Lighting the Queen's Diamond Jubilee Gallery at Westminster Abbey

About Westminster Abbey and the QDJG

Westminster Abbey is a museum, a burial place, a performance venue, a national monument, a tourist attraction, and most importantly, a working church. It houses the tombs of approximately 3,300 monarchs, scientists, musicians, politicians, poets and warriors, and contains some of the oldest and most precious artifacts of English history. Built on the site of a 10th century Benedictine monastery and still preserving traces of King Edward's original 1065 AD structure, the Abbey has been the setting for every Coronation since 1066 AD, the site of 16 royal weddings, and hosts over a million and a half visitors every year.

The Westminster Abbey nave, at 102 feet from its stone floor to its intricately detailed ceiling, is the tallest gothic nave in England. Encircling the nave over 50 feet above the abbey floor is the medieval triforium. Hidden to the public for over 700 years, the triforium was reborn in June of 2018 as the Queen's Diamond Jubilee Gallery (QDJG). Named in honor of Queen Elizabeth II's reign of over 60 years, the gallery presents more than 300 treasured artifacts from the Abbey's collection that tell the story of its 1000-year history.

The triforium itself is shaped roughly like the Greek letter omega (Ω), with views into the nave and chancel, as well as outward to the Abbey grounds, Big Ben, Westminster Palace, and the bustling city streets. Daylight and sunlight stream in through Gothic windows variously set with stained glass and clear panes to shine on rough wood floors that diffuse the light onto ancient stone walls and heavy timber beams supporting the wooden roof up to 5 meters above.

How it all began

The rebirth of the Triforium goes back to at least

2015. Stuart McKnight, partner at McInnes Usher McKnight Architects in London (MUMA), describes his first visit:

"On our first visit to the Triforium, we were struck by its otherworldly quality and unexpected characteristics – the unfolding spaces with intriguing glimpses inviting exploration, opportunities for views and the stunning vista along the Chancel, the crankiness of the timber, the beauty of the stone, the contrast between sunbeams and shadows, patterns of light and patterns of structure. We felt that it was important that the making of a modern museum display did not undermine or compete with the unique qualities of the space. "

MUMA engaged Max Fordham to study and engineer the new gallery to optimize the use of natural light against the need to protect photosensitive artifacts. Peter Fordham at DHA Designs was responsible for lighting design from initial concept to project completion.

"The lighting design is a traditional track and spot solution, using black lighting track fixed to the 5m high timber ceilings between the deep timber beams, allowing maximum flexibility on site during the commissioning and focusing stages. When we started the project, we were adamant that we wanted to keep the lighting control as simple as possible. We originally proposed small track mounted LED spotlights with built in potentiometers, so that we could set light levels for each fixture as we put them into the track at the end of the project. We were really keen to avoid DALI, since we find this protocol slow and clumsy during the commissioning stages of a heritage project, where we are often changing and

refining positions of the luminaires on the lighting tracks to suit the final positions of the objects. DALI requires a dedicated programmer to re-address the fixtures every time the fixtures are repositioned on the lighting track. But as the requirements for daylight control became more complicated, a DALI solution was quite difficult to dismiss.

XICATO® GalaXi™

Choosing Xicato GalaXi™ Bluetooth controls

Peter's epiphany came when he visited the Mike Stoane Lighting (MSL) booth at Light+Build 2016. MSL was showing their new track fixtures incorporating Xicato XIM Gen4 LED modules with integrated driver and Bluetooth connectivity, which along with compatible sensors, drivers, switches, gateways and software comprise Xicato's GalaXi™ portfolio.

"I had read about Xicato's XIM Bluetooth modules already, but never really understood what they could do in the museum and gallery environment. And I'd certainly never seen it in operation before. Mike Stoane's display had it all: the usual, lockable fixtures that I know and trust from Mike Stoane, plus Xicato's LEDs delivering quality white light which I

could control with ease using my iPhone, plus battery operated PIR motion and lux sensors hidden into a picture frame that connect via Bluetooth to the LEDs."

Back in the UK, DHA Designs worked closely with Xicato and MSL to incorporate the Xicato GalaXi modules into the project before the fast-approaching tender. The team arranged on-site mock-ups with fixtures and sensors to demonstrate the quality of light and the new Bluetooth control technology to Westminster Abbey and the design team.

"Using Bluetooth control, we were able to simplify the lighting installation instantly, by providing only non-dimmable power to the lighting track. By reducing the amount of equipment and the extent of cabling we saved over £12,000 on a conventional lighting control system."
- Peter Fordham, DHA Designs

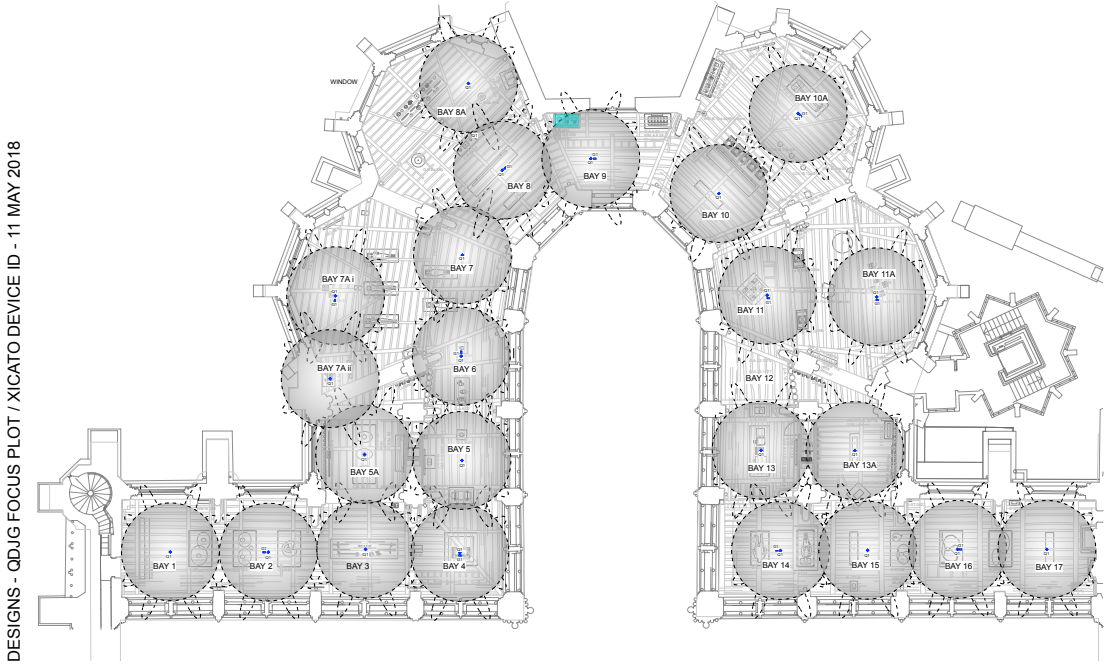
Lighting control during operating hours is automated using PIR motion and lux sensors to preserve the artwork while providing a special visitor experience. Display lighting listens to PIR sensors that announce the presence and relative proximity of visitors. Lights fade to off when no one is in the room. They fade up smoothly to a low level when visitors enter an adjacent area, and brighten almost imperceptibly to an optimal value when visitors move closer.

Lux sensors detect the presence of sunlight and daylight, and lights compensate accordingly. Sensors communicate directly with the lights over Bluetooth, and the lights know how to respond based on their individual programming, without the intervention of a hub or central controller. It's like magic… visitors rarely notice the changes, but the system saves energy and minimizes light damage to the artwork while providing a satisfying user experience.

Of course, the lighting can also be controlled manually using desktop or mobile software:

"Despite the sophistication and ease of controlling

Above: Peter Fordham checks lux level and adjusts the programmed light intensity setting from his tablet.

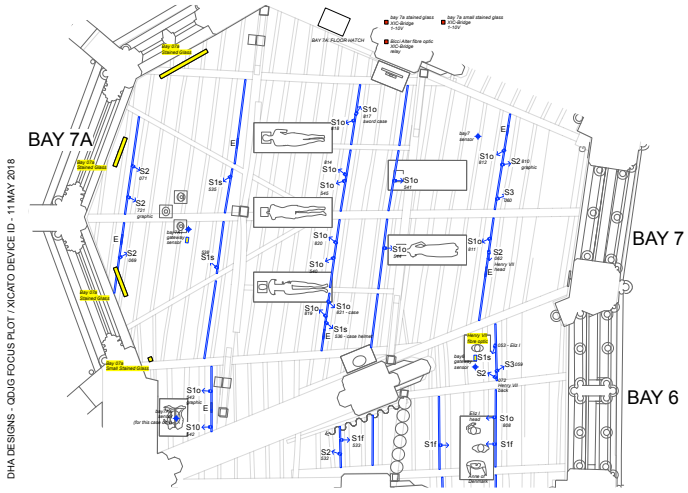


OVERALL PLAN / SENSOR & GATEWAY LOCATIONS

the fixtures on an iPhone," Peter notes, "the Clerk of Works at Westminster Abbey was adamant to have a single lighting control panel to turn on and off the lights at any time of day or night, without using a smartphone."

The solution was the Xicato Xtouch MG app for Android, available free on the Google Play store.

The actual programming of the lighting system took place in two stages: lighting plan in hand, DHA Designs first pre-commissioned the Mike Stoane fixtures with a device number and name, so that it could be easily and uniquely identified by the Xicato GalaXi Control Panel application. Once the track and fixtures were in place, the light levels, group and scene membership, and sensor responses were then programmed into each node.



Lighting plan, Bays 6 and 7. Blue lines are tracks.

Not all of the light sources were Xicato LEDs. For example, several of the displays integrate remote fiber optic lighting, and beautiful backlit stained glass displays in two of the chapel bays use linear LED strips from KKDC with remote dimmable drivers. All of these had to be controlled using the Xicato GalaXi control system. The solution to controlling third-party drivers was a GalaXi-powered intelligent bridge from Xicato partner Eulum Systems, which converts Bluetooth commands into 1-10V dimming signals, with a hard relay for on/off control.

IP Gateways and Mesh

Wireless control of a few lights in a small area is relatively easy; controlling 250 fixtures as a single group from a one location when the luminaires are scattered in a horseshoe-shaped plan around two sides of a stone Abbey is an entirely different challenge. And it did not help that a few of the lights and sensors were tucked into nooks and crannies, and some control nodes were actually buried below displays and beneath the flooring!

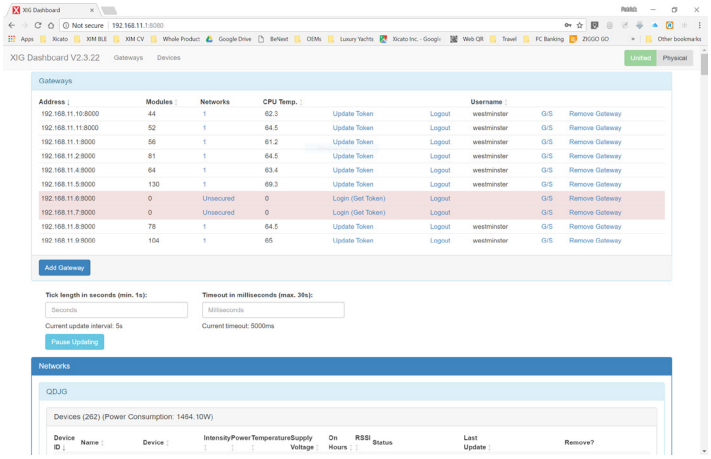
The solution to control coverage was a combination of Bluetooth gateways and Bluetooth mesh networking. The Xicato Intelligent Gateway (XIG) connects Bluetooth to a Wifi or Ethernet LAN that can serve as a backbone for control and monitoring.

Xicato XIM Artist Series at work. Lux levels on the vulnerable artifacts were carefully measured, maximum levels programmed into the lighting nodes, and maintained using GalaXi lux sensors.

Bluetooth mesh networking was activated only where required, and was simple to configure.

MSL and Xicato mapped the wireless coverage patterns of the lighting nodes and sensors and identified the best locations for gateways based on the coverage of the Abbey's Wifi routers. After installing the gateways, communications – particularly with a few outlier nodes – were made more robust and reliable by designating specific lighting nodes as relay nodes.

This process was made more challenging by the dynamics of the gallery construction itself. Wireless coverage changed as the exhibits were installed, impacting both the Bluetooth and the Wifi network. Eventually, however, DHA Designs was able to ensure that lighting commands were distributed seamlessly and reliably to all parts of the Abbey, and that the Abbey facility managers had centralized visibility to monitor every node in the space using the Xicato Control Panel software.



Xicato Intelligent Gateways enable remote configuration, control, and monitoring of GalaXi nodes.

Results

The Artist Series lighting provides unmatched color quality and consistency, while the GalaXi Bluetooth control network manages all of the lighting. The system is now up and running, and the galleries have received favorable coverage since their opening to the public on June 11. All of the lighting now switches on and off automatically using the PIR sensors across the galleries, and as the daylight levels increase, the spotlights that illuminate the more sensitive objects slowly dim down to conserve the lux-hour budget. And of course the Clerk of Works did get his touchscreen: a simple Android device that allows a staff member to manually select a lighting scene so that the galleries can be operated and maintained outside of public hours.

Asked whether he would use the same control system again, Fordham was quick to respond:

> *"Absolutely. Xicato have proved that the days of conventional lighting control for museums and galleries are now numbered. And the advantage of using Xicato's system is that you also get the consistency of colour and flicker free lighting from their LEDs as well as cutting edge lighting control. We plan to revisit the lighting again with the Abbey conservators in 6 – 12 months, once they have collected lux-hour data from their sensors, and to see how we can improve the existing program and functionality of the sensors. In addition, the Abbey have shown interest in using the Bluetooth beacon function of the Xicato LEDs in a future visitor experience*

Queen's Diamond Jubilee Gallery at Westminster Abbey

Architectural Consultant: MUMA

Engineering: Max Fordham

Lighting Design: DHA Designs, Peter Fordham

Luminaires

- MIke Stoane Lighting TTX2.70
- KKDC linear and fiber optic fixtures

LED Light Sources

- Xicato XIM Gen4 Artist Series 9mm LES, 3000K, 1300lm (XIM09953013A6A)
- KKDC linear and fibre optics

XIM is available in 19mm and 9mm LES, in multiple spectral/CRI formulas and CCTs, and lumen output from 700LM to 3000LM

Gateways and sensors are located discretely between the massive wooden beams in the triforium ceiling. Mike Stoane Lighting created a custom housing (black box in top of photo) that contained both XIG and XIS.

Xicato GalaXi™ Bluetooth products

- XIM Gen4 Artist Series LED modules
- Xicato Intelligent Sensors (XIS01-D5M1LTH-B) with PIR motion, lux, temperature, and humidity
- Xicato Intelligent Gateways (XIG-0101)
- Xicato Control Panel software (commissioning)
- Xtouch MG™ Android app (control)

Eulum TRAN-XIT 1-10V bridge (Powered by GalaXi)

About Xicato

Xicato designs and develops light sources and electronics that enable architects, designers and building managers to create beautiful, smart spaces in which people love to live and work. With thousands of installations around the globe, Xicato continues to be a leading supplier of high quality lighting solutions. In addition to the industry's finest LED light sources, Xicato is defining the future of energy efficient, human-centric environments with our GalaXi™ portfolio of intelligent lighting modules, drivers, sensors, switch components, gateways, software and connectivity.

Founded in 2007, Xicato is headquartered in Silicon Valley and has offices in China, Europe and the US.

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