

The recent experiences & future needs of users of exhibit enclosures for local environmental control of indoor cultural heritage collections

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AND ARCHAEOLOGY" CONFERENCE,
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Thank you Scott, and good afternoon everyone.

Today I'll be highlighting the major findings from an international survey of people who aim to preserve heritage collections displayed in glazed enclosures.

I'll show you some of the types of microclimatic control that users of showcases and glazed frames are deploying in heritage institutions in the Western world.

And I'll summarise for you the perceived effectiveness of the equipment and the efforts made by these enclosure users.

The inefficiencies and regularity of side-effects encountered will also be outlined... as well as the problems users most want resolved for the future.

But first, here's a little background on exhibit enclosure environments for conserving tangible heritage collections...

“ THE SHOW-CASE COULD
BE THE GREATEST SINGLE
AID TO CONSERVATION ”

Tim Padfield

Design of museum show-cases,
London Conference on Museum Climatology,
18-23 September 1967



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So... THE SHOW-CASE COULD BE THE GREATEST SINGLE AID TO CONSERVATION !!!

While at first this might seem like a big claim, exhibit enclosures have long been used for safeguarding heritage collections against dramatic events such as fire, vandalism and theft. Also, exhibit enclosures are invaluable for safeguarding against more routine environmental threats like fluctuating & extreme temperature, humidity, light & airborne pollution.

For improved conservation of enclosed exhibits and to move-ever closer towards achieving this claim, I aim to demonstrate to you during this presentation that there is room for improvement for some of the most basic and therefore most popular enclosure strategies already in use.

Through taking such an approach, we are likely to make the greatest possible contribution towards conserving indoor heritage collections from routine environmental deterioration.

But how do we embark on such a journey...?

Background: IIC & ICOM-CC environmental guidelines

2014 declaration of daily & yearly temperature & relative humidity (RH) spans

Enclosures for local control of environmentally sensitive, or loaned, exhibits



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Well, it might be that 10 months ago we unwittingly took the first step of that journey when various existing "interim" guidelines for collecting institutions were declared as no longer being interim.

Some see this relaxation of daily & yearly temperature & RH spans as posing unnecessary risks to heritage collections; all while achieving minor reductions in energy consumption. Others see that the heritage conservation field is maturing.

Regardless of your position in this debate, the Declaration & other recent guidance (PAS 198:2012) point collections managers towards using enclosures for local environmental control of the more sensitive materials that won't tolerate these changes.

These recent shifts in environmental policy actually increase our reliance on exhibit enclosures as vital tools within the heritage conservation tool-chest.

But are our exhibit enclosures up for the task?

Prior works

Research exists for enclosure issues & performance:

- McIntyre 1934, Padfield 1966, Thomson 1977, Cassar & Martin 1994, Michalski 1994, Hatchfield 2002, Thickett 2004, Calver 2005...



Challenges still arise for enclosure users:

- Bacon & Martin 2000, Watts *et al.* 2007, Ganiaris *et al.* 2015



OUT OF AFRICA! DISPLAY CASE STRATEGIES — THE THEORY AND THE REALITY
Louise Bacon and Graham Martin

MUSEUM SHOWCASES: SPECIFICATION AND REALITY, COSTS AND BENEFITS
SIOBHAN WATTS, DAVID CROMBIE, SONIA JONES AND SALLY ANN YATES

Hazing of display case glass: A review of recent work
H. Ganiaris, J. Readman, R. Payton, Hakimah Aziz and D. S. McPhail



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Well... there is already a significant body of research on the critical issues & performance of exhibit enclosures.

Even so, challenges arise for enclosure users... as can be gathered from the titles of these case studies:

[On screen rotation of titles from:

- Ganiaris, H., Readman, J., Payton, R., Aziz, H., McPhail, D. (2015) "Hazing of display case glass: A review of recent work", Glass deterioration Colloquium – Extended Abstracts. State Academy of Art and Design Stuttgart 20-21 February 2015. G. Eggert, A. Fischer (eds.). pp. 65-66
- Bacon, L., Martin, G. (2000) "Out of Africa! Display case strategies – the theory and the reality", Tradition and innovation: advances in conservation: contributions to the Melbourne Congress, 10-14 October 2000, pp. 18-23
- Watts, S., Crombie, D., Jones, S., Yates, S. A. (2007) "Museum showcases : specification and reality costs and benefits", Museum Microclimates, Copenhagen, November 2007. T. Padfield & K. Borchersen (eds.) National Museum of Denmark 2007. pp. 253-260]

And here to the right we can see hazing on enclosure glazing; a particularly problematic phenomenon which has become increasingly apparent in recent years.

... but why a user survey?

Gather many recent experiences from enclosure users so we can:

- establish current problems & trends in behaviour
- learn from the user-experience
- develop networks & a common basis for research & collaboration



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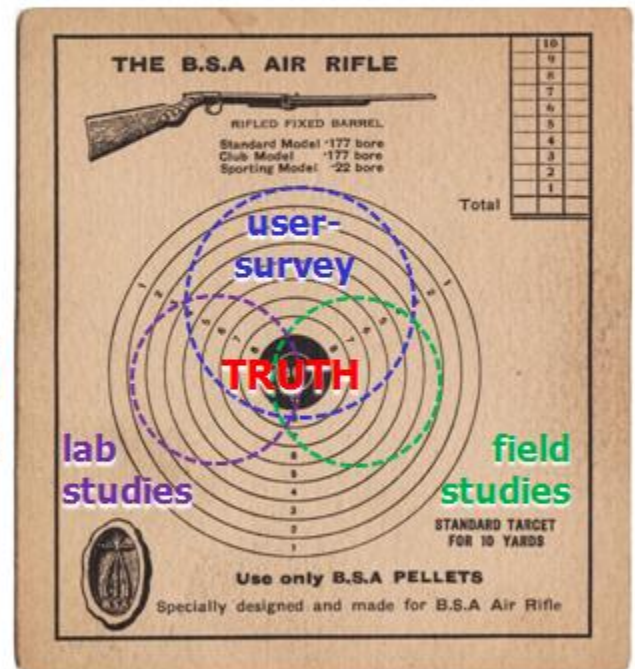
By launching a user survey I hoped to collate the recent experiences from enclosure users so we can establish current enclosure problems & trends in user behaviour, learn from the user-experience and develop research collaborations

Survey method: limits & complementarity

Survey measures:

- “typical” or average scenarios
- subjective: attitudes & behaviour
- coarse metrics (low-resolution)

... to complement the few & focussed field & laboratory studies



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Of course the survey method has its limitations since it measures typical scenarios and subjective parameters. And it uses coarse metrics.

Nonetheless, by using greater numbers of study subjects - meaning multitudes of enclosures and their users - the target is to complement the few & focussed field and lab studies

Survey format

Online 

English only

Quantitative:

- ordinal & interval scales
- compulsory lists, check boxes & radio buttons

Qualitative:

- optional free-text fields

20 – 30 mins duration



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So the survey itself was online and in English only.

It asked compulsory quantitative questions & optional qualitative questions.

It was a detailed survey – taking about 30 minutes to complete.

Survey dissemination

For people with **experience controlling environments** inside exhibit enclosures:

- conservation staff, registrars, curators, volunteers...

Dissemination online via:

- personalised emails to contacts & meeting delegates
- distribution lists
- blogs & social media for interest groups & peak bodies



- display case manufacturers to pass survey onto clients



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I targeted people actually having experience with controlling environments for exhibits using enclosures:


And I disseminated the survey in various ways:

- like 300 personalised emails
- on distribution lists
- via blogs & social media
- and via display case manufacturers so they could forward the survey onto their clientele

Survey response

1100 visits to survey in 20 days = 55 daily visits 

94 surveys submitted  = 9% completion rate 

4 exclusions (not users) = 96% eligibility rate 

- 1 x scientist & 2 x enclosure manufacturers
- 1 x spoiler



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So, the survey had over 1000 visits to its webpage in 20 days.

This resulted in a 9% survey completion rate and 90 valid submissions.

Respondent background

Majority experienced users:

- 40% have 3 – 10 years experience; 32% 11 – 30 years

Majority very recent users:

- ≥50% used during the last 13 years; >75% in last 5 years

Majority in conservation roles:

- 66% conservator-restorers & preventive conservators
- 17% conservation scientists

Majority experience from Western countries:

- 56% Anglophone countries; 42% continental European countries



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The majority of respondents were experienced users:

- 40% have 3 – 10 years experience; while 32% have 11 – 30 years

The majority were very recent users:

- ≥50% controlled enclosure environments during the last 13 years; while >75% had done so in the last 5 years

The majority were in conservation roles:

- 66% conservator-restorers & preventive conservators
- 17% conservation scientists
- however, only 1 volunteer participated in the survey.

The survey respondents were almost entirely from Western countries.

Survey results highlights

- Enclosure sizes & types
- Pollution
- Relative humidity
- Temperature
- Airtightness
- Mathematical modelling
- User-specified problems



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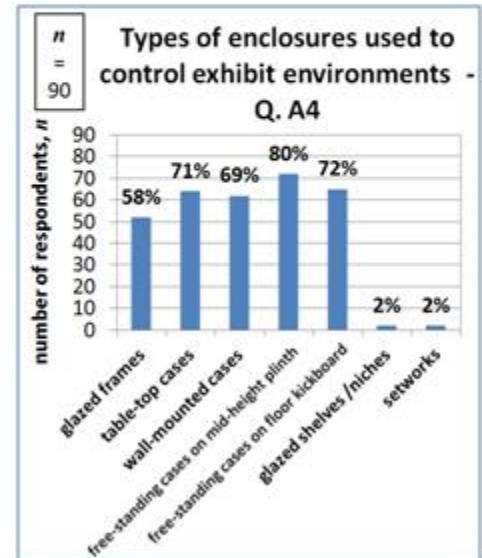
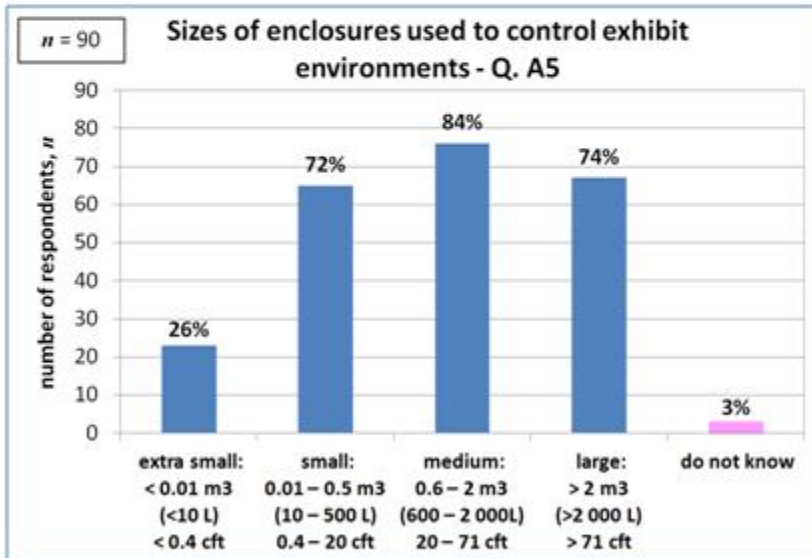
For the survey's results, I'll highlight parts on each of the following topics.

In addition to the sizes and types of enclosures, issues about preventing internal pollution, controlling RH and temperature will be covered.

Some aspects of enclosure airtightness and modelling will also be given.

Enclosure sizes & types

Medium-sized (600–2 000 L) cases & free-standing cases on floor kickboards are marginally used most: 84% & 80%



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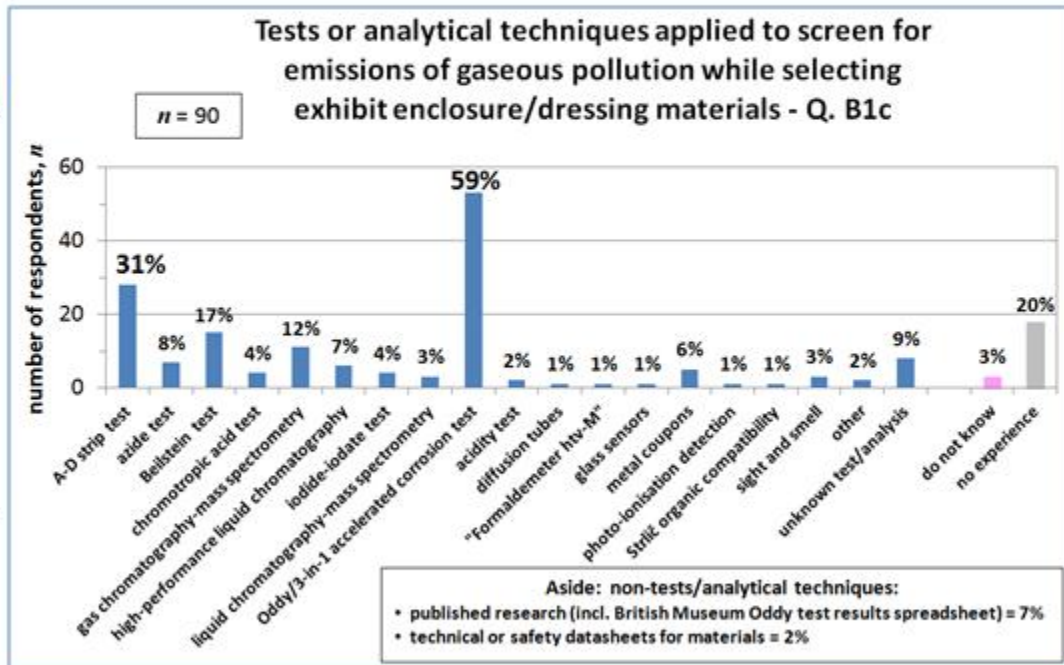
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So, besides glazed frames and enclosures smaller than 10 litres, it can be seen here that there is similar exploitation of the other enclosure types and sizes.

Pollution: internal sources

- 59% use Oddy test to screen for emissions from exhibit enclosure/dressings

- 31% use A-D strip tests



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To screen for pollution emitted from new exhibit enclosure materials, most enclosure users apply the Oddy test and A-D test strips.

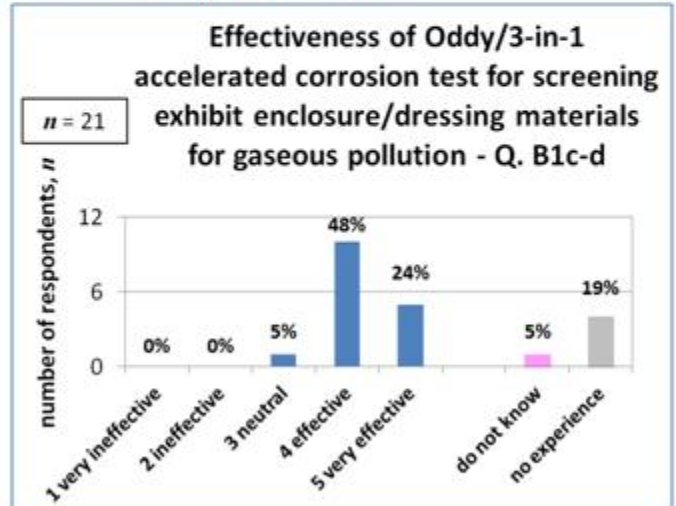
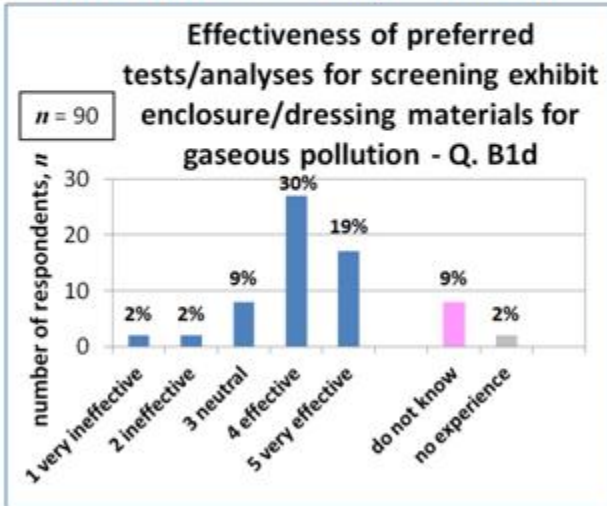
It is notable that these popular methods are inexpensive when compared with various spectroscopic and chromatographic analyses.

Even so, some survey respondents wanted to highlight that their research into material choice is limited to referring to technical data sheets and to the British Museum's Oddy and pH tests, which recently became available online.

Pollution: internal sources

49% of respondents find their preferred screening tests “effective” or “very effective”

72% of respondents only using the Oddy test find it “effective” or “very effective”



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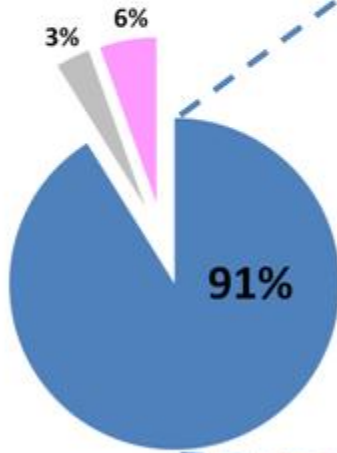
In terms of the effectiveness of the various tests applied to screen for pollution emissions, about half find them effective. However, almost 10% gave them a neutral rating.

In contrast, for those respondents who only use Oddy-tests, almost three-quarters find them “effective” or “very effective” – an endorsement, but with potential for improvement.

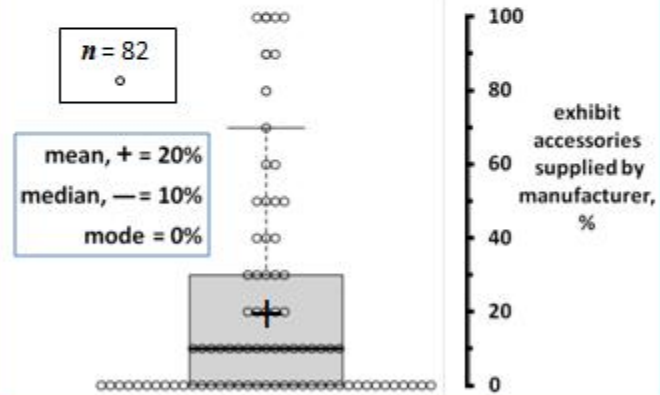
Pollution: internal sources

On average, manufacturer only supplies 20% of exhibit accessories; leaving 80% to non-manufacturers to test for exhibit compatibility

Experience with exhibit accessories* supplied by manufacturer of enclosures – Q. B1b



Proportion of exhibit accessories* supplied by manufacturer of enclosures – Q. B1b



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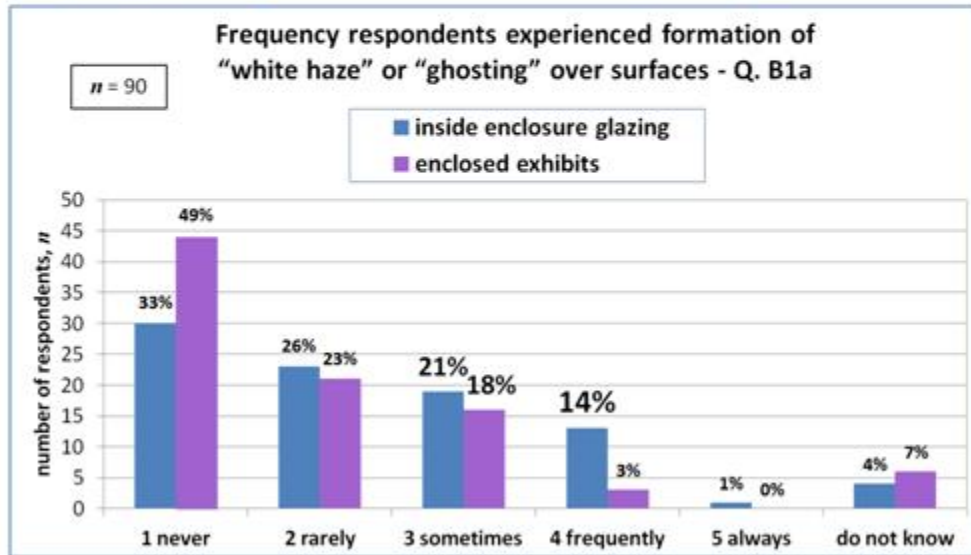
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But where are these enclosure dressings and exhibit accessories with potential for pollution coming from anyway?

Well, on average only 20% are coming from enclosure manufacturers. This leaves a significant proportion to check for exhibit compatibility – this checking will most likely be undertaken by the already over-stretched and under-resourced collecting institution.

Pollution: internal sources

14% report white haze as “frequently” occurring on glazing ≈20% report it occurring “sometimes” on glazing or exhibits



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Enclosure users were also asked how often hazing occurs: not only on enclosure glazing, but also on exhibits themselves - an additional aspect often neglected by the literature.

Fortunately, for a large minority of users hazing never occurs.

However, 14% reported haze as “frequently” occurring on glazing.... and about 20% reported it occurring “sometimes” on glazing or exhibits.

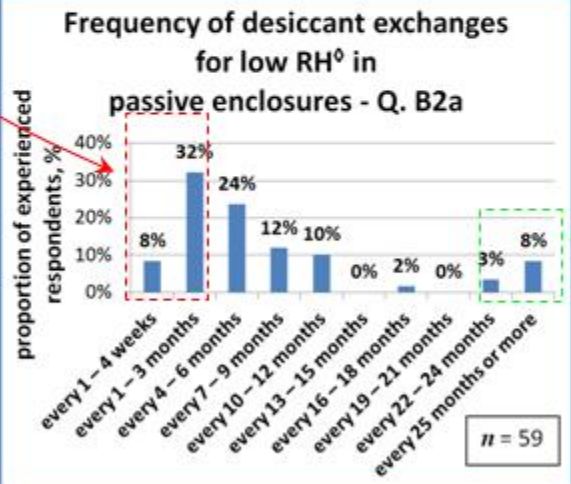
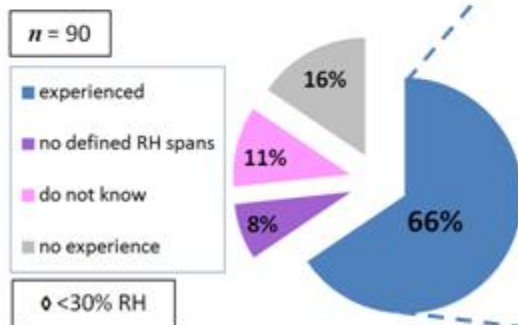
With the respondents’ permissions, they will have the opportunity to expand on their experiences with a researcher who is investigating hazing.

Relative humidity: drying air

66% experienced with using desiccants in low-RH enclosures with unforced air circulation

To maintain <30% RH, 40% of users exchange desiccant every 3 months, or more often

Experience with desiccant exchanges for low RH^o in passive enclosures - Q. B2a



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So moving on now to controlling relative humidity...

Two-thirds of respondents, use desiccants inside passive cases; meaning those with natural internal air circulation.

To give you some context, this type of environment is often applied to slow corrosion of archaeological metals contaminated with salts.

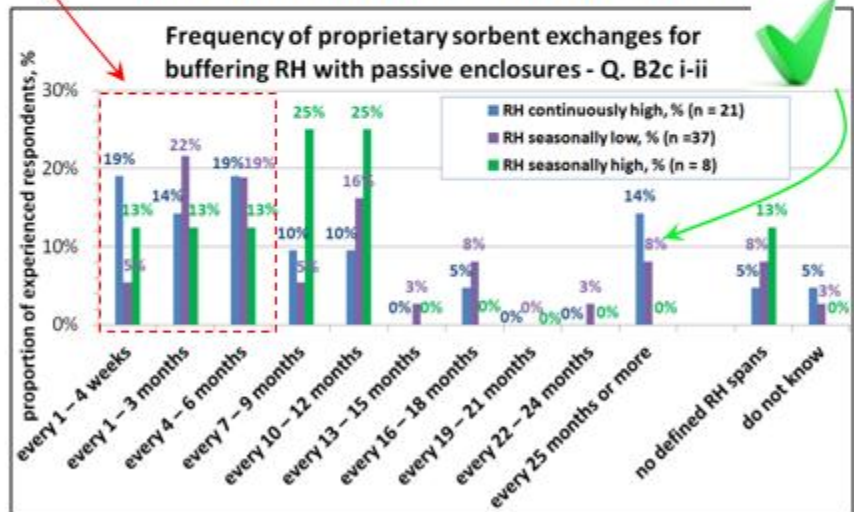
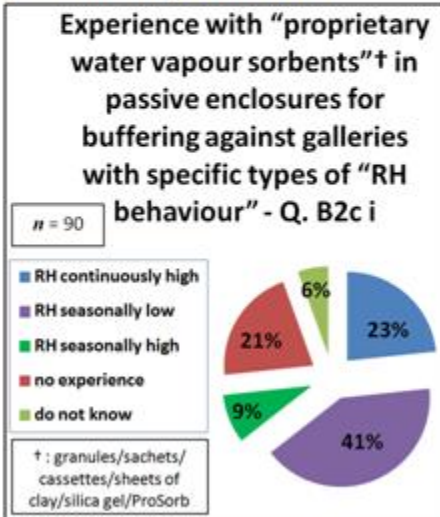
However, to maintain RH below 30%, some 40% of users have to exchange these desiccants every 3 months, or even more often. There is definitely room for improving the efficiency of these enclosures.

Drying and exchanging desiccants is such a labour intensive process, that two respondents reported that they are forced to exchange desiccants only when staff resources permit.

Relative humidity: buffering air

41% use proprietary sorbents to buffer against seasonally low RH

39-52% of users need to replace sorbents within 6 months or less to maintain suitable RH for exhibits

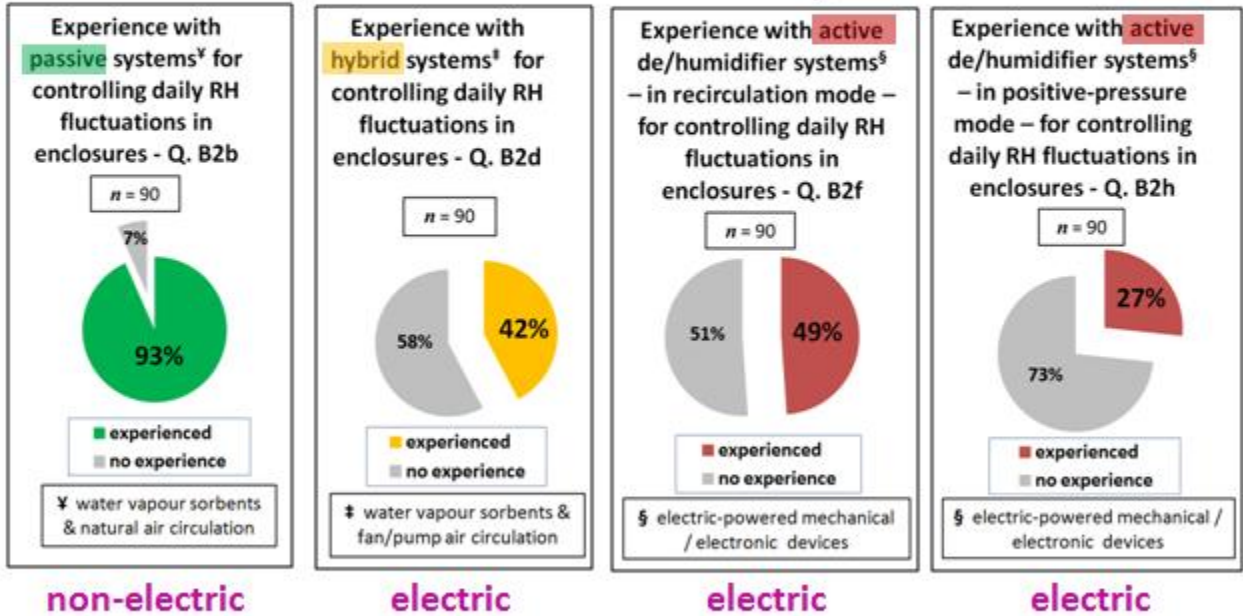


For influencing relative humidity to ranges suitable for many organic exhibits, 41% use proprietary sorbents to buffer against seasonally low RH, while 23% buffer against continuously high RH.

However, 39-52% of users need to replace their sorbents within 6 months or less to maintain suitable RH for exhibits.

It seems we are a long way from the utopia envisaged by Garry Thomson, who gave us detailed plans on how to move towards "simple, cheap and maintenance-free control of the atmosphere within museum exhibition cases" (Thomson 1977).

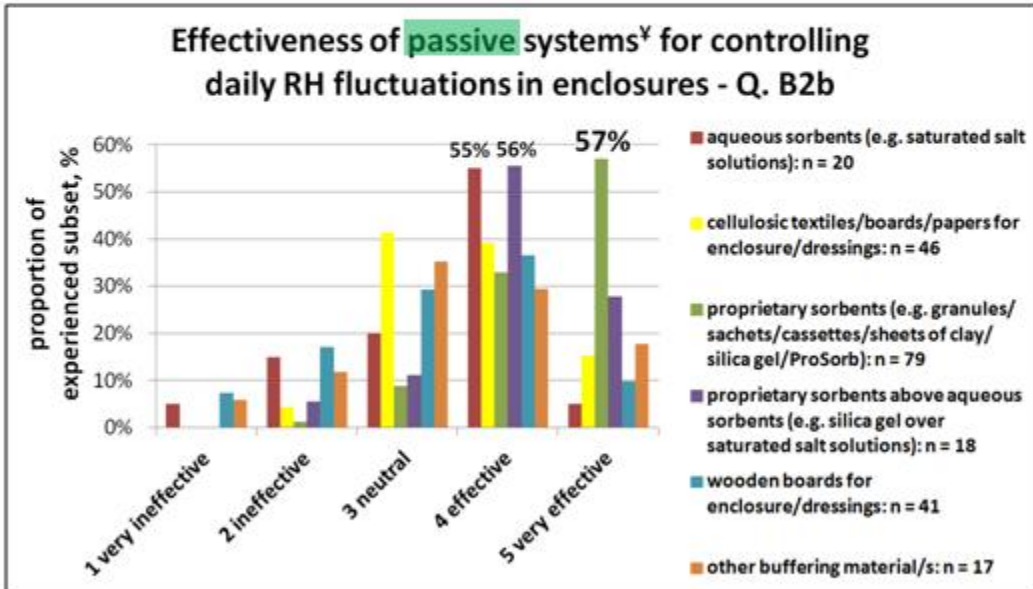
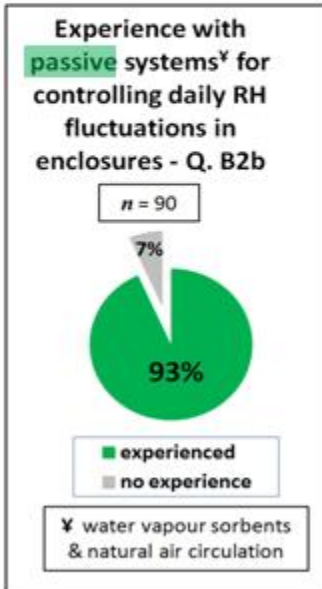
Relative humidity: passive, active & passive-active systems



Here I simply wish to highlight the unsurprising yet significantly greater exploitation of enclosures with passive RH control, when compared with those using electricity.

It is of course by no coincidence that the simpler the environmental conditioning system, the greater its popularity.

Relative humidity: passive systems



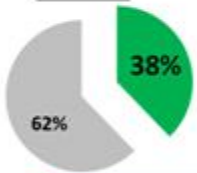
And if we look a little closer at the users' ratings of the effectiveness of particular passive systems for controlling daily RH fluctuations, then we find that use of proprietary sorbents is not only most popular (n = 79), but they are also mostly considered "very effective".

In contrast, the effectiveness of the remaining RH buffering methods are clustered around the "effective" rating.

Temperature: passive systems

Experience with passively stabilising* daily temperature fluctuations in enclosures - Q. B3a

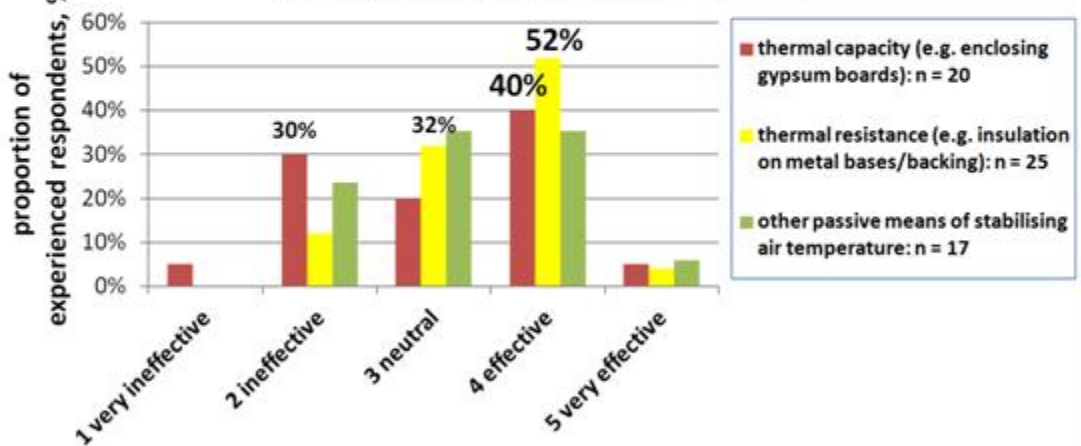
n = 90



■ experienced
■ no experience

* increasing thermal capacity or resistance

Effectiveness of passively stabilising* daily temperature fluctuations in enclosures - Q. B3a



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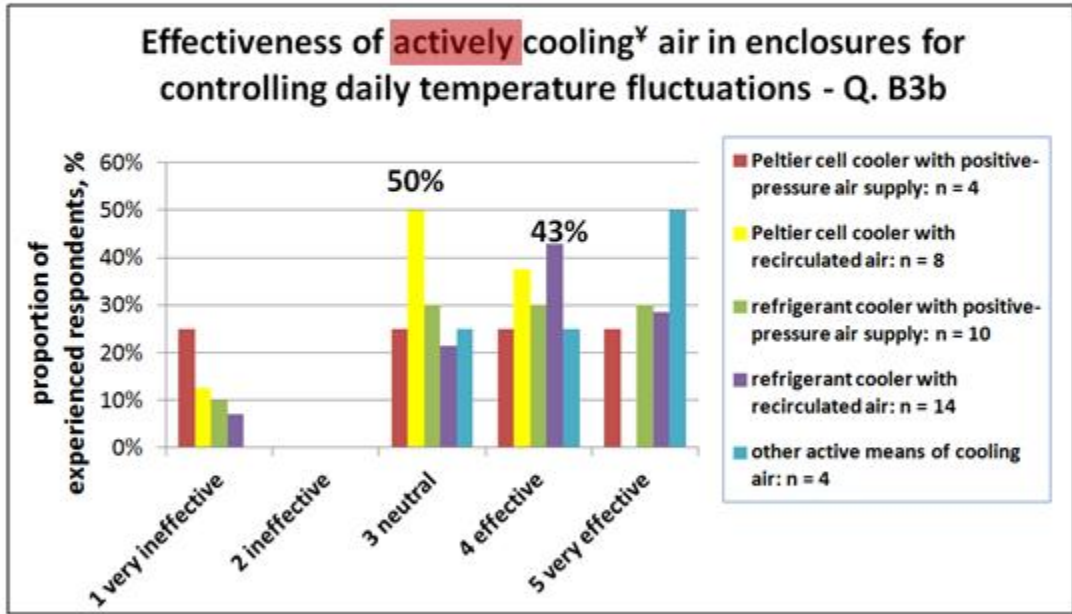
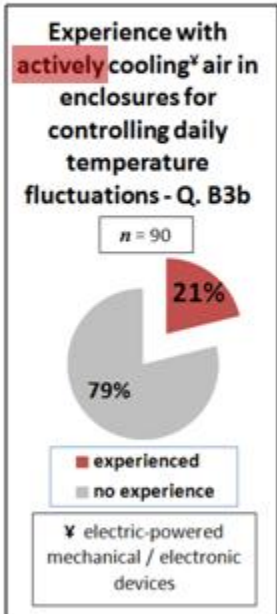
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While it is largely recognised by the field that exhibit enclosures tend to follow ambient temperature (or just above) with a minor lag in time, it appears that a minority of users are attempting to influence the thermal properties of enclosures, if only to limited effect.

It could be that they are doing this to slow the rate of temperature change rather than its magnitude; not forgetting the strong dependence of relative humidity on temperature.

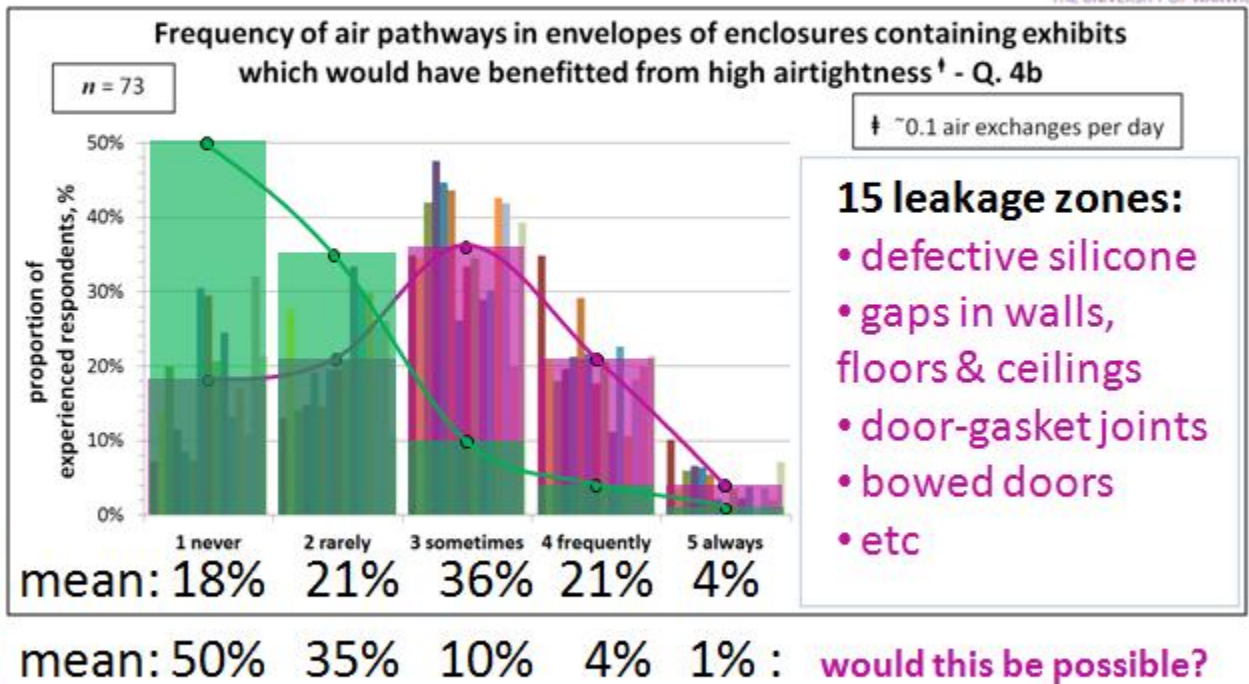
Temperature: active systems



It can be seen here that active systems which cool enclosure air are used by a minority.

As a result, the population numbers for the effectiveness ratings are too low to confidently draw conclusions between the differing types of coolers in use.

Airtightness: gaps & leaks



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So onto airtightness...

Survey participants were first asked to consider exhibits that would have benefitted from enclosures with high airtightness... Then, they were asked to nominate how frequently particular zones of enclosures featured gaps or leaks.

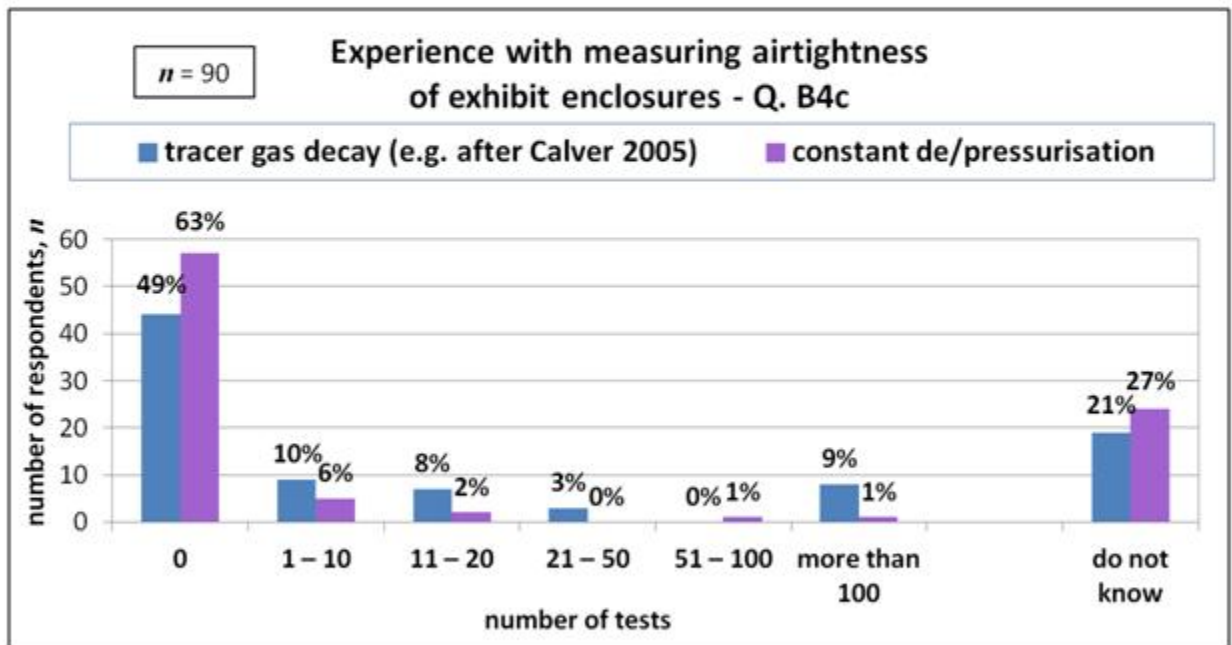
And this is what we found....

To save you straining your eyes, I ask you to look at the global trends in frequency of gaps, rather than the individual scores for each of the 15 leakage zones.

(magenta) With the encouraging exception of a slight bias of the distribution towards "never" (18%), it is clear that these zones could have gaps prevented or plugged more often.

I wonder if we could move towards this kind of trend...? (green) ... a far more desirable state for enclosures containing exhibits benefitting from high airtightness.

Airtightness: measurement



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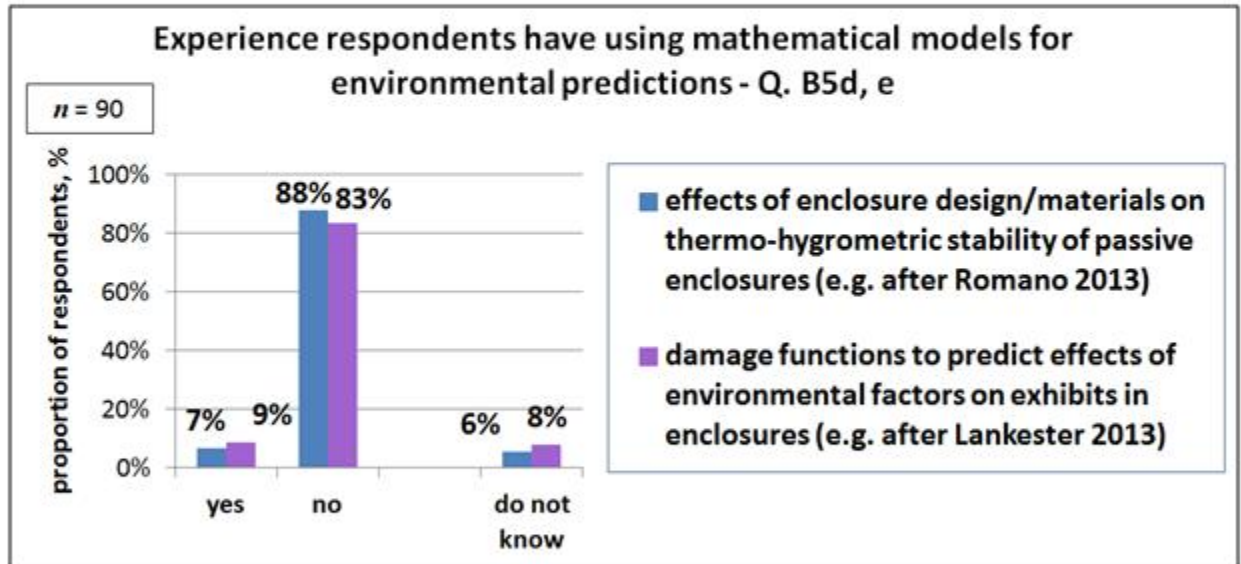
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Although, the importance of the air exchange rate on performance of enclosures and the conservation of enclosed exhibits has been emphasised by the literature (Thickett 2006), it appears from these results that these two types of airtightness measurements are not very popular.

The reasons for this low-uptake of airtightness testing will be reported in a forthcoming paper.

Mathematical modelling: environmental effects



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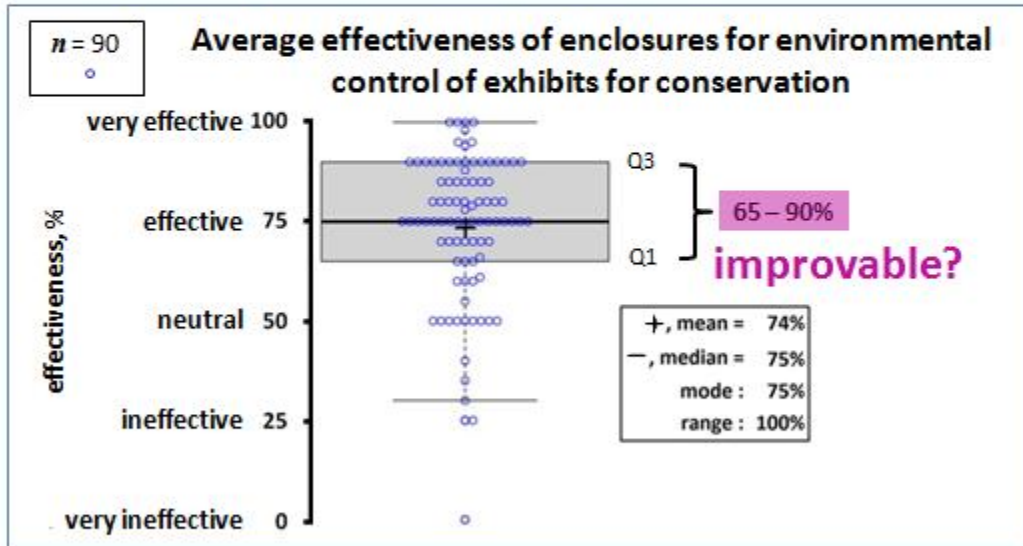
As research activity into forecasting with the use of mathematical models grows, I thought it would be interesting to see whether case users might be using these advanced methods.

The result?

So far a low uptake for these particular procedures.

Summing up...

Mean effectiveness of enclosures for environmental control is 65 to 90%, for central half of scores.



In order to gain an indication of the overall effectiveness of enclosures used by the respondents, they were asked to consider the following:

“From your experiences over the last 20 years, state on average how effective enclosures were for environmentally controlling exhibits for conservation.”

For the central half of the scores, it can be seen that their effectiveness is between 65 and 90%.

Can we improve on this? Or have our capabilities reached their limit?

Time for change... enclosure users' single-most important needs

“Outline the single-most important feature of exhibit enclosures, or their manufacture, testing, use & maintenance that you feel needs changing for improved conservation of exhibits via improved local environmental control.”



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I'd like to finalise this presentation of the survey results with the needs of enclosure users; as expressed during the qualitative part of the survey.

The survey participants were asked to:

“Outline the single-most important feature of exhibit enclosures, or their manufacture, testing, use & maintenance that you feel needs changing for improved conservation of exhibits via improved local environmental control.”

It's safe to say that the list I will reveal is not news to those in the field. Of course they are the most persistent issues. Also, some are currently works-in-progress by various parties.

Nonetheless, the list should help any fresh & enterprising people who are interested in solving these old problems - perhaps by bringing new perspectives.

Enclosure users' single-most important needs

Standards... which are achievable with realistic budget constraints & using commercially available materials

Collaboration... case manufacturers willing to work with you

Procedures... robust risk assessment and mitigation methodologies to avoid "an awful lot of trouble and expense later on"

Material availability & choice... compatible/inert enclosure materials, at least for non-temporary enclosures.

Design & manufacture... properly designed & sealed display volume. Precise materials and methods of manufacture to be gap-free. Simple accessibility and reproducible sealing of cases, but with doors that do not drop or bow.

Air exchange testing... during manufacture and after installation, & its wider use for new case specification

Internal circulation... improved circulation between sorbent & exhibit compartments, while satisfying aesthetic concerns

Standards... which are achievable with realistic budget constraints & using commercially available materials

Collaboration... case manufacturers willing to work with you

Procedures... robust risk assessment and mitigation methodologies to avoid "an awful lot of trouble and expense later on" (see Memori's decision-making flowchart: <http://memori.nilu.no/Additional#References>)

Material availability & choice... compatible (or inert) enclosure materials, at least for non-temporary enclosures

(incl. discontinued use of all particle boards & their replacement with an affordable and paintable material)

Design & manufacture... properly designed & sealed display volume; materials and methods of manufacture need to be precise enough to be gap free, simple accessibility and reproducible sealing of cases, but with doors that do not drop or bow

Airtightness testing... air exchange rate testing (during manufacture and after installation), and its wider use for new case specification

Internal circulation... improved circulation between sorbent & exhibit compartments, while satisfying aesthetic concerns

Survey conclusions & outlook

- From the users' perspective, there is room – on numerous fronts – for improvement of exhibit enclosures
- If we are going to place more heritage exhibits into the care of display cases, then resources need to be found to safely and efficiently achieve this...



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So in conclusion, from the users' perspective there is room – on numerous fronts – for improvement of local environmental control of exhibits through the use of enclosures

If we are going to place more heritage exhibits into display cases, then resources need to be found to safely and efficiently achieve this...

As a starting point, we need to fund investigations into optimising our existing low-tech procedures and equipment, which are available to the smaller collecting institutions.

“ IN OUR ENVIRONS I CAN SEE NO WAY OF IMPROVING OUR SITUATION GIVEN THE LEVEL OF TECHNOLOGY THAT IS WITHIN OUR FINANCIAL REACH ”

No. 63: the
Unknown Exhibit
Enclosure User

Collections manager/officer with 31 – 40 years experience of using exhibit enclosures in a United Kingdom archive, art gallery & museum with 50 001 – 100 000 annual visitors



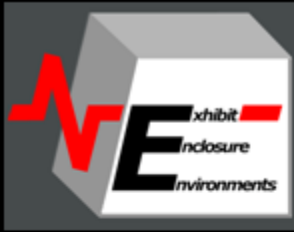
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On that note, I leave you with a quote from one survey respondent which highlights this financial imperative:

“In our environs I can see no way of improving our situation given the level of technology that is within our financial reach.”



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- SEAHA Organization Committee

Survey disseminators & respondents

Survey pilots:

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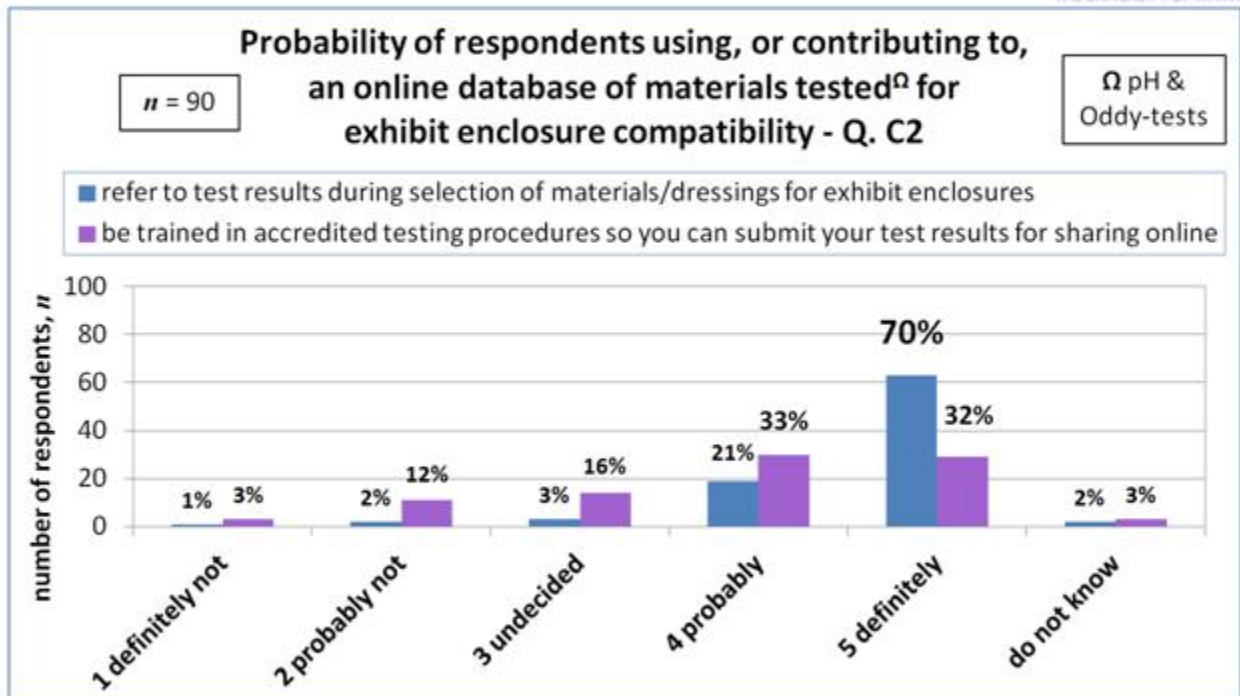
Presentation available via LinkedIn group: [Exhibit Enclosure Environments](#)



I'd like to thank and acknowledge the following people and organizations for their contributions to the survey and its presentation today.

And thanks to you in the audience for your time and attention.

... & looking forward



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One simple and economical way to immediately improve conservation of enclosed exhibits would be to reduce the introduction of new enclosure dressings and accessories which emit aggressive vapours. And as mentioned earlier, the British Museum now shares their spreadsheet of results for Oddy and pH tests.

To build upon this model, it is proposed that other collecting institutions in the United Kingdom and beyond also conduct tests for enclosure compatibility and share this information in an online database. In this way a more equitable "sharing economy" could be established.

70% of respondents said they would definitely use such a resource while selecting materials and dressings for enclosures.

While 32% of respondents said they would definitely like to be trained in testing procedures so they could share their results online.

The interest for such an initiative is clearly there, however the resources required to co-ordinate and sustain it over the long term would not be small and would require repeat investment from organisations who could most afford it and utilise this information. Some such organisations might include the Bizot Group of lending institutions, other large museums and display case manufacturers...



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