Museums and Galleries
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Introduction

Museums and galleries encompass some of the world’s most architecturally impressive structures. For over 50 years Arup has collaborated with leading architects to deliver inspiring and well-respected buildings. Our international repertoire comprises the renovation of museums and galleries in heritage buildings as well as designing new exciting facilities for exhibitions.

Creating flexible and multifunctional spaces for the display and conservation of exhibits often raises contrasting priorities amongst stakeholders. Curators focus on the protection and display of works, access and education. Operators demand secure, efficient and adaptable spaces. Directors are often concerned with national and international context. Philanthropists consider the prestige of institutions with which they are associated. Artists require flexible and inspirational environments and visitors, of course, desire beautiful and functional surroundings.

We have an excellent reputation in delivering optimal environments. We address the needs of all these stakeholders whilst achieving high quality, aesthetically stunning spaces.

Arup has a strong reputation in designing arts buildings. We have the skills to reinvent these buildings for the future. We are committed in our approach to achieving the best and most efficient designs for museums and galleries, ensuring the preservation and display of collections for future generations.

Andrew Lerpiniere,
Arts and Culture Leader
Iconic buildings

Creating an iconic building that attracts international attention is an important element of many new projects. Some may even act as a catalyst for urban regeneration.

New museums and galleries frequently become beacons attracting investment and business growth in a local area. It is not uncommon that an expressive external form is a key attractor in itself. A new institution brings a strong sense of pride to a community whether the building was originally conceived as a civic symbol or an outward expression of collections it houses.

Working with clients and acclaimed architects on landmark projects internationally, we have developed the skills to realise striking museum and gallery buildings.
Conservation

All museum and gallery exhibits, whether artistic, decorative, scientific or ethnographic in nature, need to be housed in conditions that ensure they do not deteriorate. Physical fragility presents directors, conservators and curators with a series of dilemmas about how to display and give access to, yet simultaneously preserve, valuable collections.

Uncontrolled light can lead to premature fading of paint pigments and textiles. Works on canvas may be damaged by fluctuating humidity. In order to prevent in some cases irreversible damage some artworks require closely monitored climatic and lighting conditions.

Art loan agreements between institutions are essential to the staging of touring exhibitions. These are routinely decided on meeting specific environmental requirements.

We understand these complex challenges and ensure our clients meet international standards for art conservation and environmental stability.
Visitor experience

Whether seeking quiet contemplation or intellectual stimulation, visitors enter the gallery or museum with individual expectation. Attracted by a special event or a permanent collection, they may shorten their visit, fail to recommend the exhibition or return, if the facilities are inadequate.

We have collaborated with many cultural organisations on the planning of efficient and appropriate front-of-house facilities. Well-designed entrances, ticket offices, washrooms, retail outlets, rest and transit spaces, cafés and restaurants all contribute to a comprehensive visitor experience as well as higher revenues for the institution. Pleasant catering, seating and reading areas allow visitors to recuperate and refresh. Increasingly, these add-on revenues generate a significant portion of the institution’s income, particularly where there is a free entry. Where funds are hard to secure, these make a large contribution to covering the operating costs.

The ability to circulate easily and view exhibits in the best possible environment is key to the core visitor experience. The design must consider varying degrees of visitor expectation, alternating collections or individual artefacts on display in order to achieve a desired layout and conditions.
Museums and galleries are increasingly interested in providing appropriate conditions for the preservation of exhibits with minimum impact on the environment. Arup excels at creating buildings that work in harmony with nature. Our approach to designing high-performance buildings uses the right blend of passive and active design strategies in order to minimise energy, materials, water and use of land. By employing ambient energy sources such as daylight, natural ventilation and solar energy, we reduce energy requirements as well as operating costs.

The starting point for passive design is consideration of building orientation and prevailing environmental conditions. We achieve optimal daylight by glazing design and window repositioning which can result in minimal heat loss. We also focus on reducing the need for additional heating and cooling by upgrading the thermal performance of the building fabric. Energy savings can be made through metering, demand-driven operation and lighting control.

We embrace biodiversity and natural habitat preservation through landscaping green roofs and nearby unused land. Our designs strive for minimum new water consumption by using low flow devices, water recycling and rain water collection. We advocate use of products with low lifetime embedded carbon and recycling of building materials.

**California Academy of Sciences, San Francisco**

The largest double LEED platinum-rated building and the greenest museum in the world, the Academy is indisputably a masterpiece of sustainable design.

Its sculptural Living Roof serves as a habitat for millions of plants and variety of birds. The porthole skylights provide natural ventilation and daylight. The soil substrate insulates the building and captures rainwater, resulting in a saving of 50% in mains water consumption. A semi-translucent canopy incorporating 60,000 photovoltaic cells surrounds the green roof, providing almost 5% of the energy requirements. The building is constructed almost entirely from locally-sourced, recycled and renewable materials.

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1 California Academy of Sciences, San Francisco, USA ©Tim Griffith
2 Harvard Art Museums, Harvard University, Cambridge, USA ©Nic Lehoux
3 Denver Museum of Nature and Science, Morgridge Family Exploration Center, Denver, USA ©Frank Ooms
Building or renovating a museum is rarely an inexpensive endeavour. Funding for new arts and leisure facilities often comes from the public purse, philanthropists or private investors. Once budget is established, we ensure during the design and build stages that we meet the scope and brief, keeping to programme and cost.

Museums and galleries often rely upon internally generated funding, generally through commercial partnerships in their shops and cafés. We appreciate the importance of an institution’s commercial operations. Through appropriate design in which levels of resilience are relative, we can further contribute to their financial success.

We have been involved in numerous publicly funded projects, often with specific criteria to be met in order to secure funding. We are experienced at working within precise parameters, supporting the successful applications. We have an innate ability to demonstrate rational and optimised design through our holistic approach.

**Royal Exhibition Building, Museum Victoria, Melbourne**

A UNESCO protected world heritage site, the Royal Exhibition Building flourishes as one of the world’s oldest exhibition pavilions. It provides an embodiment of the great 19th Century international exhibition movement.

Spanning 15 years, Arup has supplied restoration and support services to Museum Victoria, most recently the reinstatement of four of the ten timber flagpoles. Our delivery strategy mitigated risks, access conditions and simplified the conservation works. We delivered within a limited project budget.

1 Mori Ogai Memorial Museum, Tokyo, Japan ©Fumio Toki Associates
2 Museum Victoria, Royal Exhibition Building, Melbourne, Australia © Museum Victoria, Benjamin Healley
Operating costs

Obtaining capital funding for arts and culture projects is difficult, whether through private donations or a mix of individual, public and commercial support. Operational funds can be even harder to secure. It is important that institutions are able to forecast operating expenditure during the business case and design phases of the project; in order to plan for long-term funding requirements.

An effective understanding of the drivers that influence operational expenditure allows us to design features that keep operating costs to a minimum. A significant proportion of running costs emulates from equipment maintenance and the energy used in environmental control. The challenge is to reduce the levels of environmental service provision in gallery spaces whilst maintaining conditions suitable for the conservation of objects as economically as possible.

We use dynamic thermal simulation software to develop innovative and sophisticated control systems that maintain required conditions utilising only ventilation and heating. The removal of cooling and humidification has a direct impact on both maintenance and energy cost savings. This contributes to the long-term financial resilience of the museum or gallery.
Stepping into the 21st Century many historic and listed museum buildings are being reinvented to continue to inspire new generations. From complex restorations to correcting disparate alterations made over the years, we modernise period buildings by integrating the finest contemporary design within their historic setting.

The trend also continues for curators and artists to repurpose post-industrial shells, turning these into magnificent exhibition spaces. The conversion of industrial buildings poses a number of challenges. Often, these are located in brownfield sites which require remediation and extensive infrastructure alterations. Integration of new and existing systems demands a detailed understanding of compatibility. We perform extensive building surveys to provide critical calculations and input for the design phase.

Key challenges arise on most heritage projects, further complicated by the need to work within a fully operational building environment. Undertaking remedial work demands exceptional technical skills. The interventions should be sympathetic with the design intent of the original building to preserve the grandeur. Working carefully with the building fabric, we thread new structures and services through existing buildings. Our design solutions meet today’s requirements to create a modern visitor experience.

The New Rijksmuseum, Amsterdam

Before the renovation, the 19th Century museum lacked space for the distribution of modern-day installations. The beautiful vaulted ceilings were covered to disguise the building services.

With the passing of time, natural light had been reduced by obscured windows and suspended ceilings. The refurbishment design intent was to reinstate daylight at the Rijksmuseum and to emphasise the beauty of the historic ceilings in the galleries with the careful use of electric lighting.

In order to revert to the original architectural splendour, our team focused on the sympathetic integration of all services, whilst recovering the original geometry of the museum and its space.
Spaces for contemporary art

Competing global cities in the 21st Century often showcase their cultural aspirations by commissioning stunning new art galleries. These can take many unusual forms, reflecting fresh ambition and desire to experiment with design.

The design of contemporary new spaces is often a quiet nod to cities’ indigenous materials and heritage. By incorporating exposed structural elements, rough finishes and factory or loft-like lighting, the new art galleries can mimic the look and feel of industrial interiors.

New art galleries can make specific demands upon architects, designers and engineers. For instance, installations incorporating digital displays may necessitate the inclusion of specific conditions such as total blackout or acoustic separation between display areas. Temporary exhibition spaces need to be flexible to meet the needs of many different exhibits in terms of lighting, power and environmental control. Our solutions must enable efficient change over between exhibitions whilst providing a pleasant visitor experience for even the busiest times.

The design of contemporary spaces is a delicate balance between the architecture and engineering. Achieving seamless, clean lines whilst utilising innovative technology to showcase beautiful art is at the heart of our engineering design.

**Jumex Museum, Mexico City**

Detailed examination of the purpose and function of the spaces influenced the architecture and engineering of the Jumex Museum building. The most defining feature is the asymmetric saw-tooth roof, inspired by Jumex’s factory-space origins.

The minimalist aesthetics disguise the extensive technical services that are required to meet the exacting curatorial demands for the display of artwork. Our engineering response to the architectural vision for a monolithic treatment of walls, floors and ceilings was to seamlessly integrate the air, lighting, power and daylight controls within the architectural finishes. The result is the uncluttered geometry of the space.

1 Art Institute of Chicago, The Modern Wing, Chicago, USA ©Charles G. Young, Interactive Design, Architects
2 Whitney Museum of American Art, New York, USA
3 Jumex Museum, Mexico City, Mexico ©Simon Menges
4 Turner Contemporary Art Gallery, Margate, UK ©Richard Bryant/arcaid.co.uk
Industry, science and technology

Industry and science museums house exhibits which are frequently large in scale. These vary from planes, boats and trains, to scientific and natural history collections, industrial works and mechanical models. Arup has designed some spectacular museum buildings where leisure, heritage, conservation and education intersect.

In addition to clear lighting, comfortable and accessible environments, the technology exhibits come with the expectation of hands-on interactivity. Collections and artefacts, being more robustly constructed, are usually less sensitive to environmental variation than objects of fine art. Nonetheless, there will be some sensitive objects which require a higher level of environmental control to provide local micro-climate control, or a buffer zone. We often avoid the need to closely condition the whole space.

Scale, motion, sound and dynamic lighting may be used to create an exciting visitor experience, often with a particular focus on school children and family groups. Constant pressure for exhibits to evolve and adapt to the advanced technology means flexible and multifunctional engineering design services.

Museum of Polish Aviation, Krakow

The museum’s concrete ‘wings’ fold over the glass sidings like a piece of paper. Inspired by aeronautical themes and the art of origami, the structure resembles an aircraft’s propeller when viewed from above.

Constructed using architectural concrete, the award winning building houses a large aircraft collection, including aerodynamic tunnel and flight simulators. Our advanced structural design, mechanical and electrical services helped the architectural vision of a bold and original building to be fully reflected in its final shape.
Climate control and air quality

Designing the environment within a museum or gallery is a combination of art and science. Creating appropriate atmosphere for art works and antiquities involves making expert decisions on temperature, humidity, air filtration and noise levels.

Archives with relatively low occupancy and heat load benefit from a high thermal mass fabric that provides stable environment. Galleries, on the other hand, require a rapid response to the constantly changing conditions generated by a flow of visitors. This can be achieved by a low thermal mass fabric and robust mechanical conditioning. A buffer zone approach is often effective where spaces are less climatically-sensitive. This passive approach protects the exhibits.

Considerable emphasis must be placed upon limiting the exposure of art objects to gaseous and particulate contamination. Airborne pollutants may react with the pigments in paints, act as bleaching agents, or degrade metals. Frequent cleaning to remove dust increases the risks of wear and accidental damage.

Precious works of art require closely controlled climate where maintaining stable temperature and humidity is essential. Museums with fewer environmental controls can choose simpler options with significantly lower maintenance costs.

The Perez Art Museum Miami

One of the most striking features of the building is the structural canopy with hanging branches of native vegetation. Designed as delicate lattice, it is made of pre-cast concrete and sustainable hardwood timber.

Based on detailed calculation projecting shading, sun exposure and solar penetration throughout the day, we created a structure that is responsive to the Miami climate as well as to the shape of the building. The unique vertical garden canopy is a fusion of advanced technology and compelling aesthetics.

1 The Perez Art Museum Miami, Miami, USA
2 Oita Prefectural Museum, Oita City, Japan ©Hiroyuki Hirai
3 Art Institute of Chicago, Modern Wing, Chicago, USA ©RPBW, Nick Lehoux
Natural lighting

Adopting sophisticated solutions and approaches using natural light can create drama without sacrificing the sensitivity required in lighting valuable exhibits. A preferred option for rooms where paintings and sculptures are displayed, the use of natural light can add substantially to the visitor experience.

The variability of daylight can be an asset. This alters subtly the ambience of gallery interiors during the day, providing a visual link to the outside world. Generous natural light flow in corridors or rest spaces between galleries provides visitors a chance to relax and rest their eyes before moving on.

Use of daylight plays an important part in creating a low-energy building, which can offset the use of electric lighting. The uncontrolled nature of daylight poses specific challenges for museums and galleries. Sunlight can overheat or flood a space with illumination that is too intense for the artworks.

In order to prevent damage of light and heat sensitive exhibits or historic interiors through over exposure from the elements, our designs rigorously adhere to conservation guidelines. We implement active and passive solutions for the control of extremes of light, heat and ultra-violet (UV) radiation.

Saint Louis Art Museum, East Building

The East Building uses the uniquely designed lighting device, Light Spreader, to control light in the galleries, together with the skylights and concrete coffer structure. The system provides uniform lighting whilst protecting the artwork from fading caused by excess light exposure.

The Light Spreader device diffuses daylight and fluorescent and accommodates daylight reduction layers for sensitive art areas. Controls automate ambient, wallwash and accent circuits, switched at different daylight levels for energy and lamp maintenance savings. The device accommodates an array of integrated functions and features. These include energized lighting track, security sensors, cameras and speakers, cleverly disguised within its elegant design.

1 Parrish Art Museum, New York, USA ©Matthu Placek
2 North Carolina Museum of Art, Raleigh, USA ©Scott Frances
3 Saint Louis Art Museum, East Building, Saint Louis, USA ©Simon Menges
4 Clyfford Still Museum, Denver, USA ©Jeremy Bittermann

Overleaf

5/6/7 Los Angeles County Museum of Art (LACMA), Los Angeles, USA ©Michel Denance
Electric lighting

With the potential to change our perception of architecture and public space, sophisticated lighting design accentuates, sculpts and inspires. The effective illumination of façades and landscape can provide a distinct identity at night time. As visitors enter the building, an integration of electric lighting assists with orientation, providing a clear sense of direction through the public space.

Artificial lighting in galleries plays a fundamental role in how exhibits are experienced by visitors. The interplay between light and shadow creates visual interest and excitement whilst increasing vividness. It is essential these aesthetic aspirations are carefully balanced in order to meet conservation requirements of the collections.

The lighting systems should adapt to changes in brightness during the day and introduce the right volume of artificial illumination according to the amount of daylight available at the time. Temporary exhibition spaces may display works on paper that require low lighting, alongside sculptures where reflection and glare bring very different constraints. Clearly, flexibility is key.

As more museums adopt solid state lighting and smart technology, it is important the drive to save energy does not compromise the lighting quality. With this in mind, our designers create expressive and sustainable lighting concepts for museums and galleries.

New Acropolis Museum, Athens

As dusk falls, the electric lighting illuminates this beautiful museum, creating a key narrative element. Lighting is dramatic, punctual and carefully manipulated to highlight the contrast between existing and missing artefacts; helping the visitor distinguish the surviving collection. Careful consideration is given into ‘framing’ with spotlights only the exhibits, thus avoiding visual disruptions and intense shadows.

Arup’s holistic design approach choreographs the play of light and shadow with both daylight and architectural light, enhancing the experience and revealing the form with the unique detailing of the exhibits.

1 Brandhorst Museum, Munich, Germany ©Hufton+Crow
2 Vivid 2014, Sydney, Australia ©BlueprintStudios
3 Vivid 2015, Sydney, Australia ©Flora Sacco
4 New Acropolis Museum, Parthenon Gallery, Athens, Greece ©Peter Mauss & Esto

Overleaf
5 Perez Art Museum Miami, Miami, USA ©Iwan Baan
Fire safety

Fire safety cannot be understood in isolation. Fire engineering often negotiates a delicate balance between competing demands of innovation in design, sustainability, functionality and performance. Safeguarding precious objects in open display spaces while maintaining the flow of visitors and safety of staff are some of the challenges to fire safety posed by museum and gallery buildings.

Whether providing hazard assessments, calculations of maximum population, or measures that limit smoke spread and fire damage, our work is grounded in science. We bring insight into risk and human behaviour together with advanced techniques in simulation and analysis. Our shared global practice and international investment in research allow our specialists to stay at the forefront of fire engineering.

Our holistic approach transcends the design stage ensuring safety both during construction and in operation. Our bespoke solutions surpass life safety requirements and ensure robust protection of the building, its occupants and exhibits, with minimal aesthetic intrusion into the architecture and displays.

Royal Academy of Arts, 6 Burlington Gardens, London

6 Burlington Gardens form part of the Royal Academy of Arts’ extensive refurbishment project.

Through close collaboration with the Royal Academy, architects and insurers, Arup has developed a fire strategy, meeting architectural aspirations, property protection criteria and business continuity within the heritage constraints of the project.

The strategy facilitates a substantial increase in the permitted occupancy levels within the building, minimising the impact on the net usable area for the gallery spaces.

1 Royal Academy of Arts, London, UK
2 Waterford Medieval Museum, Waterford, Ireland ©Waterford City Council
3/4 Corning Museum of Glass, Contemporary Art + Design Wing, Corning, USA ©Iwan Baan
Building structures

The aspiration of contemporary architecture for museum and gallery buildings presents specific structural engineering challenges. The complex geometry of large open display areas, frequently favoured by gallery designers and curators, is possible by implementing long-span structures. The depth, weight and construction cost of such ambitious structures are often confined and require the appropriate load capacity for the exhibits.

Pursuing the flexibility of layout and exposition is key in meeting demands of various art exhibitions. The physical space, for example, could be re-purposed for events or temporary sculptural commissions. The implications of specifying a high degree of flexibility for display areas and routes through the building need to be considered at an early stage. This means that walls, ceilings or floors may be designed for the high loads imposed by heavy installations. Once established, we optimise structural efficiency in order to develop viable, cost-effective solutions which do not restrict future use of space.

Museum and gallery spaces often require a high degree of integration of structure, architecture and building services. We apply multidisciplinary approach to building design to deliver stable, durable and elegant buildings.


The sensitive refurbishment of the former ammunition store breathed new life into an under-used heritage building, creating a world-class gallery space. The client’s vision called for a design that did not distract from the art on display and a flexible extension space in which they could host a variety of functions.

Arup developed an extraordinary fabric roof and supporting steelwork that required the balancing of the architect’s sculptural aspirations with thermal and daylighting requirements. The fabric design pushes the limits of a pure tensile structure geometry and material capability to achieve an optimum solution.
Temporary pavilions and art installations

Arup is committed to design and innovation. We often participate in the design of small scale sculptures and installations for festivals; allowing our creativity to flourish. This also provides an opportunity to experiment and play.

Temporary, nomadic buildings can provide interim accommodation for museum and gallery collections, or form an integral part of travelling exhibitions. These installations can often be seen as exhibits in their own right. We have worked on temporary facilities for a range of artworks, museums and commercial displays with both artists and architects.

When a pavilion is not expected to last for years, we can be even more imaginative in its form, function or materials. The short-term nature of such buildings or installations allows for experimentation that may simply not be possible in structures that are permanent.

We apply the same skills to the design and construction of temporary pavilions, displays or installations that we bring to museum and gallery projects. We excel in the delivery of these fast-paced programmes, exploiting our expertise in creative problem solving and our knowledge of 21st Century technologies and fabrication.

Unnumbered Sparks by Janet Echelman, Vancouver

Created for a TED conference, the monumental interactive sculpture spanned 750 feet floating in the sky above Vancouver. At night the artwork came alive with illumination as visitors were able to choreograph the lighting in real time through their smartphones.

In order to achieve such scale and complexity, Arup created the geometric and structural design for the pre-stressed rope network from which the hanging nets were suspended. We developed software tools for designing the rope networks and analysing the complex interaction between wind loads; together with the strength and form of the sculptural net. The project embodied the infusion of art, engineering and technology, working symbiotically together.

1 Double Space for BMW - Precision and Poetry in Motion, Victoria & Albert Museum, London Design Festival, London, UK ©Glasshopper / Nicholas William Eagland
2 Skies Painted with Unnumbered Sparks by Janet Echelman, TED 2014, Vancouver, Canada ©Ema Peters
3 MPavilion, Melbourne, Australia ©John Gollings
4 Endless Stair, Tate Modern, London Design Festival, London, UK ©Mark Thomasson
Information and communication technology

Gallery and museum visitors are increasingly sophisticated, with user expectations becoming ever more aspirational. Visitors anticipate a wonderful modern cultural experience, even in the most classical and historical setting.

Information and communications technology (ICT) used both front-of-house and behind the scenes can enhance the visitor experience, generate revenues and reduce operating costs. ICT is an essential consideration in all cultural facilities, not just in museums of science and technology.

Focusing on present and future operational needs, we have developed unique models for improving the museum or gallery services offer, such as supporting media for contemporary art forms, information display, visitor orientation and ticketing.

We use our skills and experience across the whole built environment to take us further, leveraging technology to create truly clever solutions. We utilise technical integration and systems interconnectivity to create truly clever solutions. The use of ICT often leads to improved energy efficiency, maximising comfort for the occupants.

1 Macau Science Centre, Macau, China ©Marcel Lam Photography
2 California Academy of Sciences, Golden Gate Park, San Francisco, USA ©Tim Griffith
3 The Perez Art Museum Miami, Miami, USA ©Iwan Baan
4 Saint Louis Art Museum, East Extension, Saint Louis, USA ©Simon Menges
Simulations and prototypes

There can be no substitute to standing in a recently completed museum or gallery, experiencing the look and feel. Virtual models, physical prototypes and interactive 3D modelling often play an essential role in helping clients and designers to make informed choices during the design process. Proven methodologies help with a variety of technical aspects of a building prior to construction.

We have developed a range of advanced computational tools for analysing the performance of systems within buildings. Dynamic thermal modelling software predicts energy usage and climatic stability of environments suitable for art conservation. Ray-tracing software examines the entry and flow of natural light into gallery spaces. This is instrumental to achieving uniformity and for the management of light exposure.

Physical modelling, ranging from small to full-scale prototypes, is frequently used for deciding what type of daylight control systems or architectural finishes will be the most appropriate. Prototypes are often built on site to see interventions, examining how these will work in practice. Physical models allow clients and designers to experience the space virtually, providing a different perspective from a computational study.

Harvard Art Museums, Cambridge

The recent renovation of Harvard Art Museums is a great example how architecture can be informed and shaped by daylight. The slanted roof of the lantern comprises a series of intricate layers. These provide perfect light conditions to accommodate visitors and conservators.

In order to achieve this level of daylight control and flexibility, we used a full-scale prototype of the ‘lantern’ skylight. We carefully assessed the daylight conditions, the interaction with sunlight and the effectiveness of the proposed shading systems, both visually and numerically. This helped to design the optimal conditions for conservation laboratories, classrooms as well as galleries while realising the architect’s vision of a striking contemporary museum.
Building Information Modelling

A highly integrated design can be achieved through the application of modern software technology and data management processes, simply described as Building Information Modelling (BIM). The advantages realised as a result of implementing BIM are numerous. These often include improvements in the quality of the final built asset, reductions in construction and operational costs, and substantial mitigation of project risks.

The advantages of BIM are particularly relevant to museum and gallery projects. Virtual models of the building can be used to simulate and optimise the visitor experience before expensive construction activities commence. Curators and operations managers can visualise complex activities, which are often critical to design development due to the invaluable and fragile nature of the artefacts involved.

The virtual models also serve as vessels for much of the data required to run the building once in operation. The digital information can be made available at the fingertips of those entrusted with keeping the building comfortable and suitable to display the often delicate objects.

Victoria & Albert Museum, Exhibition Road, London

The Exhibition Road underground extension will house new galleries for the V&A’s internationally renowned temporary exhibitions. Above the galleries, a public courtyard will allow the visitors to enjoy this new space within the historical setting of the museum.

The long-span courtyard structure, which also forms the ‘folded-plate’ gallery ceiling, required complex geometrical solutions. This unusual relationship of architecture and structure could only be understood in 3D. We used BIM to take the client on a virtual tour around the building to understand the engineering aspects of these spaces. This helped to exploit the site to its full potential. We have brought efficiencies to the new galleries and art handling facilities whilst reducing the risk to existing structures.
Building performance and systems

The controls and commissioning designs, along with uninterrupted operation of building systems, are increasingly more demanding and sophisticated. Efficient environmental systems are integral to the function and conservation requirements, promoting optimum level energy use and cost savings.

We offer services throughout the entire building life-cycle, along with independent advice on the selection and specification of custom-designed systems. Controls and commissioning designs are essential in the early stage as part of the design brief and specifications. Once in operation, we provide performance review, occupant feedback and energy audit to ensure buildings function efficiently in a safe environment.

We approach each project individually by analysing client specific needs and developing suitable, cost-effective solutions. We design simplified controls and processes to allow our clients to effortlessly operate often complex and bespoke systems required for museums and galleries. Due to our involvement in the design process, many institutions have been able to meet earlier opening dates with full confidence in their building system and safe performance.

Victoria & Albert Museum, Medieval and Renaissance Galleries, London

We have designed a control system at V&A which meets the environmental criteria without the need of mechanical cooling or humidification. The innovative design measures both the internal and external absolute moisture content and the room temperature. At the same time this monitors the speed of the fans in order to blend the outside air with ambient atmosphere to maintain precise environmental humidity.

The cutting-edge design has resulted in significant capital cost savings on plant and reduction of ongoing maintenance and running costs. At present we are working closely with the museum to develop comparable humidity control system that will be gradually implemented across other galleries.

1 Victoria & Albert Museum, Medieval and Renaissance Galleries, London, UK ©Alan Williams Photography
2 Turner Contemporary Art Gallery, Margate, UK ©Hufton+Crow
3 Victoria & Albert Museum, Europe 1600-1800 Galleries, London, UK ©David Grandorge
Working with artists and designers

Artists and designers are often fascinated by scale and size. Large-scale installations tend to require engineering support to help transform their ideas into physical form. Respecting the essence of what an artist is aiming to do, we can make projects work in the best way possible while achieving a complete expression of the individual’s creative vision.

Art projects are often conceived, designed and executed in a matter of weeks. Particularly, where temporary interventions are concerned, speed of construction is crucial. Our understanding of structures and systems for museum and gallery buildings means we can also help exhibition designers deliver exhibit supports, cases and vitrines that are in sympathy with the design intent of the space.

Arup has long specialised in the realisation of fantastic forms. In collaborating with artists we have opportunities to explore the potential of new materials and push the boundaries of analytical techniques. It is stimulating to work on non-functional structures such as sculptures. We have a track record of working with world renowned artists on installations of the most challenging scale and ambition.

ArcelorMittal Orbit by Anish Kapoor, London

Standing at 115 metres, ArcelorMittal Orbit is Britain’s biggest structural artwork, providing unparalleled views of the Olympic Park and London’s skyline from its viewing platforms. The Orbit’s challenging form, a continuous, looping lattice of tubular steel, was developed through a close collaboration with the internationally renowned artist, Anish Kapoor.

Taken from concept to completion in only 24 months, the tight timescales were achieved through effective coordination of design, manufacture, installation and commissioning tasks that were heavily concurrent. Arup demonstrated the value, resources and capabilities that we brought to the realisation of this new iconic landmark for London.

1 ArcelorMittal Orbit by Anish Kapoor, Olympic Park, London, UK
2 Up, and Away!, Sydney, Australia ©Frank Maguire

Overleaf
5 Sydney Opera House light installation, Vivid 2014, Sydney, Australia ©Blueprint Studios
Façades

Façades are frequently the first impression we have to form the relationship with a building we are about to enter. The façade has a specific role in achieving precise and stable conditions, by acting as a buffer between internal and external environments. It is critical that temperature and humidity are tightly controlled whilst taking into consideration solar, thermal and ventilation strategies which can influence the sustainable design and operation of the museum.

In order to prevent variation in the temperature, thermal mass in the building envelope is important. Large areas of glazing promote natural light and are often desirable. The thermal performance of any glazing system, however, must be sufficient to maintain internal gallery temperatures where artefacts are displayed.

Museums and galleries are often humidified, far more than other building types. This means that the risk of moisture moving through the façade is far greater. To avoid condensation, cladding details robustly control this movement. Where the aesthetics require frameless glazing, glass walls can be layered to provide insulation and good condensation performance.

Exhibits must be protected from UV and solar radiation. We advise on appropriate coating selections to prevent solar heat gain and glass transmission selectivity that will limit UV light yet achieve true colour rendition.

Whether a contemporary urban sculpture or an outward symbol of history, façades create vibrancy and excitement as well as a special visitor experience.

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National Gallery Singapore

The National Gallery sensitively joins two of Singapore’s most historic buildings, the Supreme Court and City Hall, linking these via a new public plaza with a steel, glass and aluminium canopy.

Dappled light that filters into the space is a result of material exploration by the Arup façade team. High performance double glazed units combine with folded metal screens to generate the patterned shading beneath. The screens then swoop down to form awnings over the entrances.

1 National Gallery Singapore, Singapore ©Darren Soh
Acoustics and audio visual

Museum and gallery acoustics greatly affect how the space is perceived by artists, curators and the visitors. The design treatment will vary depending on how a building is used and the specific collections or exhibits that may be displayed.

Audiovisual tools are used in increasingly sophisticated ways, including availability of detailed information about displays to visitors in multiple languages. We select technologies according to need, independent of specific product affiliations, and tailor our designs to suit the demands of the project and the client’s budget.

In designing new museum spaces, and working with sound artists, we use revolutionary auralisation tools, such as Arup SoundLabs. These demonstrate the sound of a particular gallery, or of an audio installation in a specific space, before it is realised. Assessments for environmental, mechanical services and structural noise, reverberation and vibration also contribute to effective museum and gallery design. We are experienced in ensuring that the aural experience is appropriate to the particular exhibit and in effecting sound isolation between spaces.

Sonic Shadows by Bill Fontana, San Francisco Museum of Modern Art

This extraordinary sound art piece was created for the 75th anniversary of San Francisco Museum of Modern Art. Sounds collected by accelerometers in the roof-top mechanical plant are transmitted in real time onto a custom playback system of four ultrasonic emitters. The flat-panel, laser-like loudspeakers are attached to automated devices which move ‘beams’ of sound along choreographed trajectories.

Arup designed a bespoke software interface which controls the spatialization of sound, audio routing and movements of the emitters. The piece creates a unique sense of acoustic space, translating the artist’s interpretation of architecture and the building’s ‘respiratory system’ into a dynamic aural experience.

1 Clyfford Still Museum, Denver, USA ©Jeremy Bittermann
2 Walt Disney Family Museum, San Francisco, USA ©Cesar Rubio
3 Sonic Shadows by Bill Fontana, San Francisco Museum of Modern Art, San Francisco, USA ©Don Ross
Security

Whilst logical it is not reasonable that precious items are hidden from view in secure storage vaults. Museums and galleries protect and preserve as well as allow public access to view and admire rare artefacts. Achieving the right balance between security and public display is paramount.

We provide advice based on the international best practice to reconcile the requirements of the security team with those of curatorial staff and visitors. When working with museum and gallery clients to design security plans, we start with a threat and risk assessment to gain a thorough understanding of how each building will be used. We develop protection strategies based on the concepts of deter, detect, delay and deny.

The tools available in security design include coordinated emergency escape procedures, electronic monitoring and detection systems, planned response procedures, specially-hardened secure stores and operational plans. Furthermore, counter-terrorism services such as places of refuge and provisions against chemical or biological attack are often considered.

Ensuring back-up security facilities and suitable arrangements for works of art on loan are also important. An effective security plan balances the organisation’s physical requirements, costs and operational procedures, whilst improving visitor experience.

British Museum, World Conservation and Exhibitions Centre, London

The new World Conservation and Exhibitions Centre (WCEC) houses world-class facilities for storing, conserving and exhibiting art. The project provided an opportunity to update the existing electronic security systems, and to integrate these into upgraded control systems, in order to improve existing exhibition space and storage conditions.

Keeping the WCEC works contractually separated from the rest of the museum’s security upgrade presented Arup with its biggest challenge and was essential in order to maintain a fully operational museum during construction. Arup successfully delivered the physical and electronic security measures, whilst meeting the exacting building aesthetics.
Digital foresight and innovation

As we live increasingly mobile, digital and virtual lives, with personalised user experience at our fingertips, museums and galleries are looking for new ways to tell stories and engage their audiences. In the future, museums and galleries will continue to be shaped by a wide variety of trends.

Our foresight and innovation services focus on helping museums and galleries understand these trends, develop robust visions and strategies and explore future visitor experiences. We cover medium to long-term developments with the framework of society, technology, economics, environment and politics. We deliver in-depth and custom-made trend analyses that help organisations prepare for change within their specific context and market.

A common vision ensures that different components and contributors of a programme can effectively work towards a common goal. We specialise in co-creating visions that provide the overall direction and framework for an organisation, project, or initiative. These visions support strategy, collaboration, creative thinking, design innovation and leadership.

The innovation is driven by ‘technology-opportunity’, and crucially by what experiences we would create for people. User journey and experience design allow the analysis and conceptualisation of new innovation opportunities, helping communicate and share new ideas and allowing museums and galleries to explore new ideas through a different lens.
About us

Arup is a global firm of engineers, designers, consultants and technical specialists offering world-class multidisciplinary services with a particular focus on sustainable design. Through our work, we make a positive difference, we shape a better world.

Founded in 1946 with an initial focus on structural engineering, Arup first came to the world’s attention with the structural design of the Sydney Opera House, followed by our work on the Centre Pompidou in Paris. Arup has since grown into a truly multidisciplinary organisation, working together with leading architects as well as emerging talent to create some of the most striking galleries and museums in the world.

Arup brings together broad-minded individuals from a wide range of design spectrum. We add value to projects through technical excellence and innovative thinking.

Having long worked with major institutions on the development of spaces for the display and conservation of collections and exhibitions, we bring arguably the finest international experience to museum and gallery projects.