THE ENGINEERING ILLUSIONIST

Pulling off the feat of invisible engineering to protect priceless works of art. ***Chris Croly*** tells us how

NATIONAL GALLERY OF IRELAND

→ What an incredible brief! Achieve close environmental control of a national icon to protect more than 650 pieces of priceless artwork - but all interventions must be invisible. The historic glazed roof must remain, despite the 300kW of heat gain produced by this unwelcome solar collector; all plant must be located outside; no water services can pass through or near the gallery spaces. A tiny existing space on the roof that could be used for air handling plant isn't large enough - and is surrounded by glass - so obstructs access for all large ductwork systems in or out of the plant area. When complete, the building must control the environment to at least the same quality as a contemporary, bespoke new-build art gallery, but with even better energy performance. Good luck!

Taming the Glazing

The Dargan Wing of this treasured listed building completed in 1864 and the Milltown Wing completed in 1903. Quality natural light had been a key feature of the original design, although many windows had been blocked up during the gallery's history. The missing windows were rediscovered during construction and restored, returning natural light to the gallery as formerly intended. The cold radiation from these newly exposed windows was also welcomed as an additional challenge of providing close control of conditions within the gallery spaces.

The large areas of glass within the Dargan Wing gallery roofs were replaced with high performance glazing that incorporated micro mirrors within the panels. These micro mirrors diffuse light to reduce peak solar radiation on paintings by 80% and have a UV transmittance of only 1%.

The pop-up pod glazing of the Milltown Wing galleries required additional consideration as the lower floor to ceiling height made the management of solar gain even more critical. The glazing was divided into two separate layers to form a twin roof-light construction. This dual layered approach captures heat build-up within the glass and expels it through natural ventilation. A blind fitted between the layers of glass is programmed to close automatically should the total cumulative lux measured within the gallery reach a level which may damage paintings. This concept of cumulative lux measurement removes the concern of over exposure and reduces costs by using increased daylight levels.

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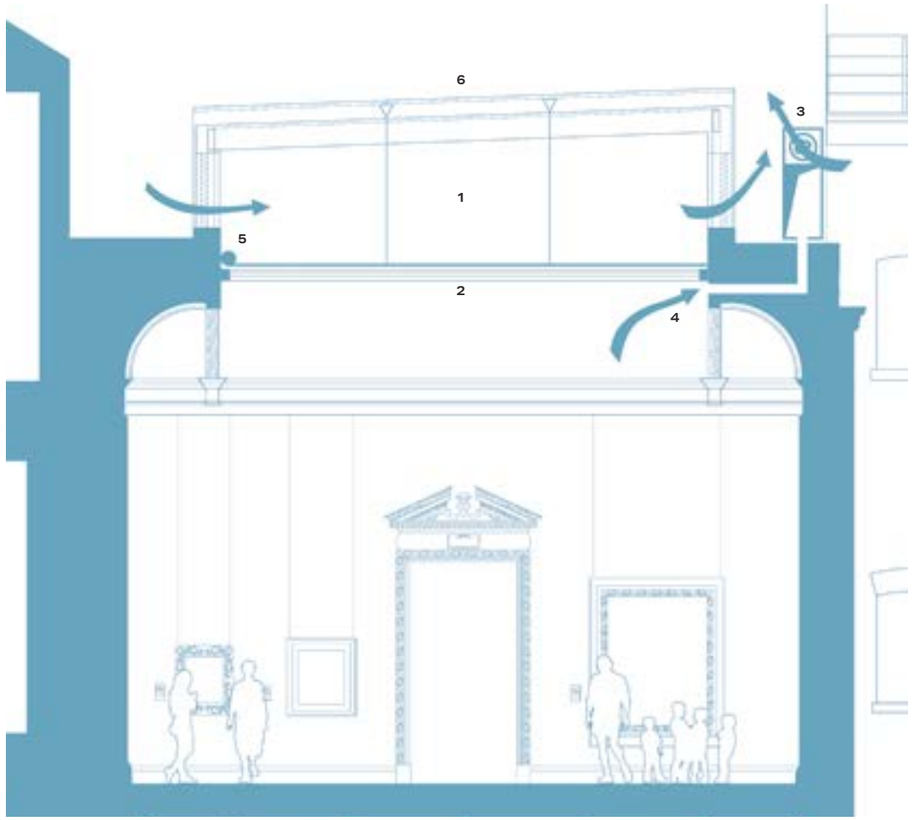
Our first elephant was the energy centre. It contains a collection of fascinating plant, although with debateable visual merit, such as the building's ice banks, CHP unit, fire suppression system and electrical switchgear. After stomping through the building and trying to lie down on the building's roof this elephant was promptly tranquilised and buried below the grass in front of the building with discreet air vents invisibly concealed within the steps between the grass and the paving.

While a small existing roof plantroom was available for air handling, it was only half the required size. A significant change of level in the middle of the plantroom exactly where the main duct riser was placed created a comical set of boundary conditions for the ensuing game of Twister that was repeatedly played until the plantroom arrangement looked adequately convincing.

The challenges continued. Horizontal distribution of services within the galleries was not possible but we identified a number of small vertical distribution options, such as squeezing supply ducts into a leftover void behind the stairs. It was acceptable to form a new, compact riser from the plantroom to ground level, but not to exit the riser at any point within the building. The only logical option was to unfold the supply ductwork below the building, allowing each duct to appear beneath the gallery it serves and work its way through concealed voids to the galleries above.

The main return air ductwork from the Dargan Wing was completely isolated from the plantroom by a large glazed ceiling and it was completely out of the question to have even a hint of a ductwork shadow crossing above the ceiling glazing. After some debate around the impossibility of the situation the comment about the glass duct was expressed - and promptly accepted as the solution to an otherwise unsolvable problem. The installed glass duct is completely invisible from within the gallery spaces below and allows all of the return air to be transferred back to the plant room without intrusion. Almost all of the supply and extract air terminals are hidden behind existing cast iron decorative grilles or within shadow gaps, leaving no hint of a modern air conditioning system.

when large objects miraculously disappear there is often a magician standing waving their hands while behind the curtain there is an engineer busy shouldering an elephant into the back of a mini



1. Naturally cooled plenum
2. Frosted glass to create invisible plenum
3. Natural ventilation with extract duct concealed in structure
4. Return air path
5. Retractable blind
6. Glass with integrated micro mirrors

(↖)
section through Milltown Gallery showing the environmental approach

Safeguarding the Past – and the Future

Rather than treating each gallery as homogenous space, a bespoke control routine that considers a matrix of sensors and adjusts air flow rates to manage conditions throughout each individual gallery was developed. This technique dramatically reduces fan energy but also protects tall paintings against variations of height and from 'dead spots' within the gallery.

The energy systems are designed to improve the environmental performance of the gallery over time with heat initially provided by a CHP unit which will eventually transition to a four pipe chiller (heat pump) based system as Ireland's national electrical grid progresses towards a 40% renewable energy contribution by 2020. Ice banks are used to smooth the electrical demand of the galleries by generating cooling during the night but, unlike traditional ice bank systems, some of the waste heat from the process is also recovered through the use of a four pipe chiller.

Through a combination of innovative climate controls and systems unique to this gallery we achieved the seemingly impossible; to control temperature and humidity to a level of precision envied by many modern, custom built galleries. Our invisible engineering solution means that visitors are completely unaware of the intricate servicing systems that are regulating the historic galleries, with equipment hidden below the building and threaded invisibly throughout its structure.