four show that the largest circular neodymium magnet and the steel sheeting areas of the display board (areas 3 and 4) required more force to separate the magnet from the display system than the areas with flexible ferrite magnet incorporated in the system (areas 1 and 2). When additional materials are added between the magnet and the system i.e. the dommette and the representation of an artefact – the bark cloth sample the force required to remove the magnet from the system was less. This is because more material is separating the attracting forces of the system and the further apart the attracting components are, the more the magnetic force diminishes therefore the easier they are to separate. As expected the neodymium magnets used were stronger or weaker depending on their size due to there being more or less magnetic material present.

The most force required to remove a magnet from the system can be seen in the combination of the large circular disc neodymium magnet coupled with the steel board, with no dommette or bark cloth between. The force required was 22.62 (N) the equivalent of 2.307kg to separate the two components of the system.
The lowest force required was in removing the small circular neodymium magnet from the flexible ferrite area of the board with domette included - 0.168(N) the equivalent of 0.017kg. This shows that typical magnetic display systems, as tested here can exert between 0.017kg and 2.307kg on one small area of suspended textile artefact. The next stage of the research looks at if the latter amount of force 2.307kg is damaging to textile samples when suspended in magnetic display systems for set amounts of time.

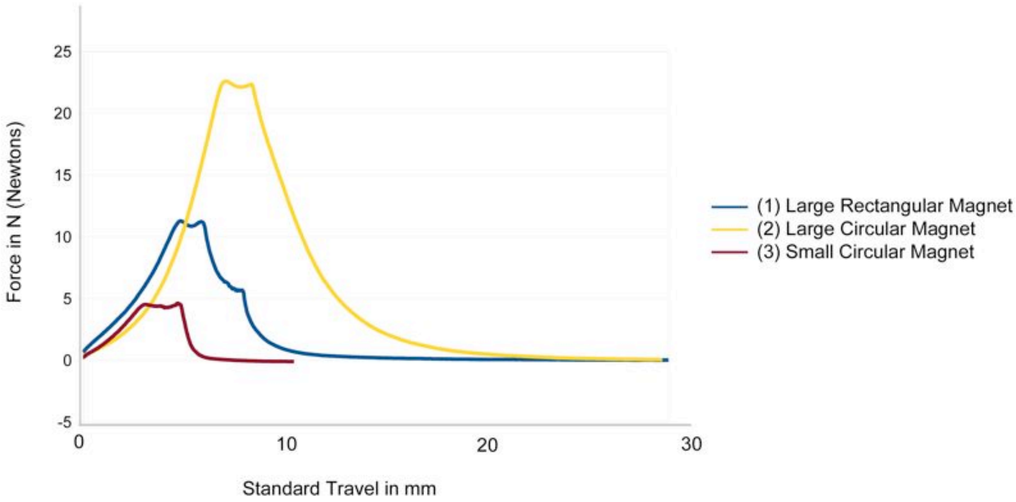
Magnet	Magnetic Board Area	Tension Compression Machine (N)	Force converted into kg
1) Rectangular	1 (flexible ferrite magnet no dommette)	0.914 N	0.093 kg
2) L. Circular		2.041 N	0.208 kg
3) S. Circular		0.474 N	0.048 kg



Magnet	Magnetic Board Area	Tension Compression Machine (N)	Force converted into kg
1) Rectangular	2 (flexible ferrite magnet with domette)	0.695 N	0.071 kg
2) L. Circular		1.631 N	0.166 kg
2) L. Circular + Bark Cloth		1.541 N	0.157 kg
3) S. Circular		0.168 N	0.017 kg



Magnet	Magnetic Board Area	Tension Compression Machine (N)	Force converted into kg
1) Rectangular	3 (steel sheeting no domette)	11.29 N	1.151 kg
2) L. Circular		22.62 N	2.307 kg
3) S. Circular		5.058 N	0.516 kg



Magnet	Magnetic Board Area	Tension Compression Machine (N)	Force converted into kg
1) Rectangular		11.20 N	1.142 kg
2) L. Circular	4 (steel sheeting with domette)	19.96 N	2.035 kg
3) L. Circular + Bark Cloth		18.35 N	1.871 kg
4) S. Circular		3.809 N	0.388 kg

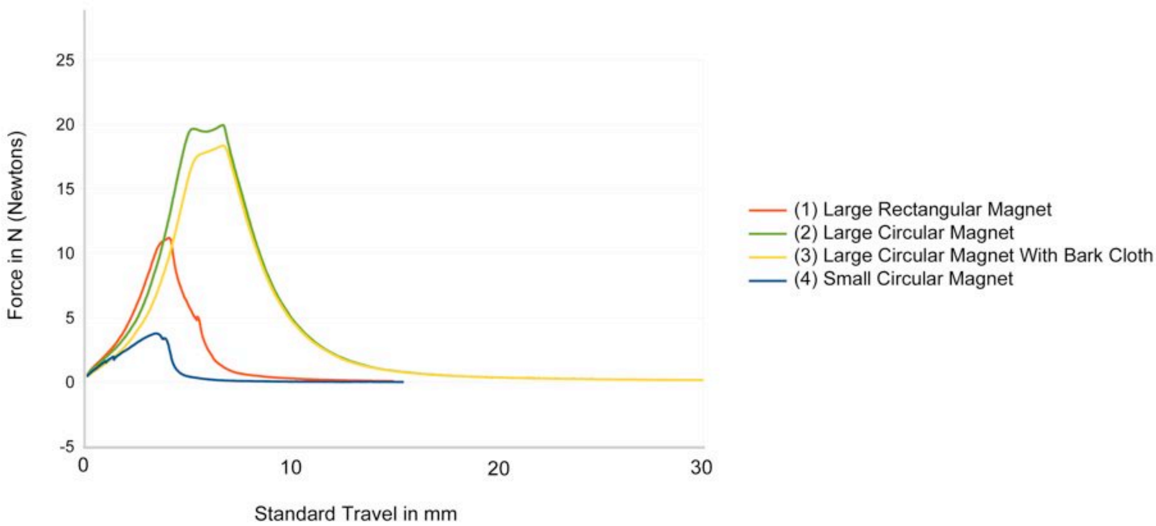


Table 4: The Compressive Force Exerted by Four Typical Magnetic Display Systems

Chapter 6. Visual Analysis of Textiles Mounted with Magnets

6.1 Introduction and Aim of Analysis

This chapter details the visual analysis of four textile samples and one textile artefact that had each been suspended in magnetic display systems over set periods of time.
The aim of this study was to discover if any damage had occurred to the textiles fibres and/or weave as a result of the compressive forces exerted by the magnetic display systems.
The proposed analysis would be carried out by visually assessing the areas where the textiles had been held between the two attracting forces of the systems; the magnetic backboards and the magnets situated on the textiles surface.
It was decided to pursue visual analysis, as it appeared the logical first step in investigating and documenting any signs of damage caused by magnetic display systems.
Simple unaided visual examination was decided upon followed by the use of magnification that would enable a three dimensional view of the textiles, i.e. stereomicroscopy and scanning electron microscopy, at a closer level than would be possible via unaided visual examination.
Three-dimensional imaging methods were desirable for the purpose of this research in order to properly examine any changes in the textiles surface such as the hypothesised damage; compressed and broken fibres or distorted weaves.
It was decided to use stereomicroscopy for the textile artefact only, as a scanning electron microscope requires fairly large samples to be taken from the textiles and this was considered too destructive a technique to be used for analysing the textile artefact.

5.2 The Magnetic Display Systems and Samples Tested

Using the data collected through the literature review and questionnaire feedback two typical magnetic display systems were created and onto these systems samples of the textile types found to be most commonly displayed using magnets were mounted, using the same range of three neodymium magnets used for the tension compression machine test. The samples mounted included cotton, silk, and bark cloth and they were suspended for one month in work room one at the Centre for Textile Conservation and Technical Art History (CTCTAH) at the University of Glasgow (samples of the materials used to create the typical display systems described here and samples of the textile specimens mounted are given in appendix 5 at the back of the dissertation to allow for reproducibility of the tests for future research).
Given the time restraints of the research project, it was necessary to source textiles that had been mounted for longer periods of time and therefore represented more realistic display timespans than it was possible to simulate.

A sample of leather suspended in a magnetic display system for a period of three years was acquired for analysis from National Museums Scotland, and a reference collection object; a Japanese toe biter slipper composed of cotton, which had been suspended in a magnetic display system for a period of three months was attained from the Centre for Textile Conservation.

Details of the textile samples and artefact chosen for analysis can be seen in figures 16 to 18 below.

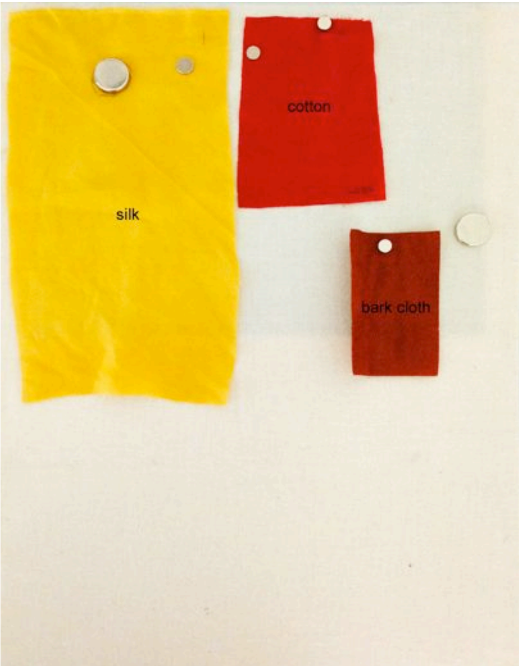


Figure 16: One of two manufactured magnetic display boards – samples were mounted for one month. Environmental conditions were monitored see appendix 7.

Figure 17: Magnetic steel display board with white cotton Japanese slipper object. The textile artefact was mounted for three months. Environmental conditions were monitored see appendix 7.

Figure 18: Magnetic steel display board at National Museums Scotland with leather sample mounted The leather sample was mounted for three years. The environmental conditions were not documented.

Figure 19: Detail of NMS leather sample showing where the object sample has faded as a result of being positioned by window for three years. Once the magnets were moved it is possible to see original colour of the leather.

5.3 Simple Visual Examination

A simple visual examination was the first step in analysing whether any damage of the textiles fibres and/or weaves had occurred as a result of the textiles in the above images being suspended in magnetic display systems.

Using both visual and tactile senses the author closely examined all four textile samples and the textile artefact.

It was observed that when the neodymium magnets were removed from the system an indentation was left on the textiles where the magnet had been situated,

The stronger the compressive force of the magnetic display system and the denser the mounted textile the more evident the indentation was i.e. the bark cloth sample mounted on the magnetic display system found to exert the highest compressive force of 22.62 (N) the equivalent of 2.307kg (the board composed of steel sheeting and the large circular neodymium magnet) possessed the most obvious indentation once the neodymium magnet was removed from the textiles surface. While the finer (thinner) textile samples; the cotton and silk under the lowest compressive force (the flexible ferrite board covered with dommette used in conjunction with the small disc magnet, which was shown to exert the total compressive force of 0.168(N) the equivalent of 0.017kg) the indentation was barely visible and the textile specimens quickly regained their former flat surfaces.

All textile samples and the artefact, which showed more of an indentation given its longer period of display and multiple layers when compared to the sample of the same fibre type; the cotton specimen, quickly recovered until their surfaces appeared uniform and there was no visual or tactile trace of where the magnet had been.

No damage to the textiles fibres or weaves was observed via the unaided visual analysis carried out.

5.4 Stereomicroscopy

As previously stated it was decided to use stereomicroscopy to analyse the surface of the textile artefact (the CTC reference collection object – Japanese slipper) by way of remedying the fact that scanning electron microscopy presented too destructive a technique to be used. Stereomicroscopy, although it did not possess the magnification capabilities of the scanning electron microscope, did offer a method of viewing the textile at a higher magnified level than was possible via unaided visual examination, as well as providing a three dimensional view of the textile, which would allow any changes in the objects surface to be observed.

With the edition of a digital camera attached stereomicroscopy could also be used to document what was being seen, as is done when conducting scanning electron microscopy, enabling further analysis prior to the initial analysis being carried out.

The textile artefact which had been suspended vertically in a magnetic display system composed of a steel back board with a neodymium magnet on its surface so it can be presumed that the total compressive weight would be around that of the strongest system noted in previously (22.62 (N) the equivalent of 2.307kg) for a total of three months, was analysed using An Olympus SZX12 stereo-microscope equipped with an Olympus DP70 digital camera was used in the analytical department at National Museums Scotland (see figure 20). After the textiles initial regain once the magnet had been removed for the unaided visual analysis (which was conducted just before the stereomicroscopy and scanning electron microscopy was carried out) no trace of the magnet could be seen and both the fibres and weave of the textile artefact appeared in good structural condition (see figure 21).

Figure 20: analysing the textile artefact through the stereomicroscope

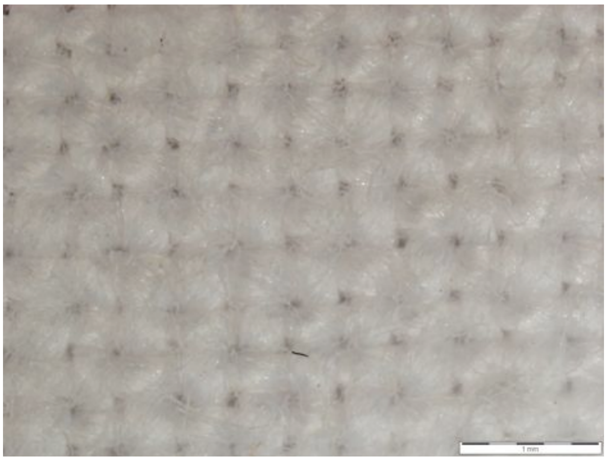


Figure 21: Magnified (12 x 20) image of cotton weave – with no damage evident

5.5 Scanning Electron Microscopy

Regarding the assessment of the fibres and weave of both the textile artefact and the four textile samples mounted using magnets; no damage was detected, either by means of an unaided visual examination or through the stereomicroscopy that facilitated the research.

It was therefore considered desirable, and the logical next step in the analysis, to look closer still at the surface area of each textile, which had been under the compressive force of a magnetic display system. This was made possible by the use of a Scanning Electron Microscope (SEM), housed at the Analytical Research Department of National Museums Scotland.

Scanning Electron Microscopy (SEM) is primarily used within the heritage sector for material identification and analysis, but also has a broad range of applications outside of conservation science in areas such as industry, medicine, and forensic science where it is chiefly used for its ability to view surfaces of solid objects at highly magnified levels.

SEM was the obvious method of choice for this next stage of visual analysis given its ability to reveal detail beyond the magnification capabilities and resolution limits of the optical microscope. For instance a SEM possesses the magnification power of 300,000× the size of the object studied[75], while an optical microscope only offers the magnification power of a few hundred times. Another notable advantage of SEM is that it produces high quality images,

75 P.H. Greaves and B.P. Saville, "Scanning Electron Microscopy," in *Microscopy of Textile Fibres*, ed. P.H. Greaves and B.P. Saville (Oxford: BIOS Scientific Publishers Ltd., 1995), 51 – 67.

which can be printed or digitally stored, allowing the analyst a longer period of time by which to analyse the results.

Assisted by the expertise of Analytical Scientist Lore Troalen (of National Museums Scotland) the author mounted specimens of each of the four textile samples onto individual aluminium conductor stubs using double-sided conductive carbon adhesive tabs (see figure 22 below). Two specimens were taken from each sample, one from the middle of the area that had been held underneath the magnet and another in an area free from the magnet for comparison.

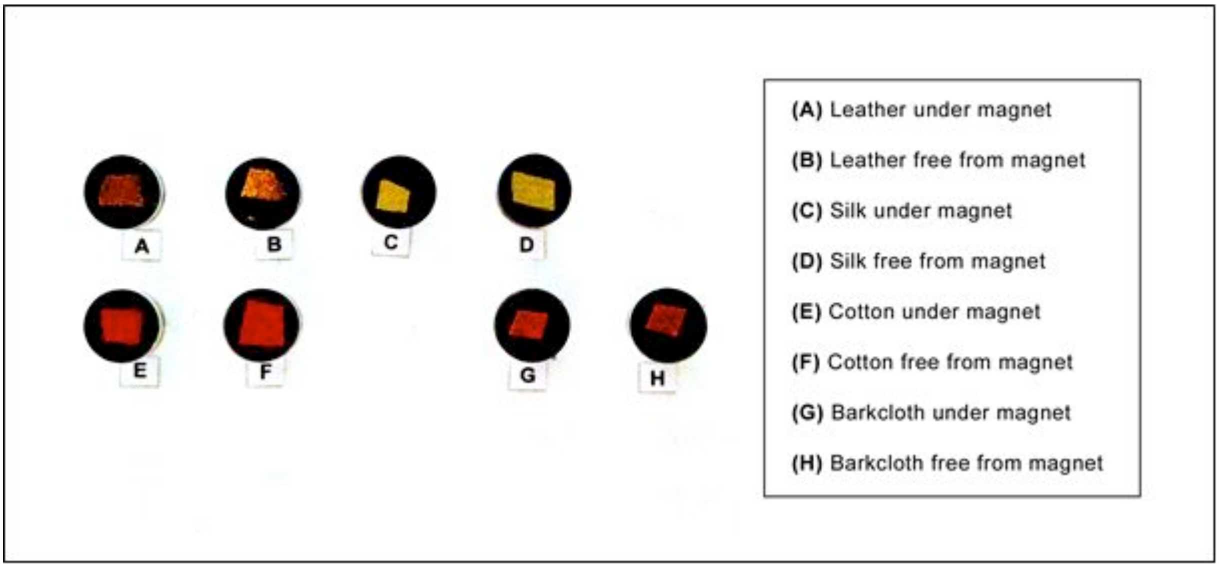


Figure 22: textile samples prepared for SEM analysis

Each specimen from the four textile samples was taken and mounted just before being analysed so that the results would remain consistent, that is for each specimen taken from an area of textile under a magnet; the magnet stayed on the area of textile until just before the specimen was taken in order to reduce the risk of recovery of the compressed fibres, for example.

Once a specimen was prepared it was placed individually into a holder on the stage inside the SEM chamber (figure 23 - 24), the chamber was then sealed and all air removed to create a vacuum. The sample could then be examined using the CamScan MX2500 SEM in controlled pressure (Envac) mode.

Figure 23: Placing a prepared textile sample in the SEM chamber

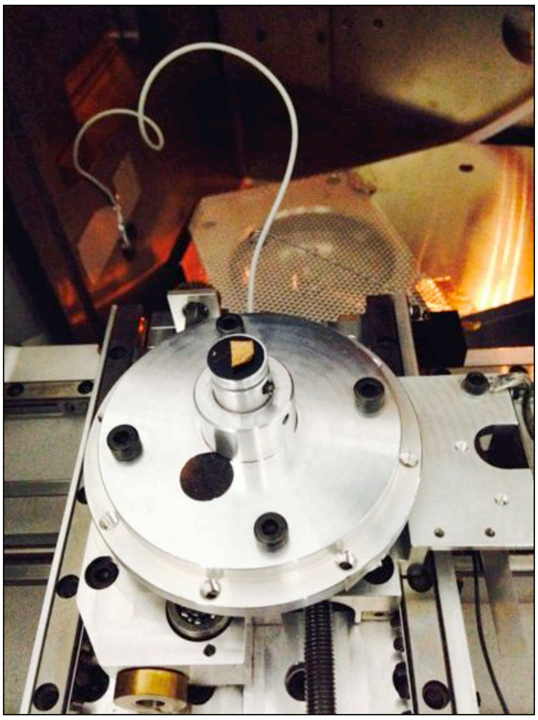


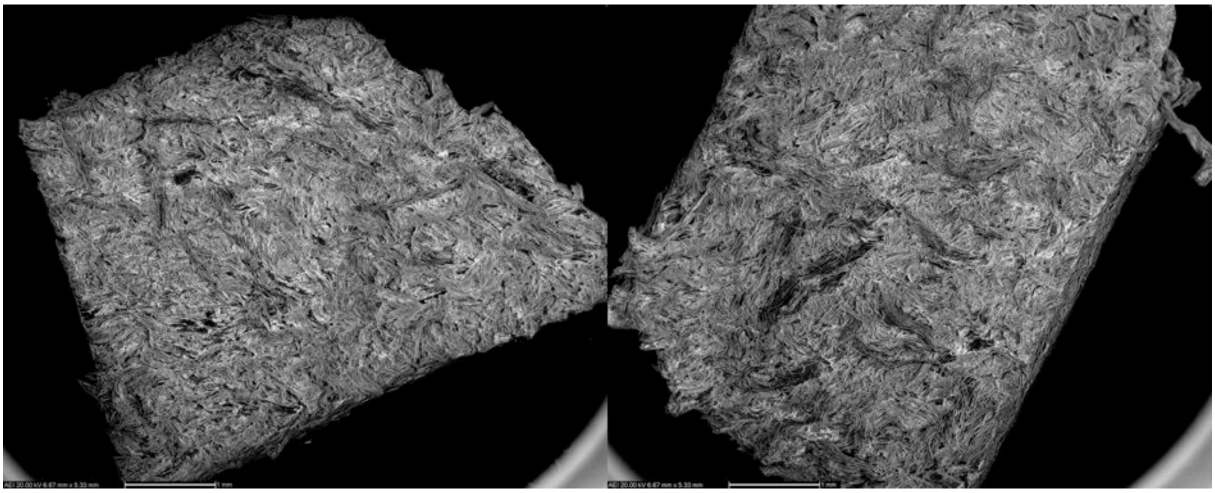
Figure 24: The mounted sample ready for SEM analysis

A Scanning Electron Microscope creates an image of a specimen's surface by firing a steady stream of electrons from a (thermionic or field emission) electron gun. The electrons are directed towards the specimen by magnetic field lenses made of magnets, which focus the electron beam to scan the surface of the specimen. The electron stream dislodges secondary electrons from the surface of the specimen that are attracted by the secondary electron detector. Additional detectors detect backscattered electrons (electrons reflected off of the specimens surface) and x-rays (emitted from beneath the specimen's surface) row by row an image is scanned onto a monitor for analysis[76].

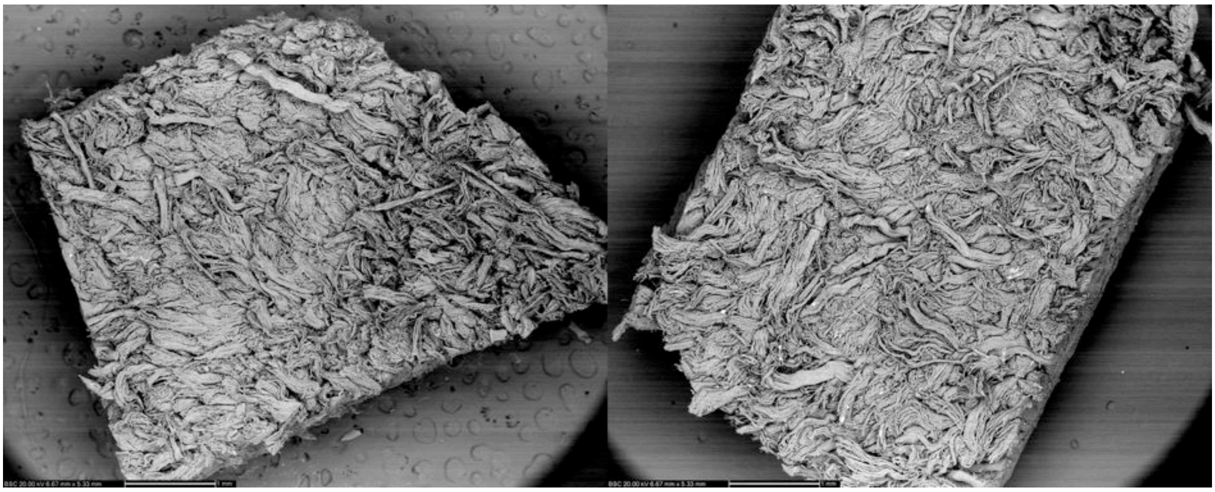
Scanning Electron Microscopy Images

All images on the left had no magnet on them while the image on the right had been held under a magnet the period of time previously stated –no damage was observed.

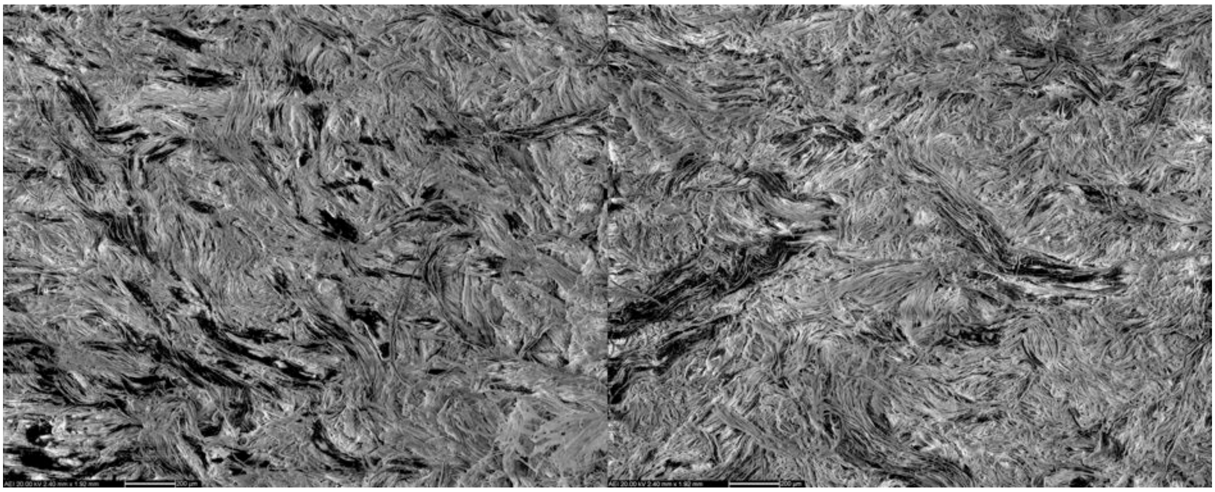
[76] "How Scanning Electron Microscopes Work," How Stuff Works, http://science.howstuffworks.com/scanning-electron-microscope.htm (accessed July 23, 2014).



leather x 15 at 25 mmwd AEI

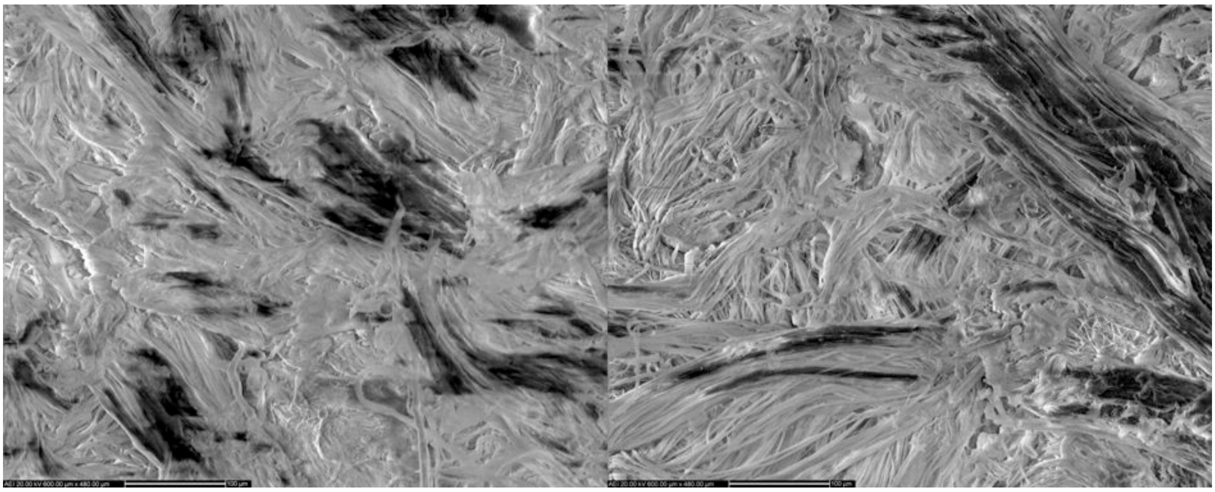


leather x 18 at 25 mmwd BSC

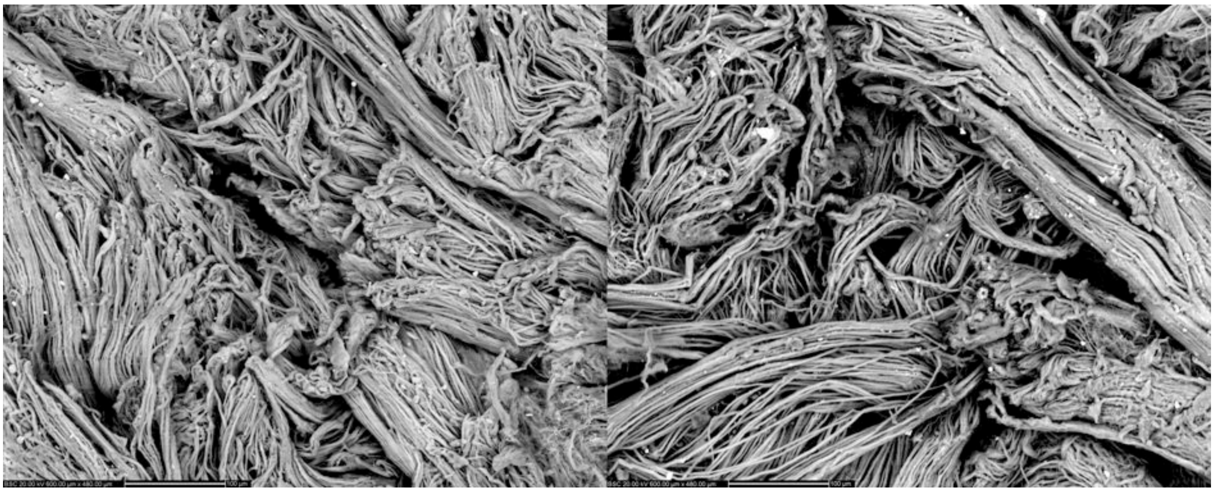


leather x 50 at 25 mmwd AEI

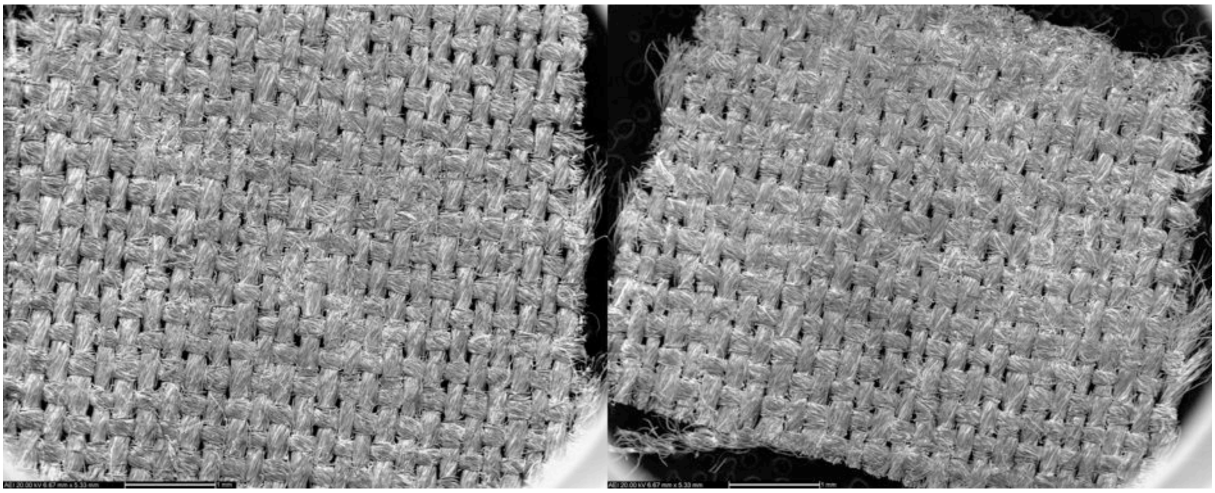
leather x 50 at 25 mmwd BSC



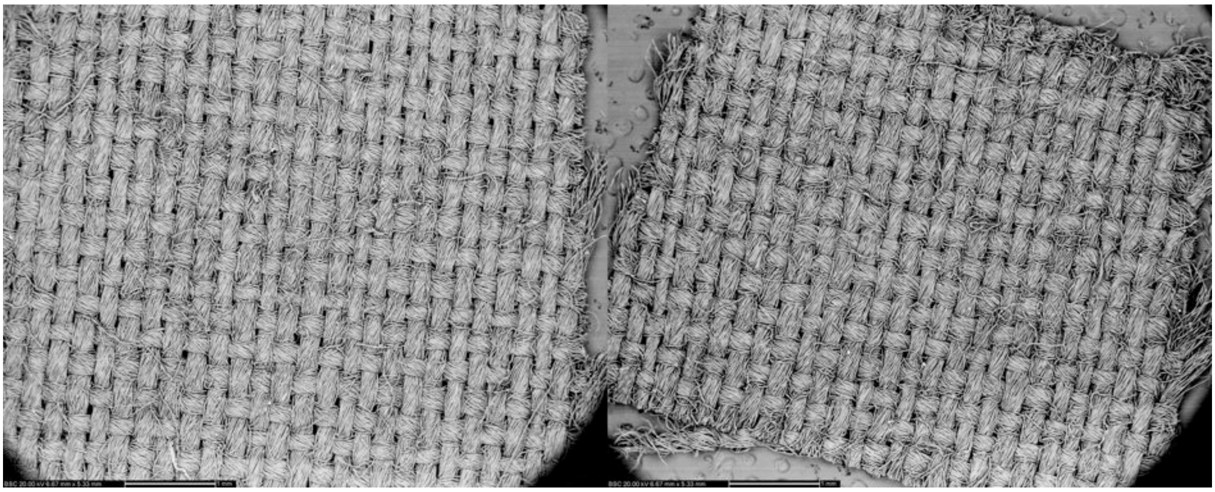
leather x 200 at 25 mmwd AEI



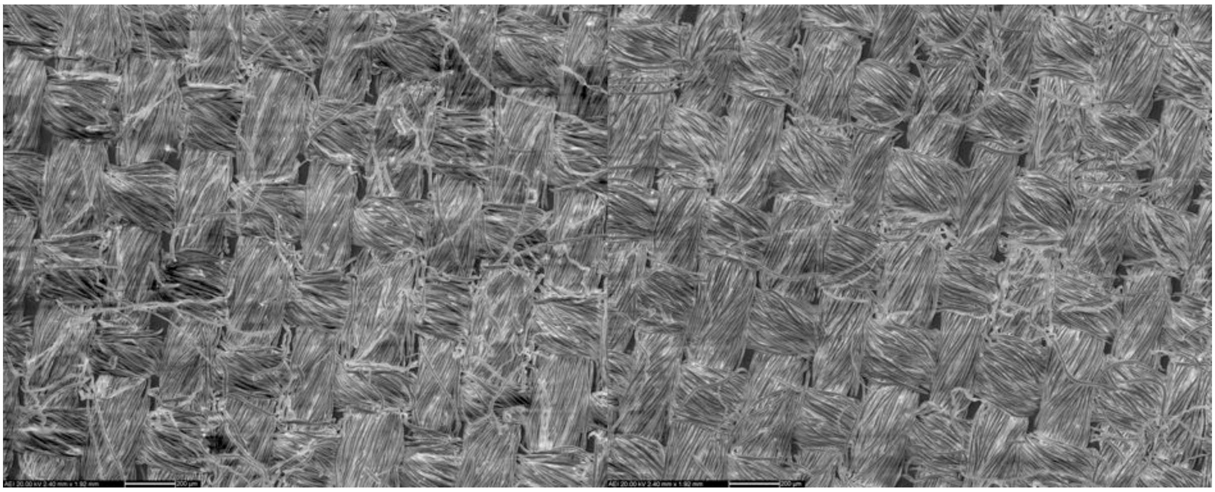
leather x 200 at 25 mmwd BSC



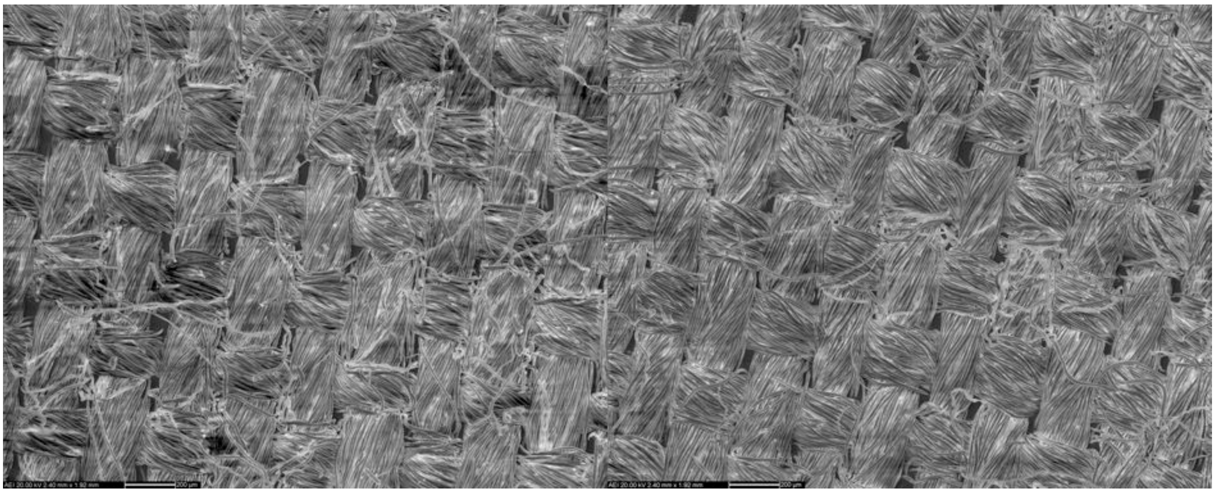
cotton x 18 at 25 mmwd AEI



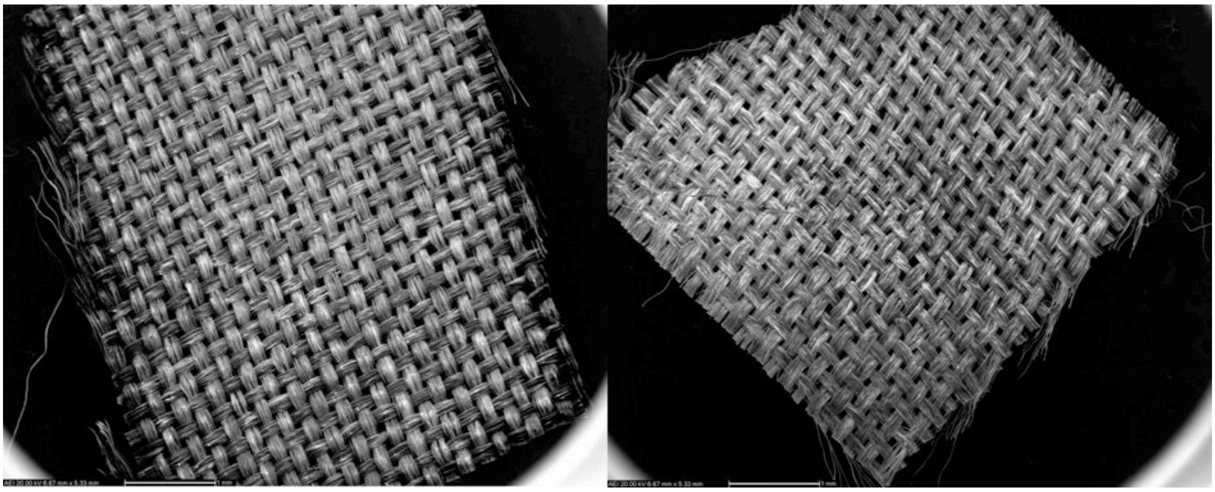
cotton x 18 at 25 mmwd BSC



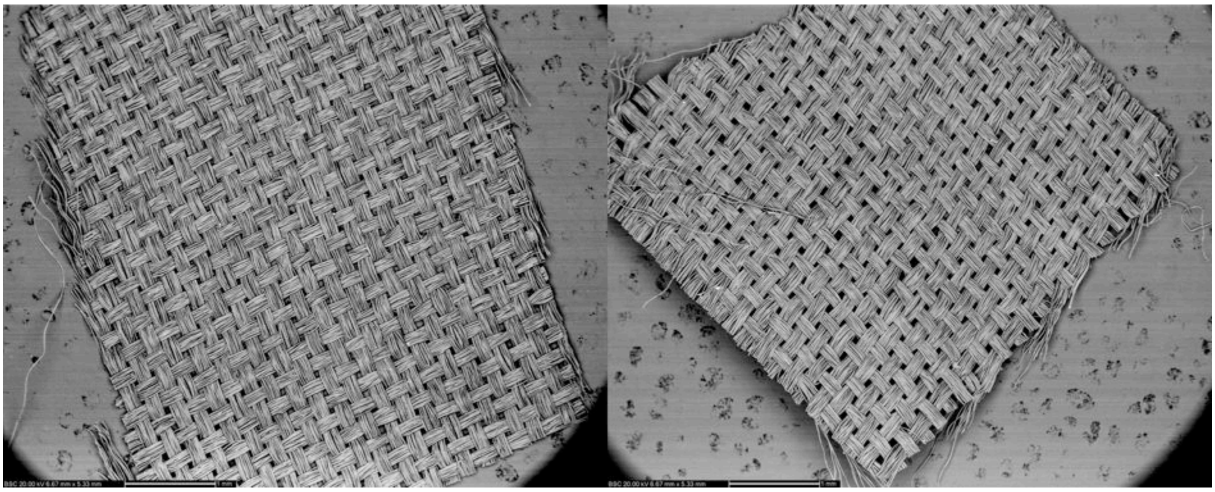
cotton x 50 at 25 mmwd BSC



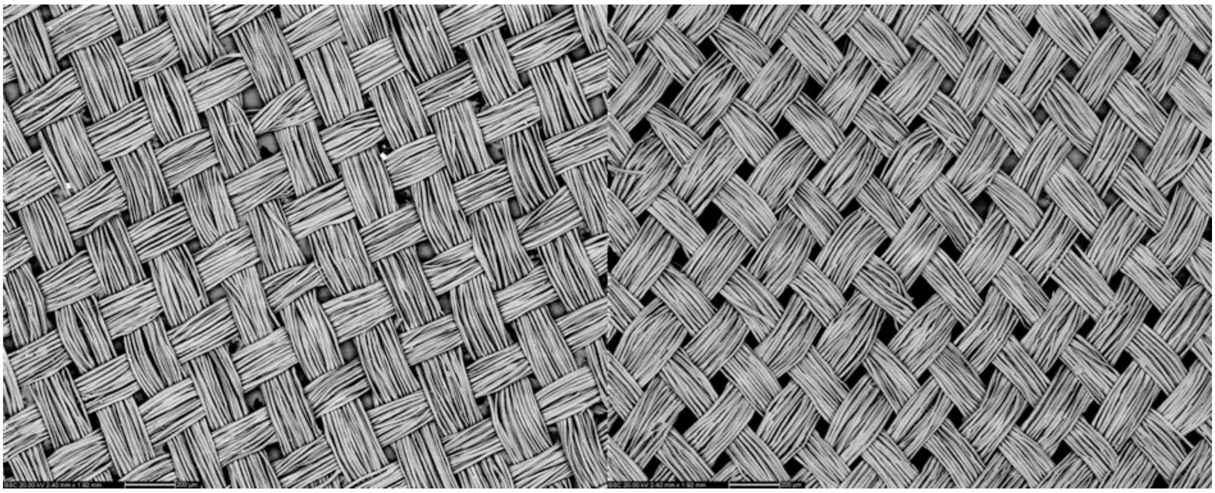
cotton x 50 at 25 mmwd AEI



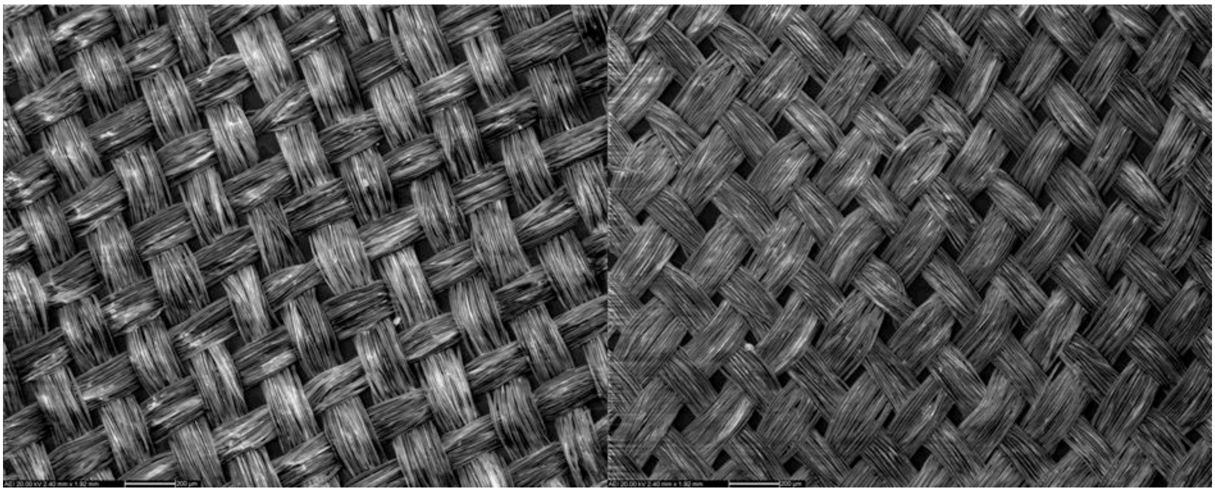
silk x 18 at 25 mmwd AEI



silk x 18 at 25 mmwd BSC



silk x 50 at 25 mmwd BSC



silk x 50 at 25 mmwd BSC

Figure 25: SEM Images of Fibre Samples

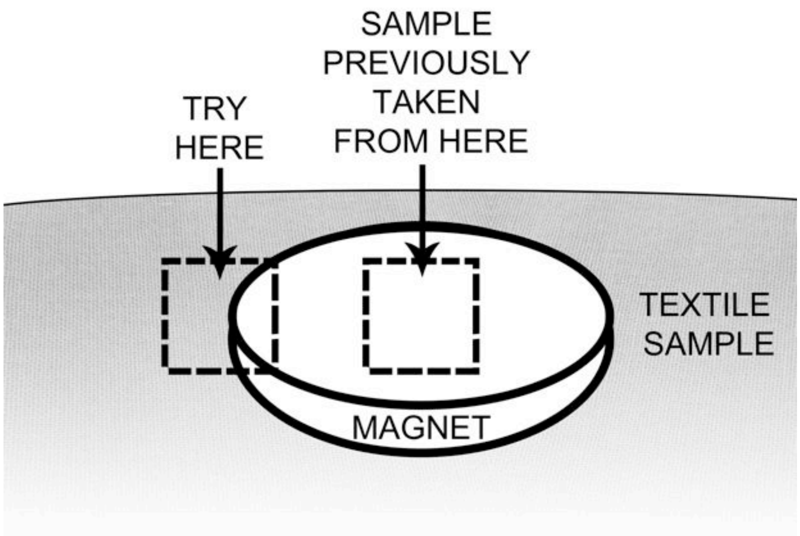
Analysing the Results

When analysing the images produced by the scanning electron microscope it proved difficult to discern between an image of a textile specimen that had been held under a magnet for a set period of time (Figure 25 –images on the right hand side) and an image of one which had not (figure 25 - left hand side). No discernable damage to any of the four samples fibres or weaves were observed.

It proved difficult to see if any damage had occurred to the NMS leather sample, which had been mounted within a magnetic display for a period of three years because of the haphazard appearance of the collagen. If this project had allowed for the textile samples tested i.e. cotton, silk and bark cloth to be suspended for a longer period of time perhaps then damage would have occurred and been observed. While it is thought that visual analysis formed a good starting point for this research topic, it has been realised that the amount of research required spans outwit the timespan of the project.

An idea for futher research concerns

Instead of taking samples from the middle of the areas to be analysed using SEM perhaps by looking at sample taken by the edge –more results. Sharp uneven tensions.



Chapter 7. Evaluation of the Project and Further Research Required

Although all of the proposed objectives were carried out, the primary aim of the dissertation: to establish whether magnets are a safe method for display for textile artefacts was not met, as while no definite damage was observed on the mounted textile samples further investigation is required before the research question can be answered i.e. analysing textile samples mounted for longer periods of time that it was possible to simulate within this project and employing other methods of analysis for example tensile strength testing to see if damage is occurring which is not visible through visual analysis.

Further research

Digital Image Correlation (DIC) will be used to assess points of compression/pressure on textile samples magnetically mounted on vertical and near vertical display systems

The tension compression test was done with the magnetic display board element of the system lying horizontally, which is not what would be seen when in a museum or art gallery, with vertical or near vertical displays being more usual as they aid viewing. The force of gravity was not taken into account, as it would have only have a very minor effect on the results. Over time however it would be interesting to monitor the effects of a magnetic display system on a textile artefact i.e. both the compression and strain and any unequal distribution of weight caused by point fasteners and compared to stitching. Digital Image Correlation as discussed by Lennard et al would be an interesting method to consider for further research into the effects of a magnetic display system on a mounted textile.

Although no definite data was discovered this research project has opened a line of enquiry into the effects of magnetic display on mounted textile artefacts that can hopefully form a platform for further research because as the popularity of the use of magnets for the display of heritage artefacts grows so does the necessity for research such has that been started here to be continued.

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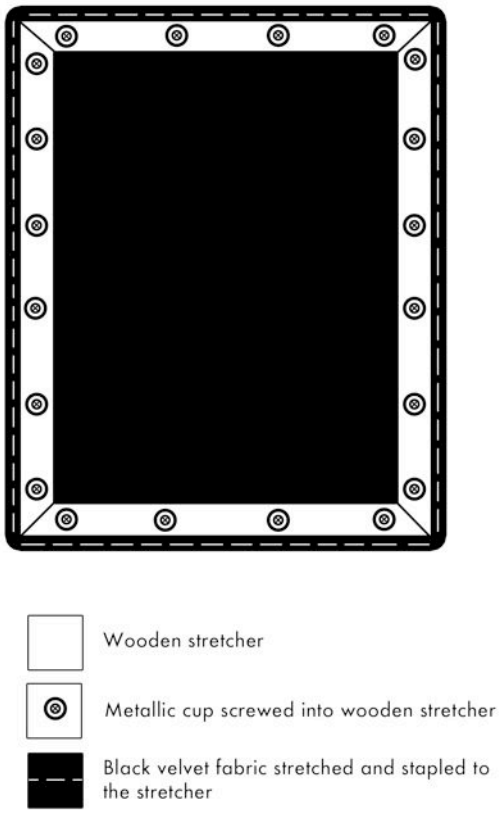
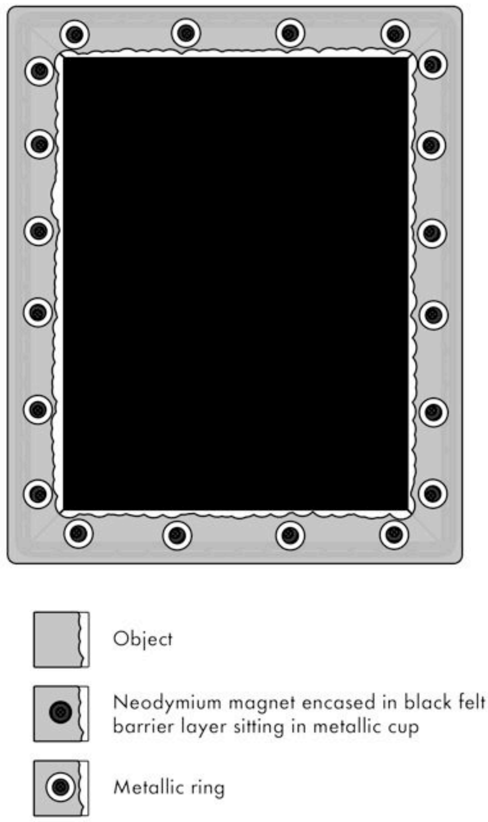
Appendix 1

Literature Review Diagrams

Please Note: The following diagrams were created for a previous piece of work by the author and have been re-entered here as an appendix with the purpose of beginning a comprehensive resource of illustrations of the magnetic display systems described in the literature, to act as a timesaving device in the problem-solving process of exhibition installation.

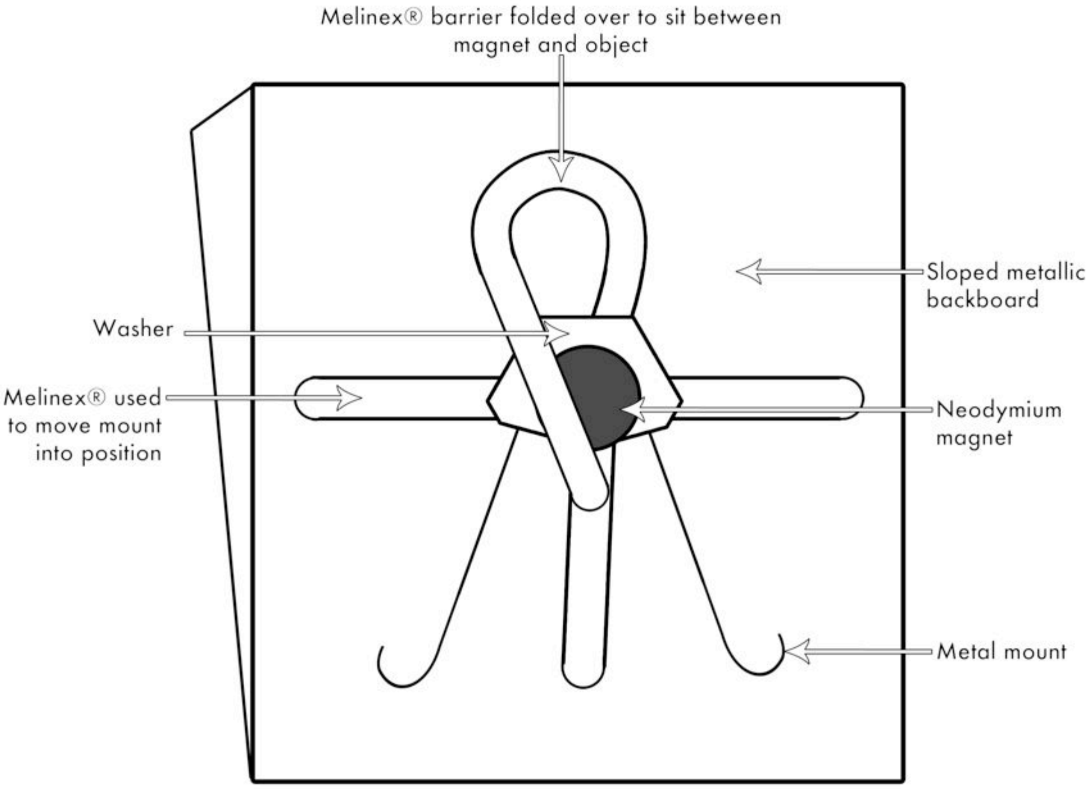
- Diagram created from the following literature:
  Verberne-Khurshid, F, I Smit and N Van der Sterren. "The Attraction of Magnets as a Conservation Tool." In *ICOM CC 13th Triennial Conference, Rio de Janeiro, 22-27 September 2002*, *Preprints*, edited by Roy Vontobel, 363-369. Rio de Janeiro: The Getty Conservation Institute, 2002.





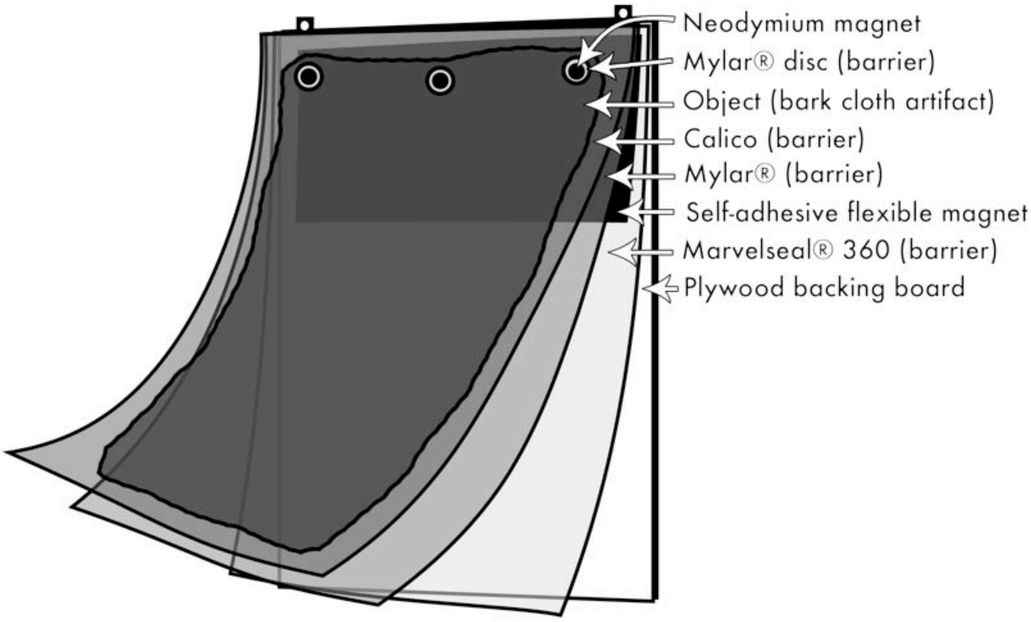
➢ Diagram created from the following literature:

Derbyshire, Alan and Timea Tallian. “The New Miniatures Gallery.” V&A Conservation Journal, no. 51 (2005): 3-6. http://www.vam.ac.uk/content/journals/conservation-journal/issue-51/the-new-miniatures-gallery.



➢ Diagram created from the following literature:

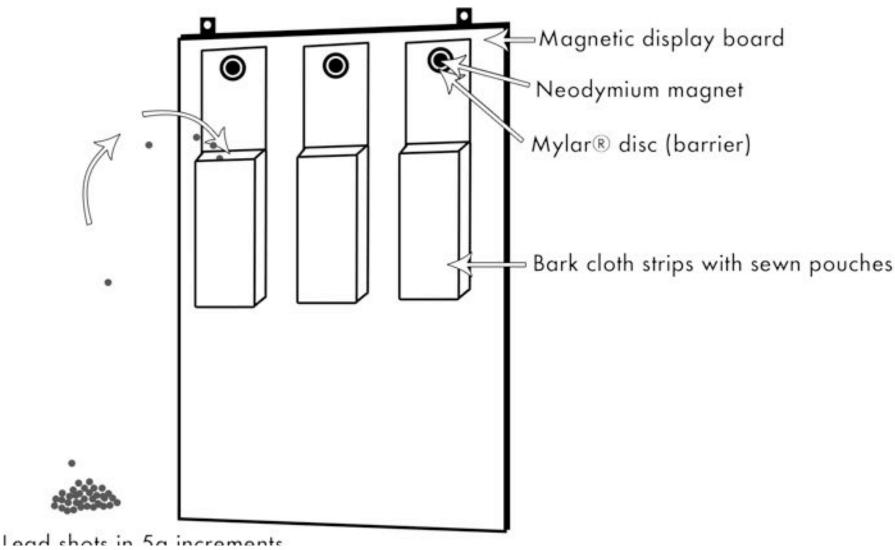
Dean-Jones, Megan. “Development of a Magnetic Vertical Display System for Bark Cloth Artefacts.” *AICCM National Newsletter*, no.111 (2009): 27-30.



➢ Diagram created from the following literature:

Dean-Jones, Megan. “Development of a Magnetic Vertical Display System for Bark Cloth Artefacts.” *AICCM National Newsletter*, no.111 (2009): 27-30.

(test 1 – determining how many magnets would be needed to hold up a given area of bark cloth).



Appendix 2

The Questionnaire

MAGNETS WITHIN MUSEUM DISPLAY QUESTIONNAIRE

Research Collated by: Rosie Chamberlin

The aim of this questionnaire is to gain a picture of the typical method of magnetic display used within the museum, as well as the typical fibre type of textiles that are displayed using magnets, and the typical environmental conditions that the objects are exposed to throughout the duration of display. The information gathered by way of interview or questionnaire will inform and enable the replication of a real life display situation during the experimental phase of the research project:
An investigation into whether the compressive forces exerted on a textile artifact suspended in a magnetic display system causes damage to the objects fibres and/or weave.
All participation is greatly appreciated and each participant will receive a summary of the results from the research once the project has reached completion.

---

1. Please provide your name, position and the name of the institution that you work in

---

2. At your institution do you know of magnets being used for the mounting/display of textile artefacts?

(If Yes continue to question 3)

- Yes
- No
- other Please enter an 'other' value for this selection.

---

3. What kind of textile artefacts are mounted/displayed using magnets?

- Two-dimensional Costume
- Three-dimensional Costume
- Flat textiles
- Embroidery
- Upholstery
- Bark cloth
- other Please enter an 'other' value for this selection.

---

4. What kind of size are the textile artefacts mounted with magnets at your institution?

(please give an indication of the largest kind of object displayed using this method)

---

5. What are the textile artefacts mounted with magnets composed of?

- Cotton
- Linen
- Silk
- Wool
- Synthetics
- Leather
- other Please enter an 'other' value for this selection.

---

6. What type of magnet does your institution typically use for mounting textile artefacts?

---

7. Is the type, size or amount of magnet(s) used changed depending on the suspended object?

- Yes
- No
- other

---

8. Are magnets used temporarily or for long-term display?

(Please state the typical display duration)

---

9. Please give an indication of the typical environmental conditions during this time (i.e. temperature and RH%)

- Controlled
- Uncontrolled
- other Please enter an 'other' value for this selection.

---

10. Why did your institution decide to use magnets for displaying textile artefacts?

---

11. Are they found to be effective?

---

12. Have any adverse effects been noticed on the magnetically mounted textiles?

---

13. Additional information

(Please add any further comments detailing your experiences/ thoughts/opinions of magnetic display for textile artefacts within a cultural heritage environment)

Appendix 3

Risk Assessment

University of Glasgow

RISK ASSESSMENT FORM

School: Culture and Creative Arts	**Section:** Centre For Textile Conservation and Technical Art History (CTCTAH)	**Location:** Room number(s) 309a, 309b, 310, 315 and Glasgow City College	**Reference No:** R50/13-14	**Related COSHH Form (if applicable):** N/A

Description of activity:

The manufacturing of magnetic display systems for the dissertation project:

An Investigation into whether the Compressive Forces Exerted on a Textile Artefact Suspended in a Magnetic Display System Cause Damage to the Objects Fibres and/or Weave.

This will involve:

- Use of sharps i.e. scissors and scalpel for preparing display boards
- Use of hand tools i.e. saw, drill and screwdriver for preparing display boards
- Possible use of woodworking machinery at Glasgow City College i.e. band saw for cutting steel sheeting
- Use of magnets for displaying textile samples on the prepared boards

Persons at risk:
Staff and students at the CTCTAH (University of Glasgow)

Is operator training/supervision required? If yes, please specify:
Yes; moderate tutor supervision

Hazards/ Risks	Current controls	Are these adequate?	What action is required if not adequately controlled?
Using sharps to cut materials	Care will be taken when using sharp tools and regular breaks will be taken to rest eyes and back. If any sharps break they will be disposed of appropriately in the sharps bin.	Yes	N/A
Hand tools (and electrical equipment)	Recently tested electrical equipment will be used and the workspace kept tidy to avoid risk of tripping on wires. All electrical equipment will be switched off when not in use.	Yes	N/A
Use of wood working machinery	Appropriate protocols will be followed when using equipment and appropriate PPE will be worn at all times.	No	Certificate held for use of woodwork machinery until (22/11/2016)
Use of magnets	Care will be taken when using magnets so as to not allow them to pull together and pinch skin or create sparks. Magnets will be placed at a safe distance from one another. Split or broken magnets will be disposed of appropriately in the sharps bin.	Yes	N/A

Completed by (print name and position, and sign): Rosie Chamberlin (student)	**Date:** 05/06/2014
Approved by (print name and position, and sign): Karen Thompson (tutor)	**Date:** 05/06/2014

Appendix 4

Table Summary of Literature Review and Questionnaire Data

Summary of Information from the Literature Review and Questionnaire

Materials Conserved using Magnets (Literature Review – Summary of Findings)

vellum/skin	textile	paper	metal
3	1	1	1

Conservation Treatments using Magnets (Literature Review – Summary of Findings)

clamping after humidification	clamping while an adhesive dries	long term joining method
2	3	2

Type of Magnet(s) used as a Conservation Tool (Literature Review – Summary of Findings)

neodymium	rare earth (either neodymium or samarium-cobalt)	flexible ferrite	ceramic (ferrite)
3	1	1	1

Textile Types Mounted using Magnets (Literature Review – Summary of Findings)

unspecified	leather	barkcloth	basketry	cotton	silk
9	4	2	1	1	1

Magnet(s) used for Mounting Textile Artifacts (Literature Review – Summary of Findings)

neodymium	rare earth (either neodymium or samarium-cobalt)	flexible ferrite	unspecified
10	4	1	2

Other Materials Incorporated in Magnetic Display Systems (Literature Review – Summary of Findings)

base materials

unspecified	archival museum board	plywood	wooden stretcher	dibond®	Honeycomb aluminium structure	polyethylene foam planks
7	3	2	1	1	1	1

barrier materials

unspecified	mylar®	marvelseal	Ultra suede	felt	Polythene foam pads
7	3	2	2	2	1

cushioning materials

unspecified	textile (other)	fibrefil	flannel fabric	ethafoam	volara
8	3	2	1	1	1

materials to attract magnet

unspecified	steel sheeting	flexible magnetic material	metallic panel	mate magnets	fender washers	metallic cups	iron bar

4	4	2	2	2	1	1	1

finishing materials			
unspecified	‘finish fabric’	cotton jersey	washed calico
8	5	2	1

Textile Types Mounted using Magnets (Questionnaire Responses)				
cotton	silk	linen	synthetics	barkcloth
4	3	1	1	1

Magnet(s) used for Mounting Textile Artifacts (Questionnaire Responses)		
neodymium	rare earth (either neodymium or samarium-cobalt)	flexible ferrite
2	2	1

Collated Textile Types Mounted using Magnets (from both the literature review and responses to the questionnaire)						
unspecified	cotton	silk	linen	synthetics	barkcloth	leather
9	5	4	1	1	3	4

Collated Magnet Types used for mounting textile artifacts (from both the literature review and responses to the questionnaire)			
neodymium	rare earth (either neodymium or samarium-cobalt)	flexible ferrite	unspecified
12	6	2	2

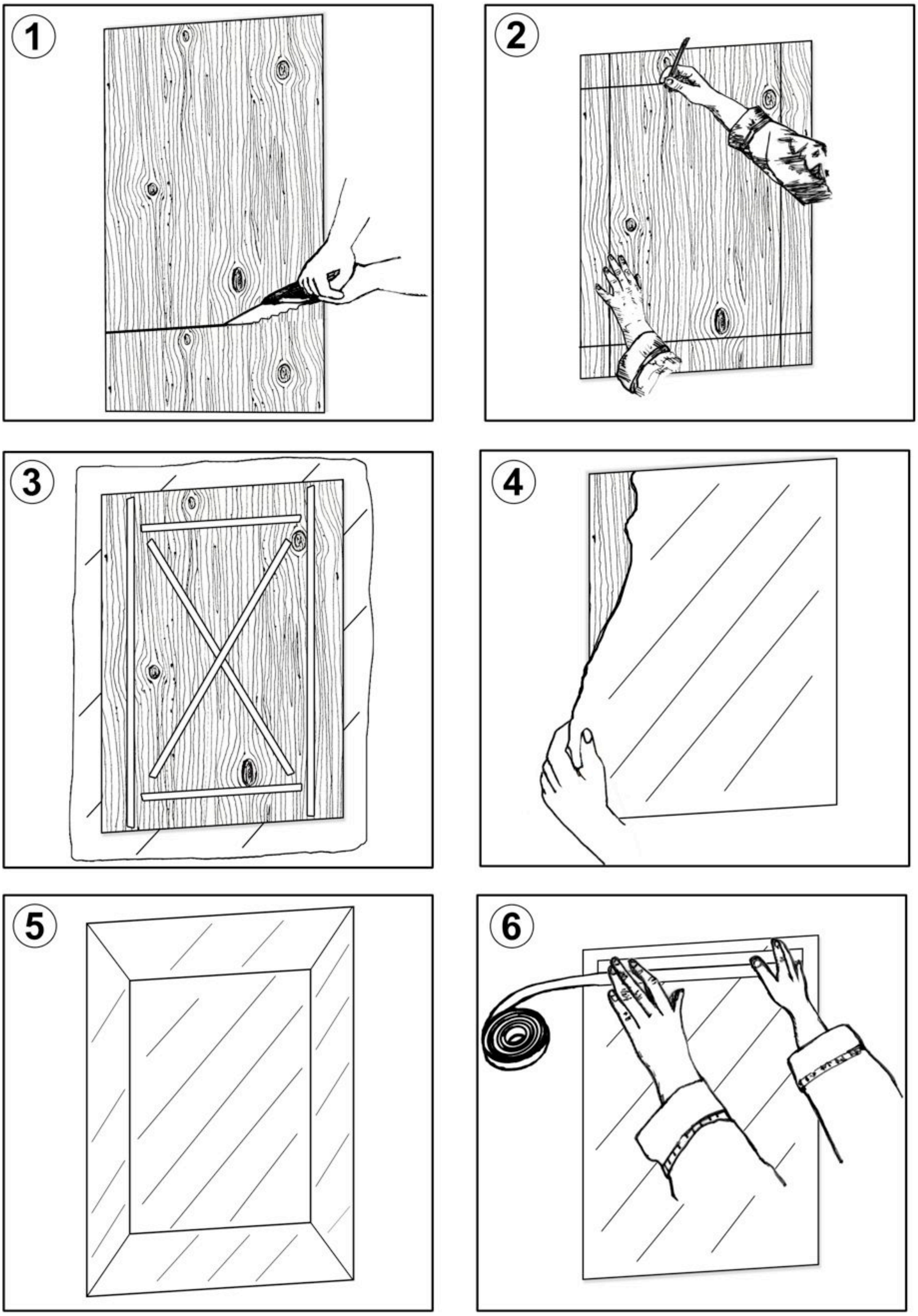
Appendix 5

Magnetic Display System Materials

(Visual Analysis)


(A) Plywood
(B) Tape
(C) Marvelseal
(D) Flexible adhesive magnet
(E) Stainless steel sheeting
(F) Melinex®
(G) Domette
(H) Tape
(I) Scoured calico
(J) Shallow staples
(K) 'Object' textile sample 1: Leather
(L) 'Object' textile sample 2: Silk
(M) 'Object' textile sample 3: Cotton
(O) Neodymium magnet
(P) Magnetic board example
(N) 'Object' textile sample 4: Barkcloth

Appendix 6
Magnetic Display System Manufacture Diagrams
(Visual Analysis)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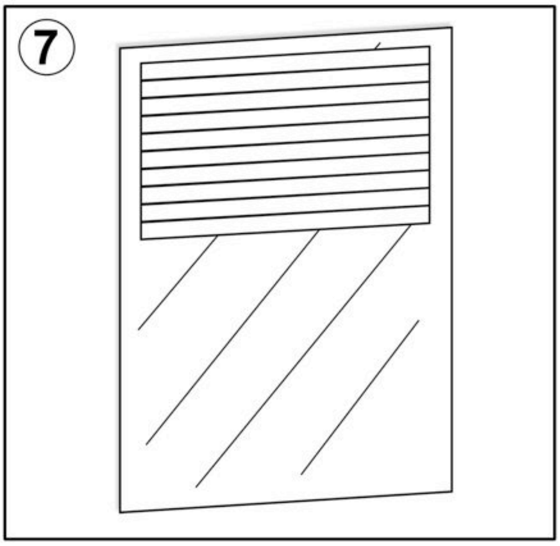
2
3
4
5
6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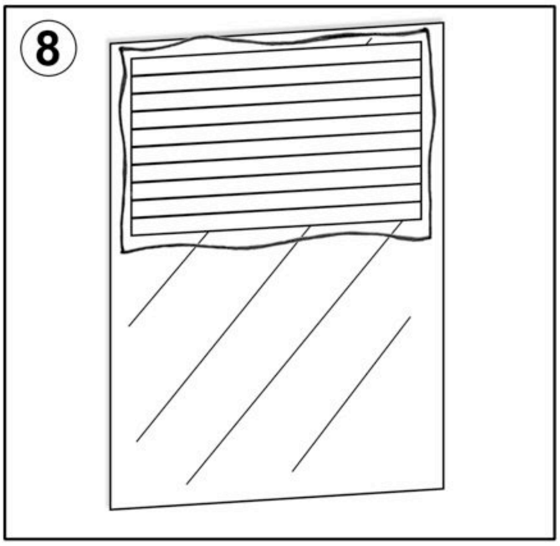
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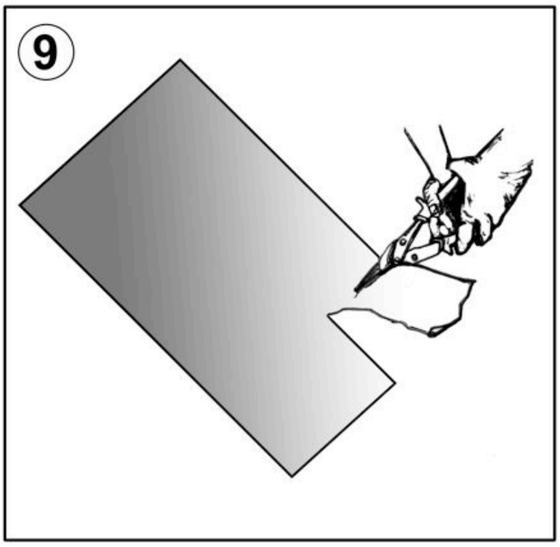
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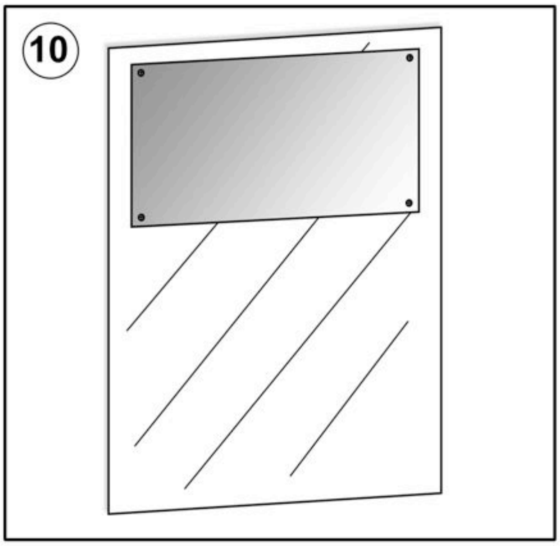
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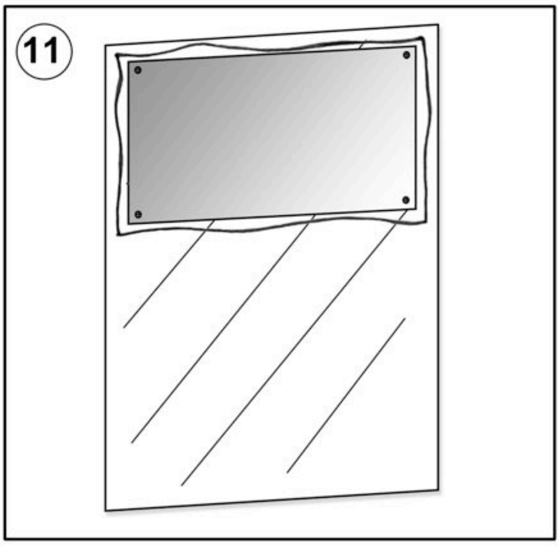
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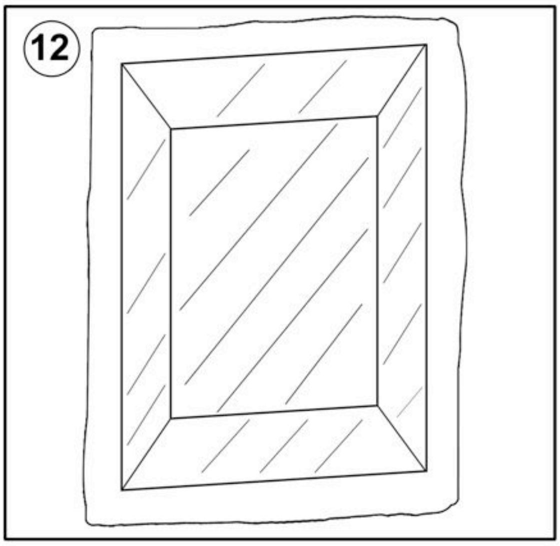
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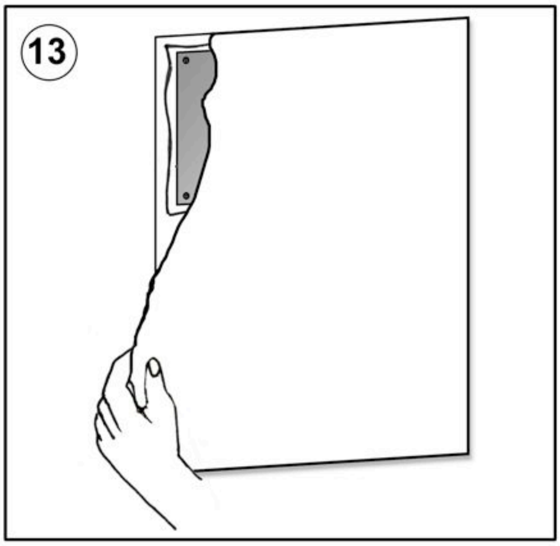
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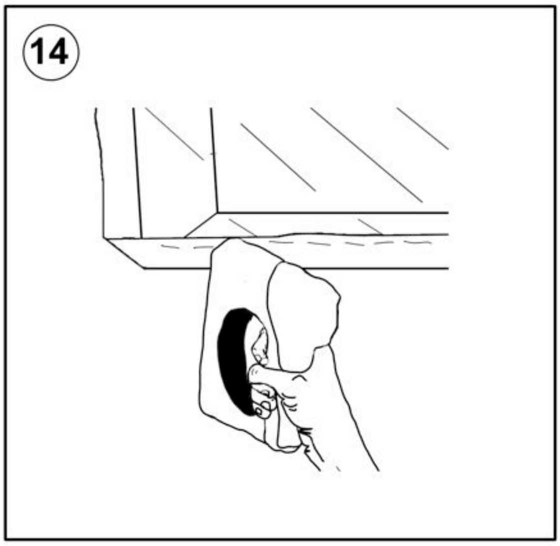
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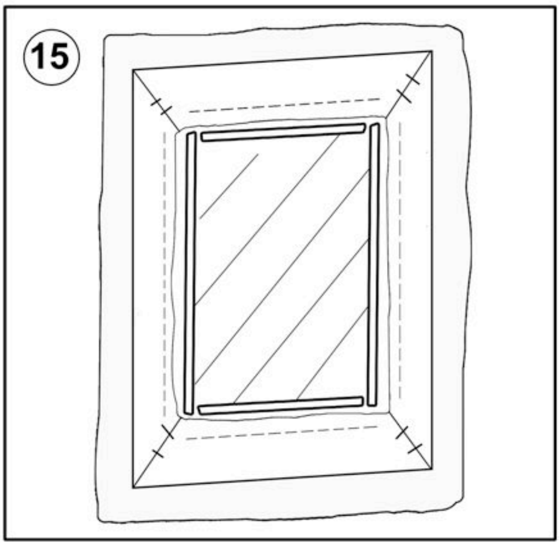
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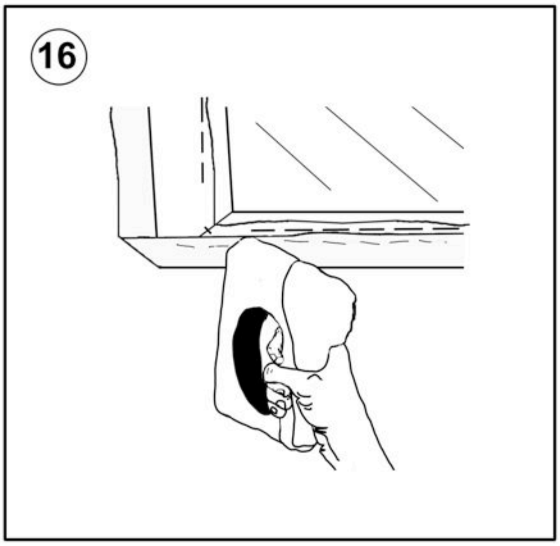
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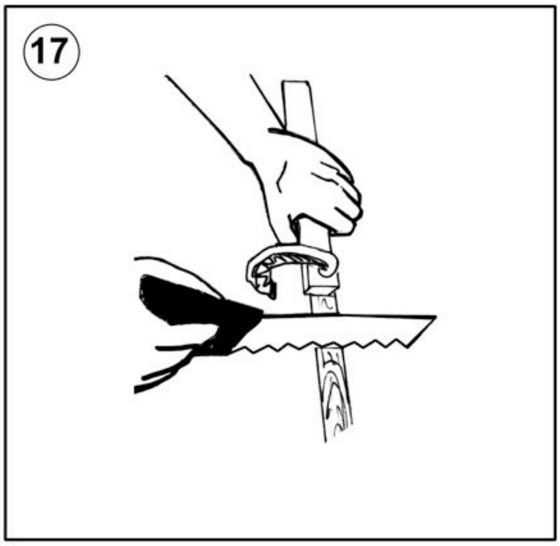
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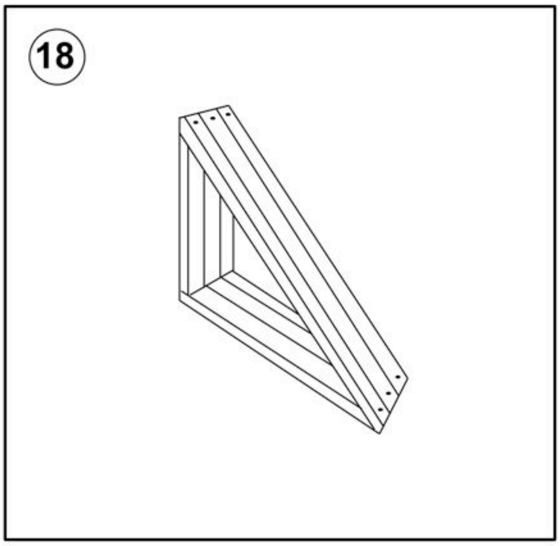
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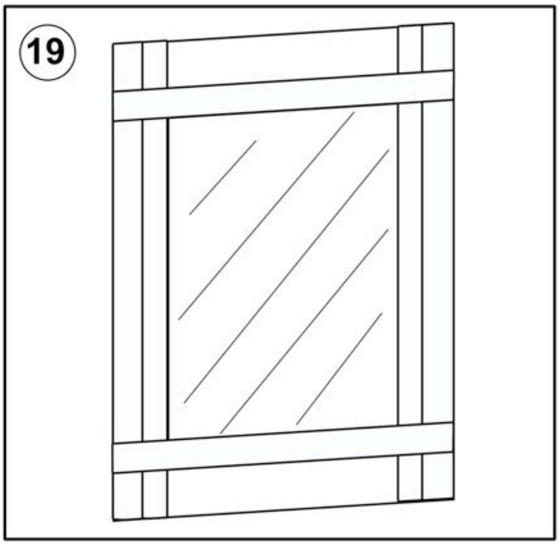
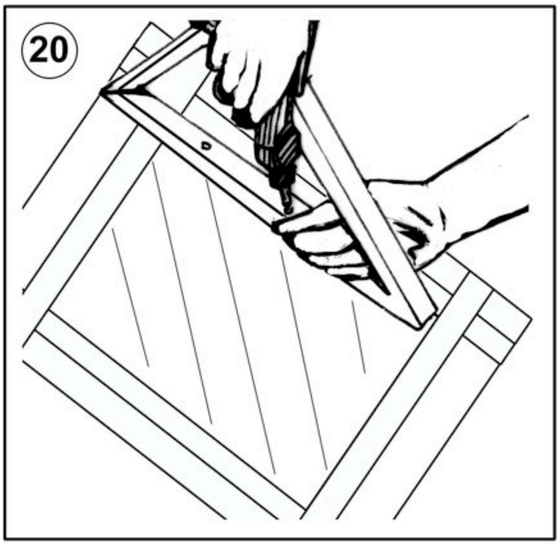
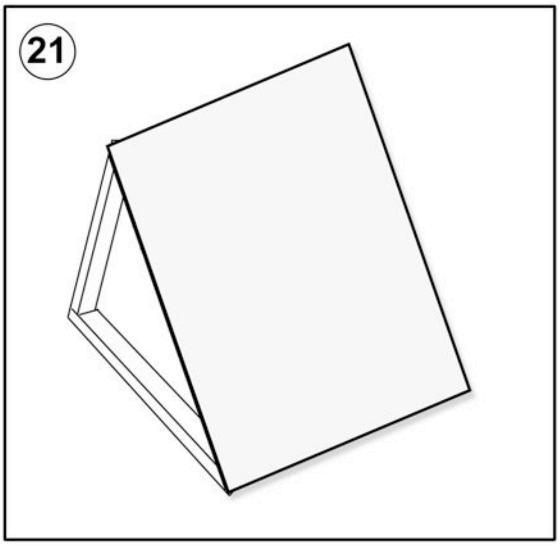






1. The ply

2. wood was cut into two backing boards of similar dimensions (450mm high x 340mm wide approx.).
3. Lines were drawn as a guide to where the various layers of material incorporated in the two magnetic display systems would be attached to the board.
4. Double-sided tape was applied to the reverse of both boards.
5. A Marvelseal® barrier layer was wrapped around both boards.
6. An extra square of Marvelseal® was used to ensure the plywood was completely sealed.
7. Strips of self-adhesive flexible magnetic material (to attract the neodymium magnets) were attached to one board.
8. ″
9. A barrier layer of Melinex® was attached to the flexible magnetic material with double-sided tape.
10. Steel sheeting (to attract the neodymium magnets) was cut using tin-snips.
11. Steel sheeting was attached to the other board using screws.
12. A barrier layer of Melinex® was attached to the steel sheeting material with double-sided tape.
13. A cushioning layer of cotton domett was secured to both boards using shallow staples.
14. ″
15. ″
16. The edges of the domett were stitched into place.
17. Calico 'finish fabric' was used to cover both boards. Shallow staples were used to hold the fabric in position.
18. Lengths of wood were cut to attach to the reverse of both boards in order to create a sloping / near-vertical display.
19. The lengths of wood were screwed together at an angle (diagram 18 shows three of four constructed brackets).
20. Frame tape was applied to the reverse of both boards.
21. The angled brackets were attached to both magnetic display boards using screws.
22. One of two completed magnetic display boards.

Appendix 7

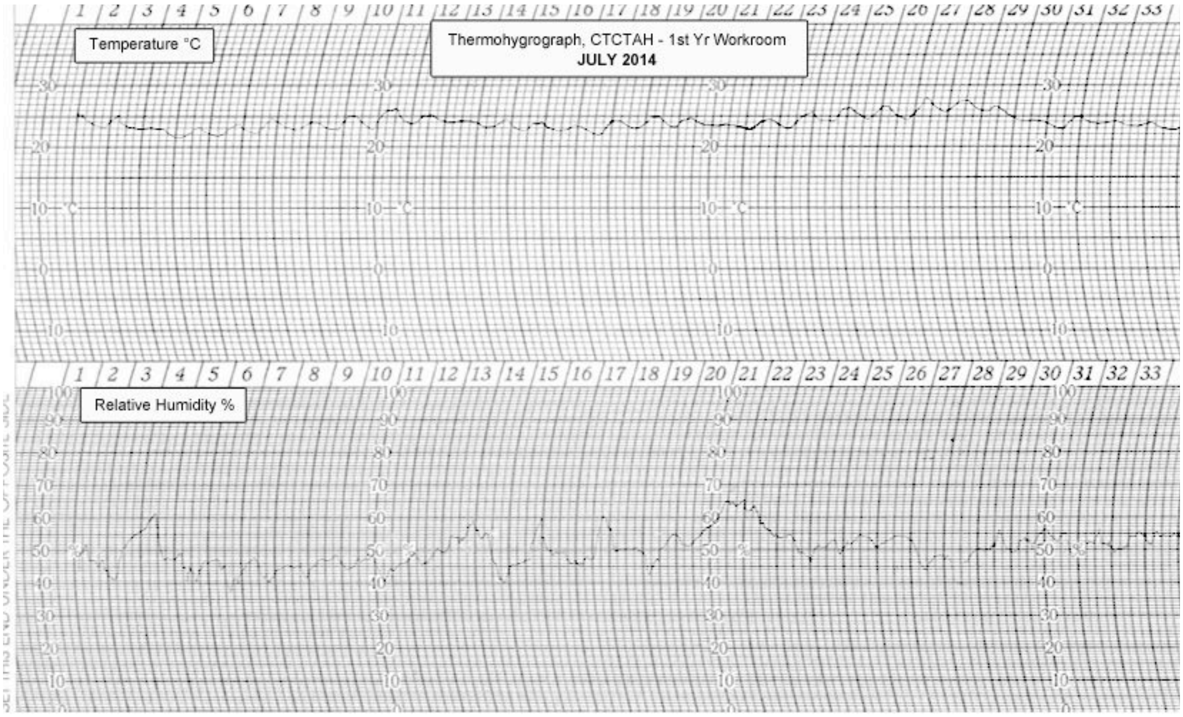
Thermohygrograph Records (CTCTAH First Years Workroom)

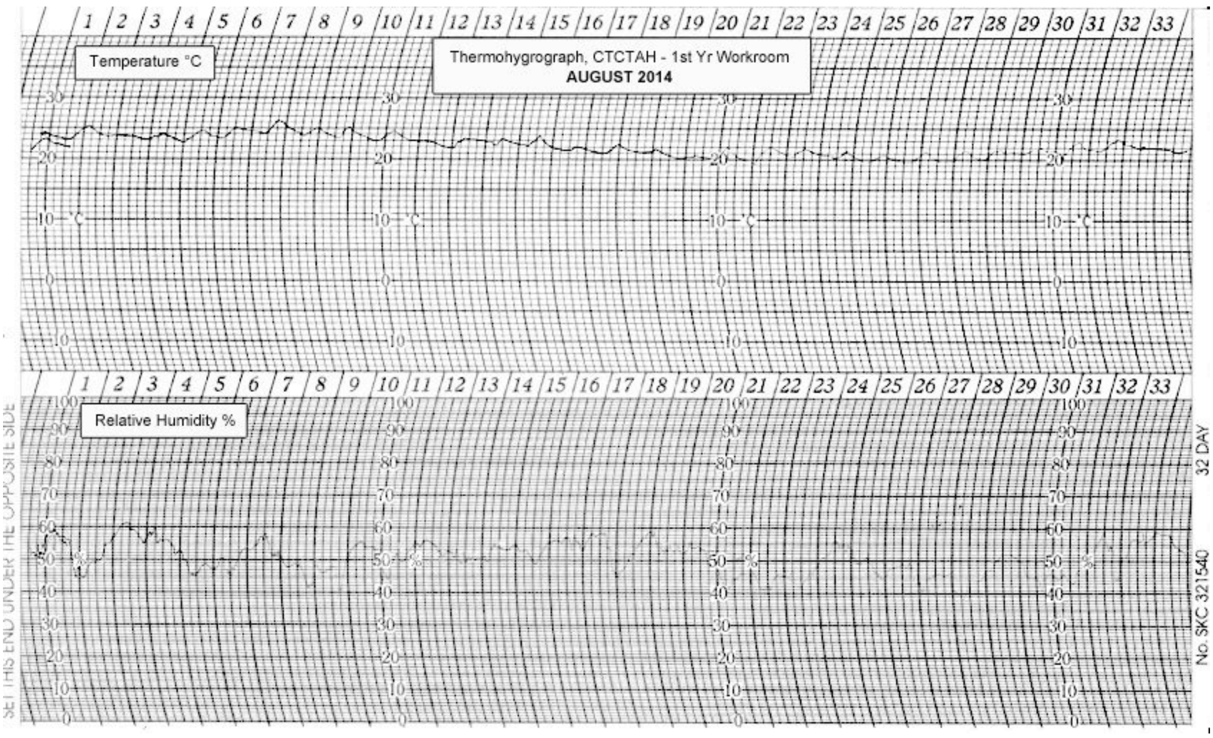
March – August 2014


Temperature °C
Thermohygrograph, CTCTAH - 1st Yr Workroom
MARCH 2014
Relative Humidity %
32 DAY
No. SKC 321540
SET THIS END UNDER
No. SKC 321540


Temperature °C
Thermohygrograph, CTCTAH - 1st Yr Workroom
MAY 2014
Relative Humidity %
32 DAY
No. SKC 321540


Temperature °C
Thermohygrograph, CTCTAH - 1st Yr Workroom
JUNE 2014
Relative Humidity %
32 DAY
No. SKC 321540


Temperature °C
Thermohygrograph, CTCTAH - 1st Yr Workroom
JULY 2014
Relative Humidity %
SET THIS END UNDER THE OPPOSITE SIDE


Temperature °C
Thermohygrograph, CTCTAH - 1st Yr Workroom
AUGUST 2014
Relative Humidity %
SET THIS END UNDER THE OPPOSITE SIDE
32 DAY
No. SKC 321540