Museum Environment

In the design and operation of museum and gallery spaces and systems, there are a number of conflicting environmental condition requirements. A conservator needs to ensure the objects deteriorate as slowly as possible; an exhibition organizer needs to display objects with suitable effect and suitable setting for maximizing their interpretive value; the services designer needs the system to meet the stated requirements for the repository; and the visitor would like to view or experience the exhibits comfortably and clearly. A suitable balance needs to be reached between these requirements, cost, and efficient system operation.

Environmental Damage to Collections

Deterioration of collections is inevitable, but the rate of change can be slowed so that their condition can be kept stable if the environment is properly managed. Environmental damage can occur in three primary ways:

Chemical

Chemical decay relates to changes in an object at a molecular level. Corrosion on metals, acid burning or staining, and embrittlement of paper or textiles are all examples of chemical damage. For organic material such as paper, vellum, wood, textiles and plastics, chemical decay is ongoing and spontaneous.
Keeping items colder and drier will slow down the rate of chemical reactions.

Biological

Biological decay is caused by the attack of organisms such as mould and insects. This is most apparent in moist, hot environments. Organic materials are highly susceptible to this type of damage. Mould spores are always present in the atmosphere and just require a sustained high relative humidity for a certain period of time to propagate. Active mould produces enzymes that can digest organic materials such as paper and textiles, weakening or destroying them. Colourful blooms can also cause stains that cannot be removed. Generally, maintaining relative humidity conditions below 65% relative humidity eliminates any risk from mould growth. Insect infestation, which can result in damage or loss due to feeding by insects or their larvae, is minimised by keeping relative humidity below 50% and by keeping space temperatures quite cool. Mould germination and its rate of growth are dependent on relative humidity, temperature, air movement, time, species of mould and the nutritious quality of the organic substrate. A precautionary upper limit of 65% relative humidity at 20oC internal space temperature should minimise this risk, although at lower temperatures mould will take longer to germinate.

Mechanical

Mechanical decay includes softening of plastics and waxes, cracking and buckling of wood, warping and delamination. This type of decay can be caused by physical force or mishandling, but can also be the result of changes in the environment that lead to physical stresses in an object. Environmentally induced mechanical decay is primarily driven by extremes of relative humidity, although temperature extremes can also affect the degree of risk if prevailing conditions are cold enough to cause brittleness or dry enough to cause cracking. Estimating the degree of risk of mechanical decay from improper humidity control within a space is difficult because the construction details of composite objects have a strong influence on their behaviour. Excessive dampness can result in differential expansion, sagging, warping and permanent deformation. Excessive dryness leads to contraction, brittleness, cracking and tearing. Risk also results from repeated fluctuations in moisture levels that cause a slow progression of micro-cracks and other forms of ‘fatigue’ in materials.

Temperature and Humidity Related Damage

Temperature and humidity are the two key measures of environmental control. They are directly linked, which is why they are typically spoken about together. The dew point (the temperature at which water vapour turns to liquid), determines what combinations of temperature and relative humidity are possible. At a constant dew point, when the temperature goes up the relative humidity goes down and vice versa.

Acceptable Storage and Display Conditions:

- Temperature – typically between 15-25°C with allowable fluctuations of +/-4°C per 24 hours;
- Relative humidity – typically between 45-55% with an allowable fluctuation of +/-5% per 24 hours;
- Where storage and display environments experience seasonal drift, relative humidity change to be managed gradually across a wider range limited to 40-60% to minimise stress on collection items.

Indoor Air Quality and Pollutant Damage

Airborne dust, as well as chemical pollutants, can damage collections. Pollutants including ozone, nitrogen oxides, sulphur dioxide and dust are the biggest concerns.

Light Induced Damage

Both visible light and ultraviolet (UV) radiation may cause damage to collections resulting in the fading of pigments and breakdown of materials at molecular level, and may degrade objects. Light can cause chemical changes, for example inks, dyes and pigments will discolour; or physical changes, for example mechanical strength can be lost or glossy materials become matt. Light induced damage often occurs over a long period of time. This fading and degradation of materials due to light exposure is described as photodegradation.

Ensuring Visitor Comfort

It is important to remember that the business of many institutions is to display and interpret collections to the public and that therefore it is essential to consider the visitor experience as well as preservation of collections when reaching decisions on the level of climate control.

Sustainable Design Strategies

The greatest challenge for today's museums/galleries is to reduce their energy consumption, while maintaining their specific functional needs. Typically, these buildings consume energy, principally in the process of environmental control in mediating between the external climate and the internal environment. Lighting and equipment also consume a significant proportion of energy.

Galleries and museums have high energy demands due to their unique environmental control requirements. The following systems should be investigated:

- Efficient heating and cooling systems
- Renewable energy generation
- Procurement of low-energy equipment
- Daylighting where possible and appropriate
- Low-energy lighting strategies
- Energy monitoring and commissioning

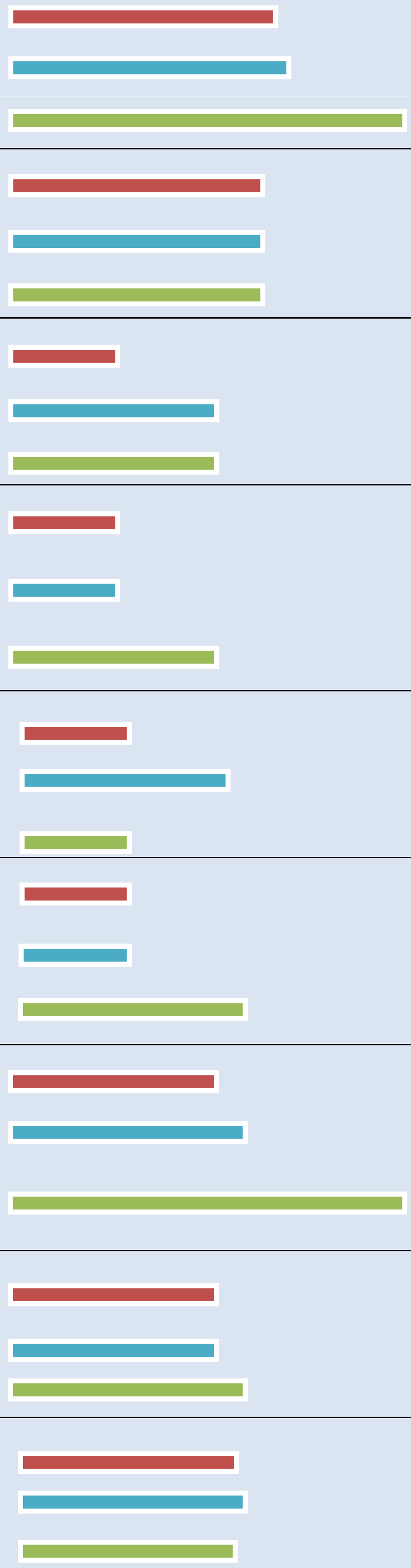
Climate Control Watch points and Strategies

Cooling and Dehumidification	Use **chilled water systems** for cooling where possible as these systems enable stable off coil air temperatures and therefore stable temperature and humidity control.
	Desiccant dehumidification systems may be appropriate as an energy efficient means of removing moisture from outside air.
Heating	Use **hydronic (Low Temperature Hot Water or Medium Temperature Hot Water) heating systems** where possible. Water based systems enable good controllability if appropriately designed and should therefore result in much more stable temperatures.
	If **electric heating** systems must be used, ensure they are thermistor controlled (i.e. have infinitely variable rather than stepped control) so as to ensure more stable conditions.
Humidification	Consider **ultrasonic humidification** where possible as this technology atomises water into the air stream rather than boiling it and is therefore more efficient.
Maintenance	Planned Preventative Maintenance (PPM) of any installed systems is also recommended. Investing in a schedule of planned maintenance measures, minimises disruption and unexpected costs, and represents an effective way of increasing the reliability and lifetime of the installed systems.
Dew Point Control	Generally, air handling systems activate and deactivate humidification and dehumidification modes based on the detected deviation from the relative humidity set point of the air within a museum or gallery space.
Sensor Location/Calibration	Ensure good quality sensors are employed that are suitably accurate. Ensure they are recalibrated on a regular basis rather than set and forget (at least every six months and ideally more regularly). Locate sensors in the areas that collections will be displayed – not tucked away in corners or on external walls or in the direct path of sunlight or supply air outlets.

Lighting Design Watch Points and Strategies

Daylighting	The oldest of all lighting techniques, daylight, is still more challenging compared to the use of electrical lighting systems. Many museums and galleries have strict guidelines on the use of daylight. However carefully designed use of daylight helps save energy.
Light Emitting Diode (LED)	The state of the LED technologies of today warrants that there are products in the market which are able to provide superior lighting solutions for gallery/museum lighting purposes. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching.
Colour Rendering Characteristics	There is currently a range of LEDs available with excellent colour rendering that achieve adequate visible colour richness that may be suitable for museum lighting applications.
Conservation	LEDs have considerably less UV and IR radiation, therefore are considered safer by many.
Disposal and Recycling	LED is a type of diode, and originates from the electronics industry. The disposal and recycling requirements for LEDs are similar to those for other common electronic components.
Control	LEDs are highly controllable, dimmable and tuneable.
Cost	In recent years, as more and better LED products have been appearing in the market, the prices of these products have also been reducing. Nevertheless LEDs are still a costly option in terms of the initial replacement cost, compared to other alternative technologies. Operational costs however are significantly reduced due to long lamp life.
Lamp Life	Good quality LED products typically have a lamp life of up to 50,000 hours and produce 50% to 70% of their initial light output at the end of that period.

LIGHTING	Category	Level (Low – medium – High)
Programmable lighting controls Lighting control systems can switch off lights automatically or reduce levels to suit particular scenarios, therefore reducing energy.	Invaviveness Cost Sustainable Benefit	
Daylighting control Where spaces incorporate both daylight and artificial light, controls should be in place that hold off artificial sources unless they are required to operate.	Invasiveness Cost Sustainable Benefit	
Controls and dimming Provide individual control of each lamp on a track so each can be individually dimmed. Consider addressable lighting.	Invasiveness Cost Sustainable Benefit	
Switching strategy Simple and understandable switching arrangement will help users recognize what controls what and therefore encourage appropriate operation. Individual spaces should be individually switched.	Invasiveness Cost Sustainable Benefit	
Display case lighting Lighting strategy for display cases must be specifically tailored in order to both ensure efficiency and meet conservation obligations.	Invasiveness Cost Sustainable Benefit	
Lighting optimisation Review existing lighting. Identify where lighting levels can be reduced or changed to improve efficiency. Confirm light sources are efficiently aimed and there is no light spill.	Invasiveness Cost Sustainable Benefit	
LED lighting LED lighting can offer significant energy savings and lamp longevity in comparison to traditional sources. Care is required to avoid issues with colour rendering and temperature. Retrofitting often possible.	Invasiveness Cost Sustainable Benefit	
Out of hours strategy Different requirements will be required during normal operational hours and out of hours. Having dedicated lighting strategies to suit can conserve energy.	Invasiveness Cost Sustainable Benefit	
Occupancy sensors Stand alone or centrally controlled occupancy sensors will ensure intermittently occupied spaces are only lit when in use.	Invasiveness Cost Sustainable Benefit	



Extract from A Practical Guide for Sustainable Climate Control and Lighting in Museums and Galleries