

Abstract

This paper reports on the outcomes of the project funded by the Leverhulme Trust to examine the role of dust in irreversible soiling and to find ways to minimize this risk. The work explores not only conservation concern for the interaction of dust with historic surfaces and their presentation to visitors, but also visitor attitudes to dust and their response to historic interiors. The work takes account of the need to provide access as well as long-term preservation, and provides an assessment of the costs and benefits of an effective dust management strategy, designed to prolong objects' existence and enhance the visitors' experience.

Keywords

dust, cementation, adhesion, perceptions, management, economics, cleaning frequency

Managing dust in historic houses – a visitor/conservator interface

Katy Lithgow and Helen Lloyd

The National Trust
36 Queen Anne's Gate
London SW1H 9AS
United Kingdom
Tel.: +44 (0)20 7222 9251
Fax: +44 (0)20 7222 5097
E-mail: katy.lithgow@nationaltrust.org.uk; helen.lloyd@nationaltrust.org.uk,
Web site: www.nationaltrust.org.uk

Peter Brimblecombe and Y H Yoon

School of Environmental Studies
University of East Anglia
Norwich NR4 7TJ
United Kingdom
Tel.: +44 (0)1603 456161
Fax: +44 (0)1603 458596
E-mail: P.Brimblecombe@uea.ac.uk; y.h.yoon@uea.ac.uk
Web site: www.uea.ac.uk

David Thickett

English Heritage
23 Savile Row
London W1S 2ET
United Kingdom
Tel.: +44 (0)20 7973 3000
Fax: +44 (0)20 7973 3322,
E-mail: David.Thickett@english-heritage.org.uk
Web site: www.english-heritage.org.uk

Introduction

The challenges of removing dust from fragile surfaces have troubled housekeepers since at least the 18th century, when instructions for household management were first compiled:

...places where the dust lodges should be attended to. Otherwise, if left too long, it takes a long time and much labour to get it off.... (Hardymont 2000)

The surfaces of decorative objects and works of art are all-important, so cumulative deposits reduce both aesthetic and evidential value. Deposited dust can cause physical damage or chemical alteration to the material. Cleaning surfaces inevitably leads to small-scale loss. With vulnerable materials such as historic textiles, these losses can rapidly accumulate.

Today, conservators are concerned with not only the physical and aesthetic effects of dust, but also cumulative damage caused by frequent cleaning or by more interventive treatments to remove dust and dirt which, if left for long periods, becomes strongly adhered. Preventive conservation strategies aim to protect sensitive objects and surfaces from soiling and to design regimes for cleaning only when necessary, rather than as a matter of habit. However, the point at which dust removal becomes a matter of necessity has yet to be established, and there is a demand from collections care staff in historic houses for standards to guide the frequency of cleaning. These need to take account not only of the perceptions of dustiness by staff, but also the effect of dust on visitors' experience of the historic interior and resources available to manage dust.

Background

Preliminary studies by the University of East Anglia at a National Trust property investigated the principal sources and distribution of dust (Brimblecombe and Yoon 2000b). Although, numerically speaking, tiny particles form 97 per cent of the deposited dust, textile fibres and coarse particles (over 1–2 µm) derived from

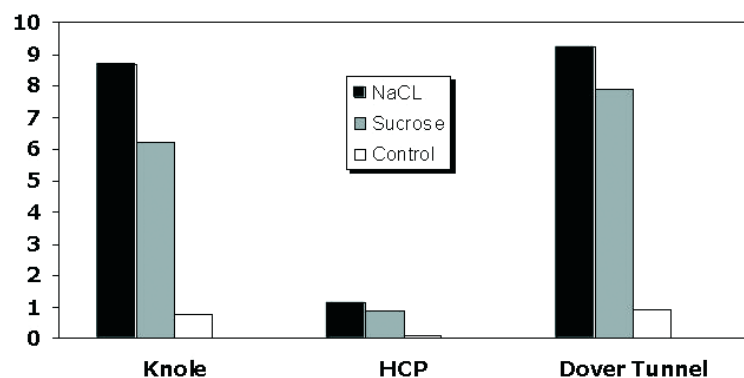
visitors' clothing are more visually intrusive and cover a greater proportion of the surface. Dust accumulation was measured as a covering rate expressed in grams per second (Lloyd et al. 2002). The highest covering rates were found beside visitor routes, but these decreased by half with every metre distance from visitors. Dust levels were high at floor level, where heavier particles were stirred up by foot traffic but re-deposited close to the visitor route. Dust and fibre levels were also high between 0.8 and 1.5 m, roughly between hip and shoulder height on an adult.

To understand better the transformations that bind dust more strongly to surfaces over time, a research project was developed, entitled 'Controls on "irreversible" soiling; minimizing damage to indoor artefacts'. Historic Royal Palaces and English Heritage joined the team, and the project was funded by the Leverhulme Trust. The heritage organizations are responsible for the care of historic houses, where the open display of collections makes them particularly vulnerable to dust deposition. The project aims to evaluate the physical effects of dust, to define cycles for minimum intervention and cleaning frequency, and to investigate how perceptions of dustiness by housekeeping staff, managers and visitors influence cleaning regimes and standards of presentation. Although visitors are the principal source of dust, providing public access to historic buildings must remain a prime objective for organizations responsible for historic building preservation. To achieve a sustainable balance between access and conservation requires effective strategies for management of dust, and optimum frequency of cleaning. Research began in May 2002 and will be completed during Winter 2005. This paper reports on results so far.

Dust adhesion

Conservators and cleaning staff have noticed that over time deposited dust becomes more strongly embedded in open textured materials, where it forms 'mud packs', or adheres to hard surfaces, and that cleaning such dust will require more aggressive and damaging methods (Lloyd et al. 2002). However, the mechanisms that cause this 'cementation' are not understood, and could be critical determinants of cleaning frequency.

During the winter of 2003–04 samples of fine soil dusts (from Kuwait and East Anglia, particle size less than 63 µm) were exposed in Hampton Court Palace, the tunnels at Dover Castle and at Knole near Sevenoaks, and this experiment was repeated during winter 2004–05. As salt occurs frequently in coastal environments and is much in evidence in deposits of lint at Dover, and as sugars are found in textile fibres derived from plants such as cotton, traces of salts and sugars were added to some of the samples. Both salts and sugars promoted adhesion by setting the dusts into solid lumps at high relative humidity (RH) at Knole (80–90 per cent) and the Dover tunnels (up to 86 per cent RH), where building structures have made it difficult to introduce environmental control (Figure 1). During the damp winter conditions prevailing at Knole and in the



weight 15

Figure 1. Graph indicating humidity at which cementation occurred at Knole/Dover Tunnel

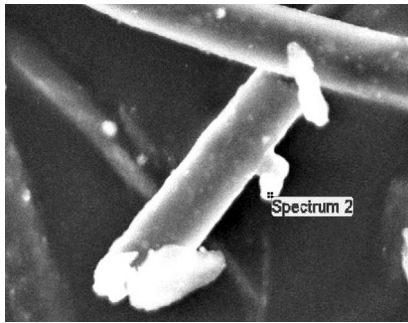


Figure 2. SEM photograph of textile fibre with particle (indicated by 'Spectrum 2' label) 'cemented' to it

Dover tunnels, particles from dust even without additives also readily attached themselves to fibres. However, adhesion did not occur to such an extent at Hampton Court, where the environment is much drier. Once attached, the particles were found to be difficult to remove from the fibres.

The response of dusts to different levels of humidity, and the way in which particles adhere to fibres, have been examined in the laboratory, where relative humidity could be controlled. There is a clear relationship between higher levels of relative humidity and the mass of particulate material that becomes attached to fibres. The cements that bind dust particles to fibres are sometimes visible under scanning electron microscopy (SEM) (Figure 2), but are very small and difficult to analyse. However, a limited amount of elemental analysis using SEM has revealed the presence of calcium containing materials. Although these could be cements, they might simply reflect the presence of calcium in the particles. Fourier transform infrared (FTIR) spectroscopy shows organic materials in addition to the calcium. The dependence of cementation on moisture suggests that salts also contribute to the process. The dust samples collected at Knole (far from the sea) are dominated by sulphate, presumably either from pollution or from gypsum from the walls. Even though a very weakly soluble salt, gypsum could contribute to the cementation process over time, in the same way as sea salt, potentially through cycles of deliquescence. Fluctuating RH was observed to cause movement of fibres which may embed them into porous or fibrous surfaces. Parallel research undertaken by a conservator intern in the Department of Engineering and Applied Sciences at Harvard University has identified exopolymers (derived from bacteria) forming under humid conditions on dust samples from Knole (Tarnowski et al. 2004). So there are biological mechanisms for cementation in addition to the physical and chemical ones noted above.

Dust perception

Cleaning regimes are driven by perceptions of dustiness from several groups of people, as well as by aesthetic and conservation concerns. Conservators, curators, managers, room stewards and custodians are all involved and the perceived views of visitors are often influential. These perceptions were investigated using techniques that depended on practical considerations such as the availability and location of different groups of people.

Visitor perceptions were initially investigated by a questionnaire, conducted when all participating houses were open and visitors available. Six short open and closed questions were asked, raising dust as an issue in the fourth question to avoid leading visitors' responses (Table 1). A limited amount of socio-economic data was collected and light levels were also recorded. Over 100 responses were gathered in each of eight houses (Figure 3).

Table 1. The questions asked in the first survey

1.	Which part of the room in your opinion needs most care?
2.	Why do you think this part of the room needs such care?
3.	What words would you use to describe the appearance of this room?
4.	Do you think historic houses are in general dusty?
5.	Why do you think dust in historic houses might cause us concern?
6.	How would you improve cleaning in this room?

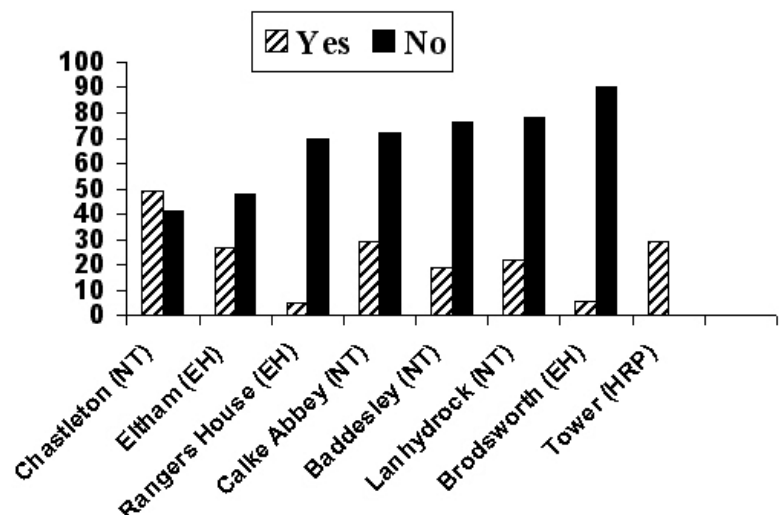


Figure 3. Historic houses rarely appear dusty to visitors. Except at Chastleton, visitors at most of the eight properties where the first questionnaire was conducted felt that historic houses were not in general dusty

The answers were subjected to semi-quantitative analysis and showed that rooms perceived to be dusty are also felt to be historic, most markedly at Chastleton House. Here a deliberate 'patina' is preserved by removing only loose dust that can be disturbed by hoghair or ponyhair brushes, leaving a grey veil of more firmly attached dust (Figure 4).

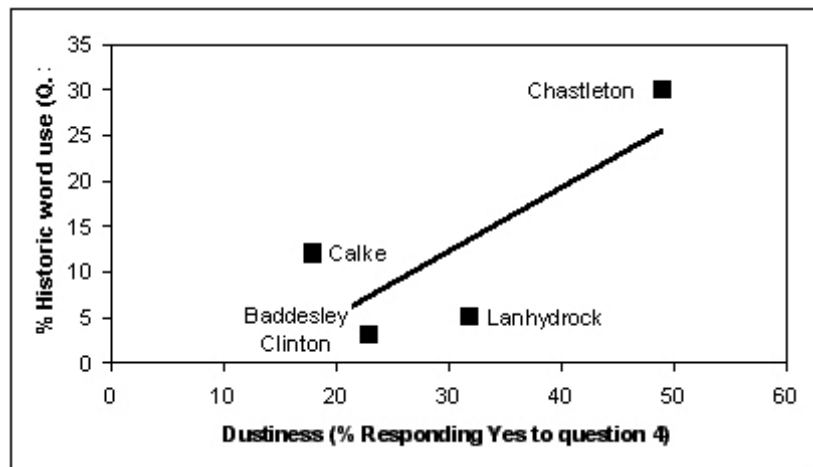


Figure 4. Historic nature and dust: contingency analysis of questions 3 and 4 in the first visitor questionnaire showed that where greater amounts of dust were perceived, there was also a greater sense of history

However, visitors did not think that dust was a primary concern, and considered historic houses to be generally clean (Figure 3), although some responses suggested that dust was detected through other senses such as smell, describing rooms as 'musty'. In fact, visitors were more concerned by the fragility of a room, particularly of the most prominent item, such as the wooden screen in the Great Hall at Chastleton (Figure 5).



Figure 5. The Great Hall at Chastleton, with wooden screen

Nor did visitors respond particularly strongly to a sense of history, citing more often comfort and a lived-in quality, darkness (in terms of colour rather than light levels) and magnificence (rarely beauty) (Lithgow et al. 2003; Lithgow and Brimblecombe 2003). However, the questionnaire revealed a dilemma for management by suggesting that where visitors recognized that dust contributed to the spirit of place, they also wanted it removed, but did not give any clear guidance on when this should happen.

A subsequent questionnaire checked the original qualitative responses by asking for numerical measures of the strength of visitors' response to the terms identified in the first survey. It also tried again to identify the point at which

visitors wanted further cleaning. As this would be difficult to do with words or real objects, 'game playing' was used. After asking whether visitors were willing to participate (around 90 per cent responded positively) visitors picked a value along a numbered scale describing a particular quality of a room's appearance (Table 2). They then ranked images of selected objects according to the level of soiling visible on the object itself, and identified the object in the sequence where further cleaning was needed. This questionnaire was run at six houses on seven occasions, yielding nearly 500 responses. The response rate was lower than the first questionnaire because questions and game-playing were more time consuming and difficult to answer.

Table 2. *Measuring feelings: this question quantified room appearance, and is shown with a sample answer from Chastleton*

2 Assuming that dust is loose and powdery, could you answer the following questions. What word best describes your feelings about this room? Tick the most appropriate box for each scale						
	-3	-2	-1	1	2	3
• Dark				✓		
• New						✓
• Formal				✓		
• Dirty			✓			
• Beautiful	✓					
• Unfurnished				✓		
• Dust free						✓
						Light Historic Cosy Clean Bland Cluttered Dusty

Calculating the standard deviation of visitor responses showed their diversity, but a broad pattern emerged confirming the association of dust with historicity. Plausible responses to the first question also established that visitors' assessments of dustiness were credible. However, although visitors were willing and able to order the objects, the order seemed to have less to do with levels of dust accumulation, than qualities associated with the object's materials. Whatever the actual level of dust, light and shiny objects such as pale coloured ceramics were invariably judged to be cleaner than darker materials such as deep-coloured textiles. There was no consensus on the point at which further cleaning was judged necessary, except that it did not occur at extreme ends of the scale (Figure 6).

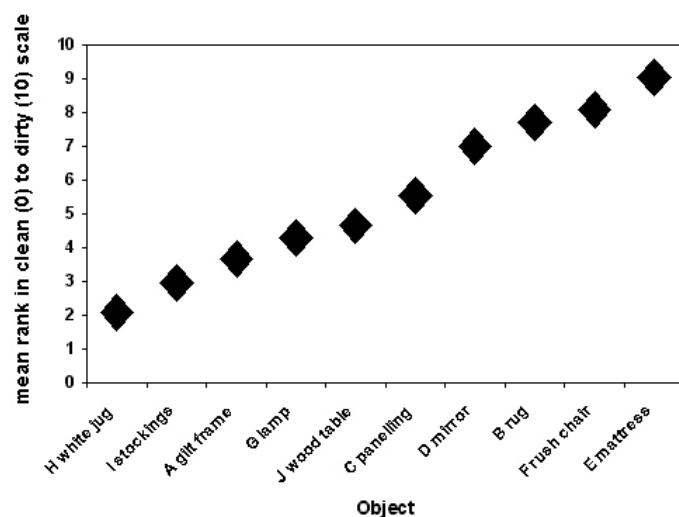


Figure 6. *Ranking objects in order of cleanliness in the Servants Room at Calke Abbey: lighter and shinier surfaces are judged cleaner than darker, matte or fibrous surfaces*

Perceptions of dust among National Trust staff were investigated by focus groups on two occasions. The first used six groups of around 20 participants, divided by role between managers, conservators, curators, house stewards, house managers and conservation assistants (Lloyd and Brimblecombe 2003). Dustiness was felt to affect both visitor experience and the condition of objects.

Each group's response was clearly influenced by the role that they performed. For example, property managers considered visitor perceptions and costs of cleaning vs. conservation treatment, whereas conservators focussed on the welfare of objects. Technical issues were well understood by all groups, but each group felt they set their own standards, influenced by conservation training and room steward feedback (house staff), presentation (curators), science mediated by compromise and resources (conservators).

Volunteer room stewards were not involved in the first meeting but clearly had an important effect on house staff, who thought room stewards passed on only negative comments from visitors (Lithgow and Brimblecombe 2004). A second focus group was used to investigate their views and those of conservation assistants in more detail. Two groups of conservation assistants were formed, and one of volunteer room stewards, each numbering six or seven participants. Each group's perception of dust was heavily influenced by the control they exerted in an interior. Whilst house staff controlled dust directly with vacuum cleaners and brushes, room stewards controlled it indirectly through managing visitors and preventing touching, regarding finger prints as the main cause of dust adhering to historic surfaces.

Both groups felt standards guiding dust management were influenced by more distant staff, but conservation assistants were particularly influenced by housekeeping traditions at their property and by the oldest member of the team, citing difficulties in reconciling these with a modern conservation approach. For example, Waddesdon Manor has a particularly well-articulated tradition, laid down by its early 20th century chatelaine, Miss Alice de Rothschild, but 'spirit of place' was cited by all groups on both occasions as a factor affecting cleaning regimes. A negative perception by one role of another's influence clearly relates to how they communicate with each other. Where this is made difficult by different roles working in a house at different times, extra efforts clearly need to be made by management staff to build team spirit and a consensus over the standards to be achieved.

Issues raised

Adhesion

The strong relationship between humidity and cementation suggests a range of management approaches to cleaning. It reinforces the need for control of RH, for example through conservation heating, to keep high humidity under control, and suggests associated benefits in prolonging the interval between cycles of routine cleaning as well as remedial conservation cycles dealing with structural problems. Where high humidity prevails (for example above 65 per cent RH), it is necessary to control dust accumulation to prevent cementation. During summer months, this reinforces the need for adequate provision of cleaning of robust surfaces, and more frequent cleaning of those fragile surfaces exposed to visitor dust. In winter, cementation on vulnerable horizontal surfaces such as bed covers could be prevented by removing dust at the beginning of the closed season, before dust covers are fitted. This would minimize the amount of dust available to cement to the underlying materials over the damper winter period. Cleaning resources could also be concentrated in areas where high humidity is difficult to control, for example cellars or rooms highly influenced by external environmental conditions.

Perception

Focus groups confirmed that conservators and management staff believe visitor expectations of presentation standards and cleanliness create pressure for more frequent cleaning. However, questionnaires revealed that visitors do not readily perceive dust but do associate it with historic atmosphere. Therefore, conservators and managers are driven by their own perceptions of the visitors, rather than actual visitor perceptions. Consequently it seems more truthful to acknowledge that cleaning frequencies are set to evoke a desired visitor response

as well as to preserve objects and interiors, rather than suggesting it is answering some outside need such as visitors wishing to see houses being well cared for.

There is clearly scope to enhance communication of the unwritten rules that guide effort and resources invested in cleaning, not only to promote visitor understanding of the need for balance between conservation and access, but also to encourage property staff and volunteers to understand the differences between their roles.

Economics

For people who manage historic collections, dust is an economic factor. Costs include staff time and equipment to remove dust, and protective measures to prevent or minimize dust deposition. The most expensive resource is staff time, for example in National Trust properties on average over a whole year each accessible room or space requires 20–30 min cleaning per day, whether the house is open or closed.

The level of cleaning is designed to maintain historic levels of presentation, and mimic traditional housekeeping practices. Effective maintenance of standards is continually challenged by a desire to increase visitor numbers and extend hours of opening, to provide wider public benefit and raise more income. Dust levels increase directly with visitor numbers, leading to more frequent cleaning, more abrasion, and higher remedial conservation costs. The reduction in hours of closure for cleaning increases risks of accidental damage and neglect, pressurizes small cleaning teams, and threatens the economic viability and sustainability of part-time employment.

To break free of the vicious circle, properties need increased funding for preventive conservation, to invest in more effective methods of protection against dust, and more staff time for housekeeping. More effective management of dust might allow the cycles for professional conservation treatment of painted surfaces and textiles to be extended, from 25 to 50 years, or 50 to 100 years, thus halving the annual average cost per object and reducing the concomitant damage.

Economic decisions to increase visitor numbers or hours of opening must take account of additional resources and time needed for housekeeping measures. Using data from National Trust properties to monitor and control relative humidity, light, visitor wear and soiling, the annual preventive conservation budget for an average house should be roughly £40,000, of which 75 per cent is for cleaning time, 10 per cent for conservation heating fuel, and 15 per cent for cleaning and protective equipment.

These costs work out at between £1 and £2 per visitor, depending on the fragility of the house and its capacity for access. However, for charitable organizations supported by membership subscriptions, whose members receive free access to historic properties, increasing the credit each property receives by this amount, for an average three member visits per year, would result in a reduction in funds available for other essential work such as building repairs. An increase in annual subscriptions to cover these costs might cause members to resign.

Conclusion

This work clearly has implications for remedial and preventive conservation, as discussed above. The study shows that there are clear mechanisms for bonding dust to surfaces, including high and fluctuating RH, the presence of sugars and soluble salts, and bio-deterioration. The results also suggest ways to manage dust by targeting cleaning resources to areas of maximum exposure and high humidity. From the point of view of both visitors and curators, the presentation of a historic house requires better communication between conservators, house staff and volunteers. The study revealed a desire for standards to guide dust management, which may be more effectively guided by conservation and presentation criteria, rather than variable visitor perceptions of historic interiors often driven by other concerns. The wealth of information gathered during this project shows that dust, although humble, informs every aspect of historic house management.

The conclusions of this research will be debated at a 'Dust To Dust' seminar in 2005 and presented at The Hague in September.

Acknowledgements

We are grateful to the partnership members for their contributions to this work: Kate Frame, David Howell, Sophie Julien-Lees and Barry Knight. Thanks are also due to staff, volunteers and visitors at National Trust, English Heritage and Historic Royal Palaces properties, who participated in surveys and focus groups, and answered questionnaires.

References

- Hardymont, C, 2000, *The Housekeeping Book of Susannah Whatman*, London, National Trust.
- Lithgow, K, Brimblecombe, P, Knight, B and Julien, S, 2003, 'Visitor perceptions of dustiness', *Presentation Abstracts and Additional Notes from the 5th meeting of the Indoor Air Pollution Working Group: Indoor Air Quality in Museums and Historic Properties, University of East Anglia, 28-29 April 2003*, published on-line at <http://iaq.dk/iap.htm>.
- Lithgow, K and Brimblecombe, P, 2003, 'Dust, the visitors' point of view', *Views* 39, 47-49.
- Lithgow, K and Brimblecombe, P, 2004, 'Conservation assistants and room stewards focus on dust', *Views* 41, 22-25.
- Lloyd, H and Brimblecombe, P, 2003, 'Focussing on dust', *Views* 39, 49-52.
- Lloyd, H, Lithgow, K, Brimblecombe, P, Yoon, Y H, Frame, K and Knight, B, 2002, 'The effects of visitor activity on dust in historic collections', *The Conservator* 26, 72-84.
- Lloyd, H, Brimblecombe, P and Lithgow, K, 2004, 'The economics of dust', *Studies in Conservation*
- Tarnowski, A, McNamara, C, Bearce, K and Mitchell, R, 2004, 'Sticky microbes and dust on objects in historic houses' presented at 32nd Annual Meeting of AIC, June 2004, Portland, Oregon, in press.
- Yoon, Y H and Brimblecombe, P, 2000a, 'Contribution of dust at floor level to particle deposit within the Sainsbury Centre for Visual Arts', *Studies in Conservation* 45, 127-137.
- Yoon, Y H and Brimblecombe, P, 2000b, 'Dust monitoring at Felbrigg Hall', *Views* 32, 31-32.