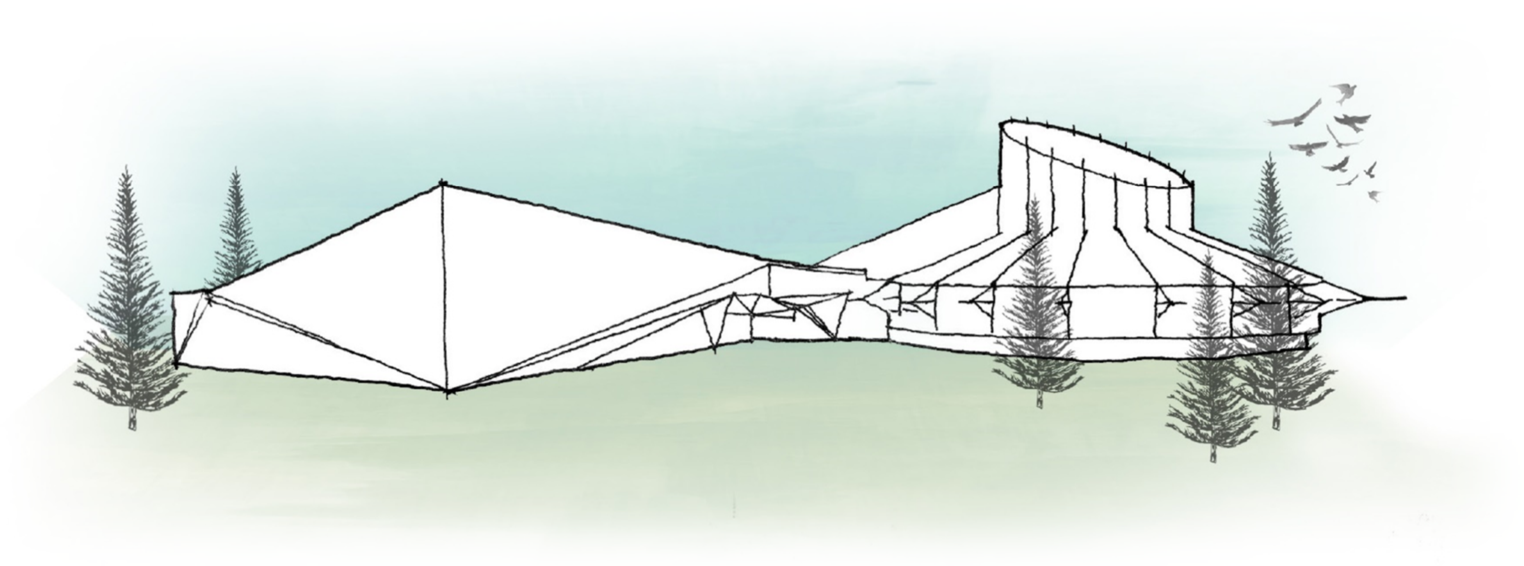
TELUS WORLD of SCIENCE Edmonton

Aurora Expansion

Canadian Consulting Engineering Awards 2023

DIALOG



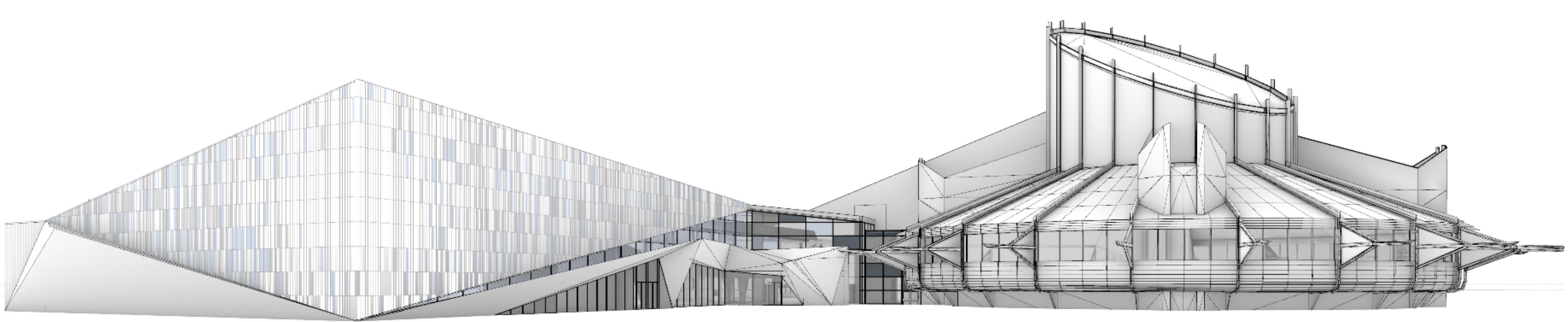
Project Summary

TELUS World of Science Edmonton (TWOSE) is *the* destination to engage Albertan's hearts and minds in science. Located in Coronation Park, Edmonton, Treaty 6 Territory and Metis Nation of Alberta Region 4, TWOSE's mission is to ignite curiosity, inspire discovery, celebrate science, and change lives.

DIALOG was engaged to provide architectural and engineering design services for the renovation and expansion. The vision for the facility aligns well with DIALOG's core values, which include meaningfully improving the wellbeing of our communities and the environment we all share. In 2019, over 550,000 patrons visited the science centre to explore the galleries, catch an IMAX show, or browse the gift shop. TWOSE hosted 86,000 students from 656 schools, shaping the minds of our future scientists through interactive, curriculum-based programs. For Albertans who live a bit too far from Edmonton, TWOSE also provides outreach services, visiting 96 schools in 60 rural communities.

The Aurora Expansion is the final and most impactful stage of the multi-year, multi-phased Aurora Project. The expansion includes the following:

- A science gallery devoted to understanding the complex and vitally important science of the polar regions.
- A new science-based pedestrian-oriented entrance forecourt leading to an expanded lobby with a new box office, founders' room, indigenous traditional room, and gift shop.
- A reimagined entrance to the building, creating a naturalized, interactive programmable forecourt in a pedestrian-first environment.



Integrated Design

TWOSE engaged DIALOG based on our integrated design approach and our history of working with the science centre over many years, dating back to the expansion of the original, Douglas Cardinal designed building in 2001.

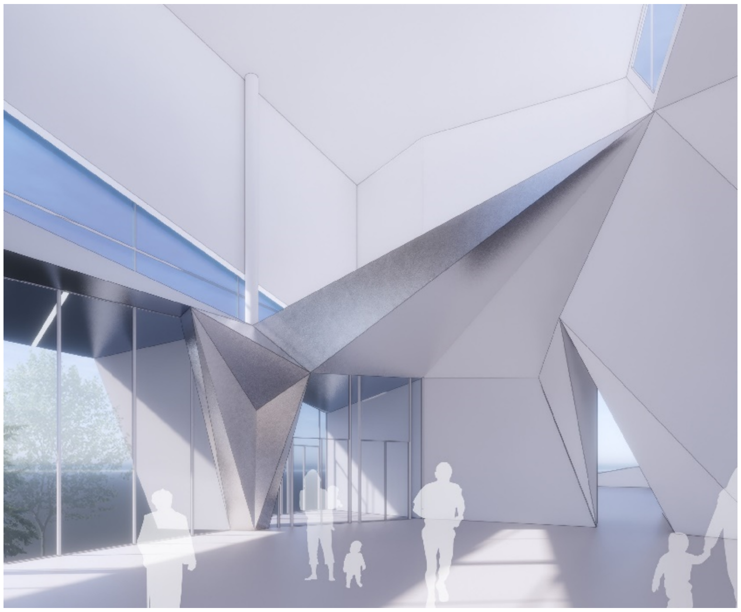
DIALOG provided the following consulting services, from design through construction:

- Structural Engineering
- Electrical Engineering
- Mechanical Engineering
- Architecture
- Landscape Architecture
- Interior Design

A collaborative approach to design was applied to successfully execute this complex and highly technical project. Imaginative and innovative approaches to detailing as well as interfacing between existing engineering systems and architectural finishes were critical to making this project a success. Limiting the interface between old and new makes expansions much easier, but the goal of this project was to expand the open space with a grand lobby, utilizing a consistent design language. Removing a significant portion of the existing building envelope and increasing interface area between old and new was a challenge for the design and construction team, but taking a single step into the breathtaking new lobby makes it all worth it.

To develop the design and create construction drawings, the DIALOG team worked in three dimensions. The 3D model was instrumental in the success of the project, as 2D drawings could not fully explain the complex geometry of the walls, ceilings, and roof lines.

The construction team took advantage of the 3D model to assist in visualization of building components prior to constructing. This integrated 3D modelling approach helped identify and mitigate project risks from an early stage.



Architectural Design

The architectural design respects and enhances the existing building and Coronation Park. With a subtle transition in form, materiality, and patterning, the design creates a dialogue between the old and new. The new building introduces architectural features that echo the existing building, like the sharp edges that mimic the original Cardinal building.

The Arctic Gallery is the main massing element of the expansion. With its angular form and varying metal colour on its façade, it is a metaphoric representation of a melting glacier. The south facing wall of the Arctic Gallery appears to fracture revealing a pattern of blue glazing.

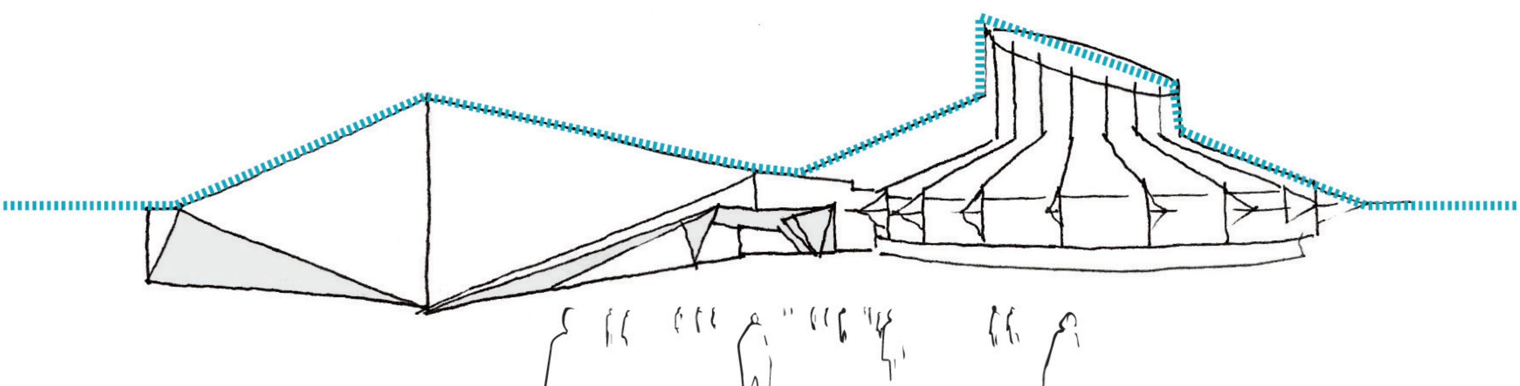
A continuous folding architectural feature starts from the roof and connects the building back to earth, creating three main anchor points rooting the building into its context and functioning as water collection channels – collecting, redirecting, and celebrating water as it feeds the local planting.

The folding plane wraps around the main entrance vestibule creating a strong visual and spatial definition of the building entrance, welcoming visitors into the centre.

The renovation and expansion of the main floor is strategic with enlarged visitor services: increasing the size of the pre-admission lobby space, adding a new and larger gift shop, a new founder's room, and an indigenous traditional room. The new gallery space is dedicated to the science of the polar regions with an interactive, programmable media wall located on its prominent south-west corner façade.

The project reimagines the entrance to the building to create a naturalized, interactive programmable forecourt engaging visitors upon arrival.

The redeveloped visitor drop-off and separate bus loading zone creates a pedestrian first environment with enhanced connections to Coronation Park.



Structural Engineering

The Aurora Expansion project includes complex structural challenges including highly variable soil conditions and exposed structures with steep slopes, sharp angles, and complicated tie-ins to the existing building. Architecturally exposed columns and roof structure with an ambitious cantilever canopy structure necessitated thorough analysis and detailing to meet the structural and aesthetic requirements. Special detailing was required along the interface between the two buildings, allowing the transfer of gravity and lateral loads while allowing for differential movements between building, where appropriate.

The selection of the structural system for the main floor was driven by the in-situ subgrade conditions on site. Significant volumes of organic fill materials in excess of 4 metres deep were identified through the geotechnical investigation, which have poor load-carrying capacities and potential to contain harmful gases such as methane. The fill materials are not suitable for supporting a slab under permanent loading conditions and would have to be removed and replaced with engineered fill if a slab-on-grade system was selected.

Structurally, the main floor can be divided into two parts: the Gallery and Mechanical Room area on the western portion, and the Entrance Lobby and Gift Shop area on the eastern portion. Due to the heavier loading conditions, greater potential for future modifications, shallower anticipated fill soil depths, and fewer interfaces with the existing building, the Gallery and Mechanical Room areas are supported on a slab-on-grade system.

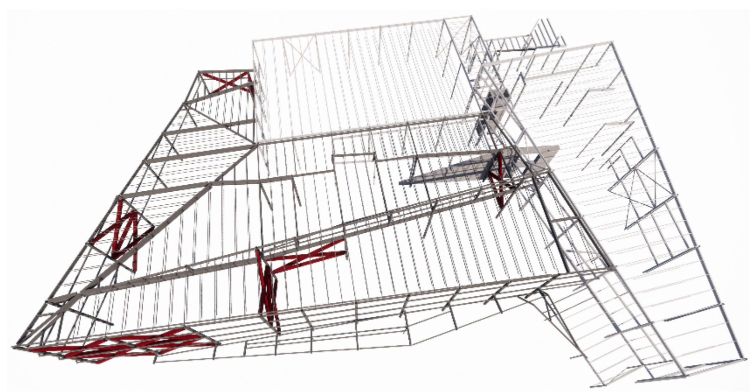
The slab-on-grade consists of a 150 mm thick floating concrete slab reinforced with macro poly-fibre reinforcement on a 150 mm thick compacted granular ventilation layer on top of compacted granular fill. The use of macro poly-fibre reinforcement over standard black bar reinforcement in the slab-on-grade improved the construction schedule by eliminating the rebar subtrade and placing time, was more cost effective, was more sustainable, and provided better performance with smaller shrinkage cracks forming due to the quantity, arrangement, and mechanical properties of the fibre reinforcing.

In the Entrance Lobby and Gift shop area there are smaller loads, less potential for future modifications, deeper fill materials and more interfaces with the existing building. For these reasons, a structural-slab-on-grade supported on cast-in-place concrete piles was used to form the main floor in this area. This structural system did not require the removal of the organic fill materials that extend as deep as 4m below grade, which would be extremely costly and time consuming. Since the fill materials were not removed, a methane mitigation system was required below the slabs, complete with a passive ventilation system and a liquid applied vapour impermeable membrane.

The new roof consists of several different sloped planes over two different levels. The vertical wall of the "Pop-up" roof separating the two different roof planes is clerestory glass, allowing natural light to pass through into the main floor areas. The new roof consists of steel decking supported on open web steel joists and steel W-beams, which match the construction and appearance of the adjacent existing gallery roof that is joined to the space. Several girders are cranked or bent at the various ridge and valley lines, forming the folded planes over the column-free gallery space as shown in the adjacent images. The steel columns, steel bracing, and girt connections are all exposed to view and are in close proximity to occupants. For this reason, this steel is finished to Architecturally Exposed Structural Steel (AESS) Level 3. The new roof elevation was selected to match the existing roof level, where possible, to reduce the impact of snow accumulation and drifting on the existing structure that would otherwise necessitate strengthening which can be costly.

The interface between the new and existing structures were often structurally connected to transfer gravity and lateral loads. This system was selected to eliminate the need for an expansion joint at the interface between the two buildings, which are costly and often lead to maintenance challenges over time. To achieve this system, a detailed analysis of the existing buildings lateral system was completed to ensure the impact of the new addition did not overload existing braces. Existing structures were analyzed to ensure that the new gravity loads being applied could be safely supported without strengthening in most instances.

A canopy is provided along the south edge of the building and is framed with structural steel beams and steel roof deck that extend up to 4m beyond the perimeter columns. Careful consideration was given to minimizing penetrations through the building envelope, minimizing the risk of water ingress and thermal bridging along this line. The canopy also extends into the building on the other side of the curtain wall.



Electrical Engineering

The electrical system design was selected to address the service needs generated by the buildings' program as well as allowing capacity for future gallery changes.

A major opportunity to improve the existing lobby was the implementation of LED lighting. The existing lobby, built in 2001, relied on 68 x 250W halogen lamps to illuminate the space. They were replaced with 34 x 42W LED fixtures. Not only do the new fixtures provide better illumination in the lobby, but they also provide over 90% energy savings.

The new gift shop and lobby area are illuminated using high efficiency LED downlights with hyberbolic reflectors to reduce occupant glare. Meticulous ceiling coordination was carried out in the 3D model to ensure that the playful, star-like lighting layout would maintain uniform illumination throughout the space.

An advanced centralized lighting control system was installed to keep building operation simple and straightforward, yet still provide powerful and accurate control over the new electrical systems. All new LED lighting is dimmable allowing TWOSE to set the ambience just right, whether they are hosting a school trip at 9am, or an adult's only event at 9pm. The control system is also tied into the gallery fit-up, allowing building operators to turn off gallery lighting, exhibits, and receptacles with the single press of a button. Outdoor receptacles are centrally controlled via the same system, and feature timeclock on/off scheduling. By making the control system easy to use, building operators are more likely to dim the lighting or turn off receptacles, ultimately saving energy and prolonging the life of the building assets.

Mechanical Engineering

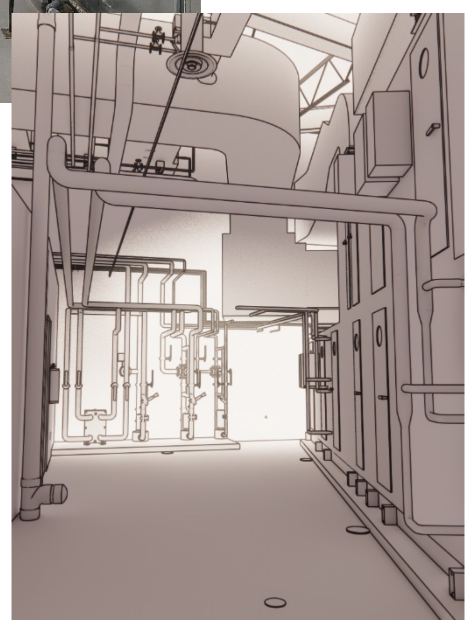
The mechanical system design was selected to address the service needs generated by the buildings' program, as well as allowing capacity for future gallery changes. Previous renovations within TWOSE added new systems and mechanical rooms with each new project, resulting in an inefficient system with many maintenance schedules and points of failure. The strategy for the Aurora project was to tie into existing systems where possible, adding resiliency and limiting duplication. A new high-efficiency condensing boiler was installed to tie into the existing system, adding redundancy and supplementing the additional loads required.

Visual connection between the interior lobby and the outdoor plaza was important, so rather than using large radiation cabinets, sleek low profile radiant cabinets were selected to fade away into the mullions. Trench heating systems were explored early in design, but maintenance and longevity concerns steered the project team toward the final radiant cabinet system design.

The mechanical engineering team used 3D modeling systems to design and coordinate mechanical rooms. By designing in three dimensions, the team could optimize the layout of the mechanical room while verifying that appropriate maintenance clearances were maintained. The mechanical room features a double door that goes directly outdoors, allowing maintenance personnel to bring parts and tools directly into the utility rooms without disturbing or damaging the gallery.

The gallery was designed for maximum flexibility with all-air systems. This keeps the walls free of radiant systems, allowing the gallery to take advantage of the full height of the perimeter walls.

The air handling unit serving the gallery includes a heat wheel, which uses warm exhaust to pre-heat the incoming air. This improves system efficiency in the winter months and contributes to the facility's overall energy efficient design.



Sustainability

Targeting LEED® Silver certification, the building and site are designed to inspire thought about our relationship with the local environment. Energy efficient buildings demonstrate a lower environmental footprint by saving energy, conserving water use, embracing healthy materials, building natural capital, and promoting wellness. This approach is enhanced by focusing on the community and ecology. Addressing issues such as water, air quality, and living in a cold climate, the project creates a story that is uniquely local.

A grid-tied solar PV array was installed as part of this project, contributing to the overall energy efficiency of the building. The 38.4 kWDC array is comprised of 96 monocrystalline solar PV modules, aimed south-east. The array is designed to generate over 40 MWh of electricity in its first year of operation, offsetting over 19,000 kg of greenhouse gas emissions. This is equivalent to offsetting 75,000 km driven by an average gasoline powered vehicle.

Water conservation was a major consideration for this project. Low flow fixtures are used in new washrooms. Storm water from portions of the roof and canopies is directed into wetland landscaping instead of the sewer system. The constructed wetland features native and drought-tolerant plantings to eliminate the need for irrigation with potable water.

The building is designed to promote energy efficiency, reducing electricity and gas usage and their impacts on atmosphere and air quality. Heating is decoupled from the ventilation in the lobby to provide comfortable conditions along the glass while saving energy. Glazing is located strategically to carefully manage solar heat gain: allowing heat to enter in the winter but providing shade in the summer. The new roof features a high albedo membrane to reflect solar rays that would otherwise contribute to higher heating loads in the building.

An energy model simulation was completed, considering envelope design, mechanical and electrical system efficiencies confirming that the building meets NECB for Buildings 2017. The final design models indicate 32% energy savings with 44% energy cost savings compared to the ASHRAE 90.1-2007 baseline building. As such, the project is targeting 17/19 LEED® Optimized Energy Performance points.

To further the educational narrative of sustainability and science, the project partnered with EPCOR to install a free-to-use Level 3 DC electric vehicle charger. In addition, future provisions for eight Level 2 charging connectors were provided, including underground infrastructure and electrical system capacity. The inclusion of these EV chargers and TWOSE's adjacency to Yellowhead Trail is a major benefit to Canada's initiative to provide coast-to-coast EV infrastructure, not to mention TWOSE's benefit of attracting out of town guests to the science centre while their vehicle is charging.

Closing & Team

The TELUS World of Science Edmonton Aurora Expansion is an example of what can be achieved through integrated design with a passionate and collaborative client. The total construction cost of $13.9m was under the $14.7m budget, with only 5% of construction cost due to change orders throughout this technically challenging renovation. The Design Development phase of the project was completed in early 2020, with the construction documents and construction phase of the project occurring through the COVID-19 pandemic. The construction schedule slipped by approximately one year due to pandemic restrictions, project complexity, and product lead times. However, the grand opening aligned well with the re-opening of many public services.

The result is a truly outstanding facility that strengthens the TELUS World of Science Edmonton's mission to ignite curiosity, inspire discovery, celebrate science, and change lives.

Project Team:

Structural Engineering: **DIALOG**
Electrical Engineering: **DIALOG**
Mechanical Engineering: **DIALOG**
Architecture: **DIALOG**
Landscape Architecture: **DIALOG**
Interior Design: **DIALOG**
Civil Engineering: **WSP**

Client: **TELUS World of Science Edmonton**

Construction Manager: **Delnor Construction Ltd.**