Light Fading of the Painted Deck of *Australia II* in a Museum Environment

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Abstract

The long-term loan of Australia II to the Australian National Maritime Museum predicated a detailed condition report on the spruced up vessel prior to its transport from Perth to Sydney. Since the deck of the vessel had been subjected to several repainting episodes, it was deemed prudent to measure the colour of the areas with a chromameter, since it is virtually impossible to measure subtle changes in colour over prolonged periods without the aid of such devices. Results were obtained from a study of the colour changes to the green deck surfaces eight years after the vessel was placed on exhibition under standard museum exhibition conditions. After up to 3.34 million lux hours, there is significant colour change in the newer painted regions and minimal change in the older original painted areas.

Introduction

The America's Cup remained unclaimed by a foreign nation for a period of 126 years until the Bond syndicate, with the yacht *Australia II*, took the pride of the United States away when the ***auld mug*** was unbolted from its stand in the New York Yacht Club in Newport, Rhode Island in the United States of America. This event took place in 1983. The famous winged-keel, designed by the late Ben Lexcen, is believed to have been a major contributing factor to the success of the racing campaign. In 1985, the yacht with associated material was bought for $2,000,000 by the Australian Federal Government and accessioned into the National Historical Collection, managed by the fledgling National Museum of Australia. Since there was no public exhibition area available to the National Museum in which to exhibit the prized yacht, it was decided to return it to Western Australia to the Western Australian Museum. The vessel remained in Western Australia on loan where it was exhibited, unrigged, at the Historic Boats Museum at B Shed on Victoria Quay in Fremantle until early 1991. The vessel was sailed on at least two occasions during this period and sustained damage in a collision when racing off Fremantle in 1986 and during a Bicentennial race in January 1988. Also during this time the vessel was fully documented and underwent extensive conservation treatment for corrosion and other damage. The details of the work program, supervised by Maritime History curator Sally May, have been recorded and kept along with all the documentation of the conservation work undertaken by the builder of the boat, Steve Ward. Prior to this restoration program, the conservation staff at the Western Australian Museum had noted internal corrosion problems in the aluminium-magnesium alloy hull plates of the vessel. Localised pitting corrosion was so severe that bubbles of hydrogen gas, confirmed by a flame "pop" test, were clearly discernible during a condition inspection of the areas beneath the floorboards.

The detailed treatment of the interior of the hull has been previously reported (MacLeod & Kelly 2001). Analysis of the wastewater trapped above the drain point in the bilges confirmed that it was a mixture of concentrated seawater and the breakdown products of human waste. The combination of the organic acids and the high concentration of chlorides had proven a bad brew for the corrosion resistance of the hull. Salt-water penetration of defects in the exterior coating of the hull plates caused some blistering of the paint and eventual delamination of some sections of the glossy white surface. During conservation inspection of the vessel after treatment to repassivate the exposed bare metal sections inside the yacht, it was decided to conduct a series of colour measurements on the deck. These painted areas were clearly a mixture of old and new green paint, with and without the crushed walnut shells, which had been added to the paint as an anti-skid surface. The colour measurements were done in 1990, using a CR 122 chromameter, as part of the routine documentation of surfaces deemed to be at risk from potential light damage. Details of the inspection and measurements are shown in Figures 1–4, however, time did not permit any photography during the 1999 measurements.

Figure 1. Colour measurements in 1990 by the forward hatch covers, showing newly painted surfaces being recorded by David Gilroy. Photo Ian MacLeod

With the establishment of the Australian National Maritime Museum (ANMM) in Darling Harbour, the Federal Government decreed that *Australia II* should be housed in Sydney. It was prepared for travel by Western Australian Museum staff in Fremantle assisted by the boat's original builder Steve Ward and his team. It was then shipped to Sydney in January 1991 by Wilhelmsen Lines, as a sponsorship to the National Maritime Museum. The vessel was covered with a tarpaulin in the period between leaving Western Australia and its installation in the ANMM's Leisure Gallery in June 1991. It was then inspected and cleaned before being fully rigged by Ken Beashel. The deck was again covered until the opening of the ANMM in late November 1991.

Exhibition Environment

The Leisure Gallery is ten storeys high and was designed by architect Philip Cox to accommodate *Australia II,* which was displayed on a purpose-built support at an angle of 8° from the vertical plane. Virtually the entire north wall of the gallery comprises 6mm thick Pilkington ACI Safety Glass (MAN AS

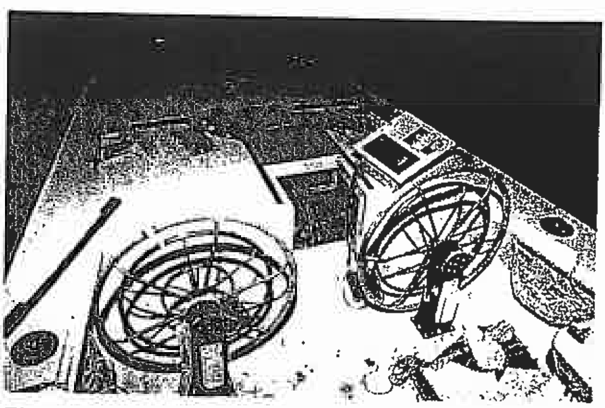

Figure 3. Cockpit showing touch up areas on the starboard side and chemically bleached zone on the floor of the cockpit. Photo D. Gilroy

Figure 2. David Gilroy measuring the colour of the old deck paint near the mast and by the running track. Photo Ian MacLeod

2208, Licence No 52) which is grey and filters out 53% of total solar heat, thereby reducing visible light transmission, but has no specific ultraviolet absorbing properties. Electrically operated louvred blinds which remain permanently closed, but which emit a small amount of diffuse natural light during daylight hours cover the glass. The gallery is artificially lit during opening hours 363 days a year and during as many as

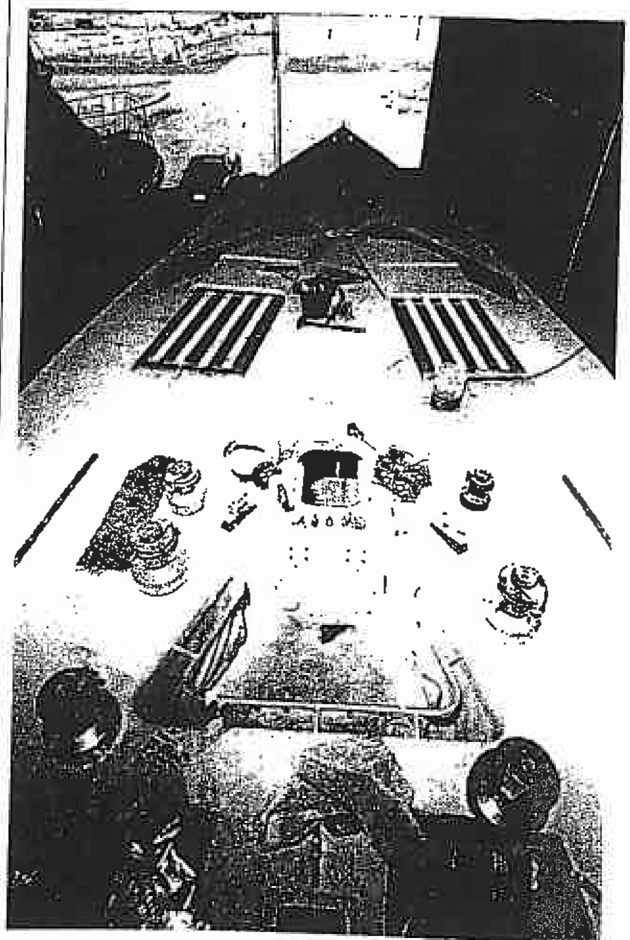

Figure 4. Overall view of the patched colour of the forward section of the vessel during conservation treatment works in 1990. Photo D Gilroy

334 evening functions in a year. Six 1000 Watt mercury vapour lamps reflected off the ceiling provide the main source of light. The cost of electricity consumption associated with these high UV emitting light sources may have been a factor in the adoption of such light sources. Additional lighting includes two 150 Watt metal-halide pro-lights directed down the sails from above the mast, two 150 Watt metal-halide ripple-effect pro-lights directed onto the underside of the hull, and two 150 Watt metal-halide Fresnel fittings – medium zoom with an oval-shaped beam spread – directed onto the sides of the keel. During an average day, ultraviolet radiation on the deck – measured using a Crawford UV Monitor Type 760 in conjunction with a Minolta Illuminance Meter T-1 – ranges from less than 1,600 $\mu watt.m^{-2}$ for most areas to a maximum of 6,400 $\mu watt.m^{-2}$ on the stern. Light levels throughout a typical day vary from typical minima of 32-46 lux under artificial light to maxima of between 53-128 lux when the sun falls directly on the Gallery's north wall.

During the ***Creative Nation*** statement of Government cultural policy by then Prime Minister Paul Keating, it was announced that the Commonwealth "will offer to return the yacht *Australia II* to the Fremantle community". This offer was accepted by Western Australia in January 1995 and the handover was set to coincide with the completion of the new Western Australian Maritime Museum building in late 1998. Subsequently the Chairman of the Australian National Maritime Museum, Miss Kay Cottee, successfully negotiated to delay the vessel's return until after the completion of the Olympic Games held in Sydney in September 2000. The Premier of Western Australia, Richard Court, announced that a new maritime museum would be built at Forrest Landing, Victoria Quay, Fremantle to house the yacht and the rest of the collection of the former Historic Boats Museum at B Shed. To that end, conservation staff have been involved in determining the final configuration of the exhibition gallery in which the vessel will be housed. A key determinant of the configuration of the building is the amount of light that would be shining upon the deck of the vessel. It was therefore decided to check on the amount of fading that the deck had received during eight years of exhibition at the Australian National Maritime Museum in Sydney.

Colour fading measurements

The issues of light damage to objects on exhibition are the bread and butter of conservation work in a large number of museums. Among the earliest attempts to quantify the effect of light on the fading of dyes and pigments was the work of the Scottish textile designer James Morton in 1902. He exposed textiles to light in his greenhouse and sent samples to his brother-in-law in the Punjab, India for exposure to expose the dyes to even stronger light (Duff 2001). In work since then, despite some excellent papers by Michalski (1997) and Derbyshire, there are few papers which quantitatively measure colour changes over a period of many years using chromameters.

Although the paper by Ford (1992) reported the colour changes during only a three month exhibition of textiles at the Australian National Gallery in Canberra, the fading data is relevant as the total amount of light is similar to the average exhibition conditions in the Leisure Gallery at the ANMM. Their conditions involved the use of unfiltered tungsten-halogen globes with average UV levels of below 5,700$\mu watt.m^{-2}$, which is similar to the amount of energy falling onto the deck of *Australia II* whilst it has been on exhibition. These works reflect what is happening under standard museum lighting conditions and are not subject to the interpretation of data associated with accelerated ageing (Pretzel 2000).

The 1999 colour measurements were made using a Minolta Chroma Meter, Model CR-200b, which is a tristimulus colour analyser featuring a 8 mm diameter measuring area, diffusely lit by a pulsed xenon arc lamp with detection via silica photocells filtered to match the CIE standard observer response. The **Lab** format of the colour provides a readout which gives:

- L values for the lightness (positive values) or darkness (negative values),
- a values that are positive for red and negative for green, and
- b values that are positive for yellow and negative for blue.

Since the **Lab** system of measurement most closely corresponds to the ability of the human eye to detect change, the instruments were calibrated with a white tile before measurements were conducted. The colour difference ΔE was calculated according to equation 1 in accordance with BS 1006:1978.

$$\Delta E_{CIELAB} = \{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2\}^{1/2} \longrightarrow 1$$

with ΔL^* = the lightness-darkness difference,
Δa^*= redness-greenness difference,
Δb^*= yellowness-blueness difference, and
ΔE_{CIELAB} (ΔE) is the calculated colour difference.

The surface of the vessel was measured in a number of locations that related to observed differences in the texture, i.e. rough with walnut shells or smooth without the shells, and to areas that had a different hue, owing to the fact that the areas had been previously patched with new paint. As far as possible, the regions of measurement corresponded to those that had been previously documented during the inspection in 1990.

In order to compare one set of measurements with another, the colour changes, measured in terms of the change in ΔE, are divided by the total illumination received in terms of millions of lux hours. The measured ranges on the deck give us a minimum exposure of 32 lux and a maximum exposure of 128 lux. Thus the ΔE values will vary by a factor of four between the ranges of light exposure. We have assumed that the deck has been exposed for ten hours per day for 365 days per year and for exactly eight years. This amounts to a total of somewhere between a minimum of 0.93 million lux hours (Mlux.hr) and a maximum of 3.34 Mlux.hr.

It should be noted that the surface areas had to be cleaned of the normal dust and grime associated with long-term exhibition of materials in open exhibition galleries. Despite the filters on the air-handling units in the ANMM, it takes only a few years before another high level general cleaning is required to restore the tonal qualities to the exhibition. Two areas on the deck were measured directly before the surfaces were cleaned. The measurements were repeated after cleaning the surfaces with a cloth, warm water containing a non-ionic detergent and then drying them with a lintless cloth. The data from these tests provided an indication of the true colour masking nature of the general dirt and dust that had been deposited on the deck of the yacht. Typical data that reflect the impact of the dust and grime on the apparent colour changes of the deck are summarised in Table 1.

Table 1. Effects of cleaning the deck, two metres aft of spinnaker lug hook, November 1999

Location	L*	a*	b*
Dusted, new light green	76.5 76.9 76.3	-7.9 -8.0 -7.8	13.5 13.1 13.2
Mean	**76.6 ± 0.3**	**-7.9 ± 0.1**	**13.2 ± 0.2**
Washed, new light green	76.9 77.0 76,9 77.4	-7.8 -7.9 -7.7 -7.9	12.8 12.6 12.7 12.4
Mean	**77.1 ± 0.2**	**-7.8 ± 0.1**	**12.6 ± 0.2**

From the differences in the L*a*b* values of the dusty and the washed surfaces, the colour difference associated with cleaning the surfaces can be calculated according to equation 1. This gives us a colour difference (ΔE) of 0.75 between the cleaned and the dirty surface. Similar colour measurements have been done on Aboriginal rock paintings at Walga Rock in Western Australia (MacLeod et al 1992). In this case, the removal of the local dusty covering layer changed the chroma of the rock surface by increasing the L* values by 4.9%, lowering the a* value (red) by 11.6% and had no effect on the b* values. These changes simply reflect the removal of the iron-rich dust from the surface, giving a ΔE value of 2.7 for the cleaning operation. In the same way, examination of the data in Table 1 shows that the cleaning of the deck on *Australia II* had the main effect of increasing the lightness reading L* by 0.5 and to decrease the blueness (b*) by 0.6 units. Since the colour of the dirt is grey-black, the changes in the b* value is not unexpected. There was no change in the red-green values of a*. In order to determine if this change is significant we need to look at the reproducibility of the individual sets of data from the output of the chromameter. The ΔE values associated with variations from measurements of the same spot are $\Delta E^{st.dev.}$ of 0.31 for triplicate/quadruplicate measurements of the dusty surfaces and $\Delta E^{st.dev.}$ of 0.33 for the washed surfaces. Since the colour difference between the two sets of measurements (ΔE 0.75) is greater than the sum of the ΔE values associated with the standard deviations (0.64), the colour difference can be deemed to be significant.

The data sets (Tables 1 & 2) collected with the CR-200b meter in 1999 are characterised by a low standard deviation associated with the mean of replicate measurements. This is primarily due to the large size – 8 mm diameter – of the meter's sensing head, as compared to the 3 mm diameter sensing head of the CR 122 meter used for the 1990 measurements. Since the CR-200b covers an area approximately 7.1 times that of the CR-122, it is less prone to sampling errors. This is reflected in the 1990 data shown in Table 3, which has higher standard deviations associated with the colour measurements. The larger head relates to general colour, rather than any point defects. Each measurement point consisted of a set of four or five readings. The smaller head on the CR 122 used in the initial measurements had been chosen for use in documenting colours of pigments and images on Australian rock art sites because of the small size of the

Table 2. 1999 colour measurements on new green deck paint.

Location	L*	a*	b*
Bow, 3.17 metres down on starboard side opposite black area and hook	77.05±0.26	-7.83±0.10	12.63±0.19
Port hatch cover near water break	79.93±0.29	-8.53±0.15	14.58±0.36
Starboard hatch cover near water break	79.63±0.55	-8.38±0.33	14.18±0.45
Port side near main mast winches	80.63±0.43	-7.85±0.25	13.68±0.44
Starboard side near main mast winches	77.80±0.84	-7.94±0.23	14.56±0.11
Forward of compass, starboard side	80.34±0.38	-7,88±0.31	13.92±0.50
Centre of stern, multiple areas	80.68±0.90	-8.34±0.30	14.42±0.66
Aft of small winch, fwd of compass port side **DUSTY**	80.73±0.25	-8.43±0.15	15.33±0.12
Aft of small winch, fwd of compass port side **WASHED**	81.55±0.24	-8.85±0.06	15.68±0.13
Mean of new washed green paint	**79.70**	**-8.20**	**14.21**

individual painted areas (MacLeod 2000).

The data listed in Table 2 were subjected to statistical analysis to see if there was any systematic difference in the colour of the deck between the matching points on the port and the starboard sides of the vessel. The individual variations down one side of the vessel were greater than the differences between the mean of the port and starboard values. However, when the colour measurements were plotted against the distance from the bow, the starboard data showed a systematic trend to increased L* values moving from the bow to the stern, while the b* value also increased. The port side showed a very strong correlation of increasing L* values with distance from the bow and the trend for b* was also the same as on the starboard side.

Analysis of the 31 sets of colour measurements performed in 1990 (Table 3) shows that the colour patterns fall into three main categories, namely that of old rough texture, new rough texture, new smooth painted areas as well as a single area where some chemical reaction between a spilled reagent, thinner etc had caused the green deck paint to bleach. The rough surfaces are those sections of the deck in which crushed walnut shells have been incorporated and the smooth areas relate to surface touch-ups post 1983 activities. The principal difference between the green coloured surfaces noted in 1990 was that the new areas of touch-up work had a deeper hue in the a* value (more green, i.e. negative a*) more intensity in the b* value (yellow for + b values) than the original deck treatments. This indicated that there had been some fading during service use and on exhibition. This is further supported by the increased L* value of the oldest surfaces compared with the newer paint. It should be noted that the same paint using the same pigments from the same manufacturer as the original materials used in the America's Cup Challenge was

Table 3. 1990 colour measurements on the deck of *Australia II*.

Area of investigation	L	a*	b*
Forward deck, old rough	79.81±0.67	-7.97±0.29	13.51±0.24
Rough texture, old paint	77.77±0.25	-8.23±0.4	14.64±0.17
Old rough paint	78.79±0.15	-8.80±0.11	15.61±0.23
Mean, old rough surface	**78.79±0.72**	**-8.33±0.40**	**14.58±0.68**
Rough new paint	75.92±0.30	-11.12±0.27	17.95±0.19
Rough new paint	77.96±0.63	-12.56±0.29	18.26±0.32
Mean, rough new paint	**76.94±1.44**	**-11.84±1.02**	**18.10±0.21**
New paint smooth	77.84±0.72	-12.63±0.33	18.85±1.67
Smooth surface, retouch	81.85±0.03	-10.34±0.18	15.43±0.81
New smooth surface	76.30±0.13	-13.61±0.20	21.45±0.25
Mean, smooth new paint	**77.20±3.76**	**-12.05±1.40**	**19.05±2.64**
Chemically bleached surface	79.74±0.17	-5.48±0.19	-2.46±0.10

used for the retouching work.

There was no statistically significant difference between the retouched L*a*b* values between the surfaces in which the crushed walnut shells had been incorporated. When the deck of *Australia II* was inspected some nine years later, it appeared that there had been essentially no change in the colour of the old painted areas but it was more difficult to tell if there had been any changes in the newly retouched areas.

In order to compare the colour of the deck in 1999 with that in 1990, the formula in equation 1 must be used to calculate the $\Delta E^{99\text{-}90}$ values for each of the paint and surface types. Using the data summarised in Tables 1-4, it can be seen that those surfaces denoted as newly painted in 1990 have undergone significant fading during the eight years of exhibition in the ANMM Leisure Gallery. The colour change for the older green paint is much less marked and this may simply be a reflection of the longer time interval between measurements of the original surface, which was applied in 1982 and had eight years of light exposure to bring about the bulk of its fading. Since fading is generally governed by linear relationships between the logarithm of the light intensity and the colour change (Feller 1978, 1994), it is not unreasonable to expect that the worst of the fading of the original deck paint had taken place in the eight years since it was first applied, as the vessel was prepared for the America's Cup campaign. If it is assumed that a similar colour decay law operates for the original painted surfaces and the touch up materials, it can seen that the data for the new green paint, as noted in the 1990 measurements, is in the first stage of the rate laws that control the degradation of colour of the paint. Inspection of the data in Table 4 shows that the new rough paint has degraded to very similar values of L*a*b* as was previously observed for the old rough original painted surfaces.

A cursory examination of the data summarised in Table 4 shows that there was little systematic difference between the colour of the retouched deck paint from the 1990 measurements and the old paint, when measured in November 1999. This is in marked contrast to the large differences noted during the original measurements in 1990, where a ΔE value of 5.2 was calculated between the new roughened paint and the old, with a ΔE value of 6.0 between the smooth new paint and the old roughened paint.

Following the Olympic Games, *Australia II* was removed from exhibition in Sydney and returned to Western Australia. Early in the summer of 2001, the preparation of the vessel for a parade in Fremantle saw the yacht removed from storage in the Historic Boats Museum on Victoria Quay, the mast stepped and then secured with full rigging for the journey along the streets of Fremantle. Data from the weather bureau in Perth shows that the total irradiance the deck received during the eight days of outside exhibition was 224.3 $MJoules/m^2$ or an average of 28 $MJ.m^{-2}/day$. This equates to approximately 6.4 Mlux.hr for the eight days exposure or 0.80 Mlux.hr per day. Typical summer daylight irradiance levels during normal ten-hour working days averaged 16,000,000 $\mu watt.m^{-2}$ or 16 $watt.m^{-2}$. Based on our average light measurements in Fremantle, the ten hours of exposure and eight days of sitting in the sun equated to the deck having received the equivalent of at least 6.4 Mlux.hr, which is roughly twice as much as the calculated maximum it received during eight years on exhibition! The coincidence of the ten-hour exposure average measurements and the data from the weather bureau is a positive indication that the average conditions to which the vessel had been exposed has been accurately calculated from climatic data supplied by the Commonwealth Bureau of Meteorology.

When gauging the impact of the effects of light on the two-pack deck paint, it is useful to look at the data in terms of the colour change per million lux hours (ΔE/

Table 4. Summary of mean colour measurements on deck paint for 1990 and 1999.

Surface type	Date	No of data sets	L*	a*	b*
Old rough	1990	3	78.79	-8.33	14.60
New rough	1990	2	76.94	-11.84	18.10
Smooth new paint	1990	5	77.20	-12.05	19.05
Old rough	1999	10	76.40	-8.40	14.20
New rough	1999	10	79.50	-8.20	14.20
Smooth new paint	1999	7	77.60	-8.20	14.00

Table 5. Colour changes for the green deck paint after 8 years in the ANMM Leisure gallery

Types of surfaces	ΔL^*	Δa^*	Δb^*	$\Delta E^{99\text{-}90}$	ΔE^{min}/Mlux.hr	ΔE^{max}/Mluxhr
Old rough	-1.19	0.13	-0.60	1.34	0.40	1.44
New smooth	2.30	3.85	-4.85	6.61	1.98	7.10
New rough	2.56	3.64	-3.90	5.92	1.77	6.36

Mlux.hr) for in that way the materials performance can be compared to standards such as the Blue Wool Fading scale, used by Ford (1992) in his study on the effects of light on textiles whilst on exhibition. In attempting to gain an idea of what the ΔE data means in terms of standard fading experiments, it is useful to reflect on the data collected by Ford on textiles exhibited under similar conditions to *Australia II*. Based on our greatest colour loss, which occurs for the repainted areas of the deck, the ΔE per million lux hours was seen to range from 2 to 7.1, depending on the range of lux over the yacht during the time it was exhibited in the gallery in Sydney.

Using the data from faded textiles, it is possible to calculate the equivalent ISO[1] rating of the deck paint. The calculated ISO values for the new green paint lie between $^{min}3.4_{calc}$ (for the 7.1 value) and $^{max}4.5_{calc}$ for the ΔE/Mlux.hr value of two, with a $^{mean}ISO_{light\ green}$ rating of 4. Using similar calculations, the $^{mean}ISO_{calc}$ for the old rough paint is rated at 5.3 and for the new rough paint the $^{mean}ISO_{calc}$ is 4, which is the same, within experimental error, as the smooth new green paint. The implications of these Blue Wool Fading standards become apparent when making comparisons with data relating to the fading of works of art. According to all the commonly used scales, the new green paint can only be regarded as being moderately stable. Derbyshire and Ashley-Smith (1999) determined the logarithmic relationship between the number of millions of lux hours (Mlux.hr) needed to bring about *one just noticeable fading unit* (JNF) for the ISO levels of 1-8, with category 1 being the most sensitive. Using an average ISO rating of 4 for the new green paint, this implies that it would take 10.8 Mlux.hr to bring about one JNF, which is the amount of fading equivalent to a geometric grey scale of four, GGS4. Since the maximum light exposure in the gallery in Sydney is of the order 3.34 Mlux.hr, it is not surprising that there was no apparent change visible with regard to the condition of the deck paint.

The Reciprocity Rule simply states that the same amount of fading will take place in one year at a given amount of light exposure as will take place in ten years at one tenth of that exposure level. Based on this rule, it would have taken roughly 27 years of exposure in the Leisure gallery conditions to bring about one JNF on the deck paint of *Australia II*. The important point to note is that under conditions similar to the exposure of the deck during the summer of 2001, it would take roughly 88 days, less than three months, of outdoor exposure to bring about the same fading as would happen in 27 years in a museum controlled environment! This data can be compared with the accelerated ageing experiments on the Bullerswood Carpet at the Victoria and Albert Museum in London, where Pretzel (2000) conducted accelerated ageing on various dyes in the carpet. After an interval of 1.6 Mlux hours the rate of fading could just be observed, under ideal conditions and with accurate reference comparisons. After a total of 5 Mlux hours the ΔE values for blue and burnt sienna converged at 2.5 units and the red and green converged to 3.2 units. Pretzel uses a ΔE value of 2 or grey scale 4 as a measure of how much colour change is associated with one *just noticeable fade* unit. Other recent studies have focused on obtaining data from accelerated light ageing with a micro-fading tester, which is giving encouraging results for conservators and curators who cannot wait for eight years to see if there are going to be any changes (Whitmore et. al. 2000).

The initial assessment made by MacLeod was that there was no apparent change in the main colours on the deck and this is supported by the JNF data and the total amount of exposure the yacht had received during the intervening nine years. However, with data from the chromameter measurements it was possible to determine how much change had taken place.

Conclusions

The data obtained from colour measurements at the beginning and end of eight years of exposure of the deck of *Australia II* to optimum museum lighting conditions in the Leisure Gallery of the Australian National Maritime Museum in Sydney, has confirmed that colour fading has taken place. This data confirms

1. International Standards Organisation

that measurable degrees of fading can still occur even under conditions of low ultraviolet light and generally low levels of illumination. There are very few published reports on the way in which modern materials and paints have performed under museum lighting conditions and so this paper acts as a warning for all who believe that because a yacht was designed as a racing vessel, it will last well in terms of the preservation of the original surfaces and materials.

It is likely that continued decay of the colour of the deck will take place and that any outdoor activities such as sailing and street parades, will accelerate the degradation of this iconic object. The data obtained from the chromameter measurements has been used as a guide to illustrate the risks posed to museum objects if they are "returned to their natural environment" and sailed once more on the high seas. Such practices should be subjected to detailed risk assessment before any decision to reactivate the sailing program is considered. Although this data was reported to museum management, *Australia II* was transported by sea to the United Kingdom to take part in the America's Cup Jubilee Regatta in Cowes, England in August 2001. The yacht was shrink wrapped with an opaque polymer for transport and the syndicate sailing the yacht made some attempts to minimise the amount of sunlight falling on the deck. It should be noted that the yacht was accidentally grounded and some significant abrasion of the keel occurred. The damage was repaired within a few hours of the incident.

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Sue Bassett

Being doubly qualified as an archaeologist and a materials conservator, Sue Bassett brings a depth of experience to conservation problems associated with the stabilisation of complex objects. She has gained extensive shipwreck experience and has played a key role in the *in-situ* analysis of degradation processes on shipwrecks in tropical Queensland and in the United States of America. She is currently head of conservation at the Museums and Art Galleries of the Northern Territory in Darwin.