University of Waterloo's
Mike & Ophelia Lazaridis Quantum-Nano Centre

2013 Canadian Consulting Engineering Awards Submission
Technical Building Category

Halsall

Project Summary

The University of Waterloo's Lazaridis Quantum Nano Centre (LQNC) is a showcase for innovation. The building is a world-class facility providing the environment for exceptional research, collaboration and innovation. Built to bring together researchers from varied disciplines, LQNC exceeds expectations in vibration and acoustic control and electromagnetic interference for experiments at the "nano-scale".

The LQNC comprises three main buildings linked by a main atrium. The bar building to the north houses the Institute for Quantum Computing, the tall rectangular "honeycomb" building to the south houses Nanotechnology, and the low volume to the west houses the shared Metrology and Clean Fabrication laboratory suites. Structural subconsultant Halsall Associates applied creative solutions to overcome the complex geometric challenges and strict requirements, resulting in a world-renowned research facility.

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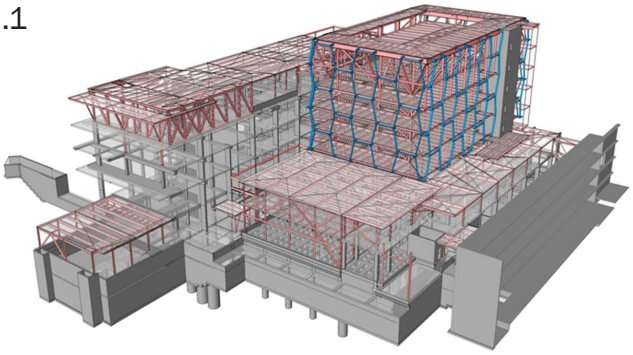

Photo:
.1 Revit Model (south exposure)
.2 Rendering (south exposure) c/o KPMB Architects

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Innovation

The complexity of the LQNC provided a unique challenge. This five-storey 285,000 ft^2 building, houses more than just offices, classrooms and interactive spaces. It includes laboratories to accommodate ultra-sensitive research at the atomic and molecular scale and a fabrication facility that will create nano-scale materials. All of this while providing the environment for world-class collaborative research.

In order to achieve the architect's vision, Halsall Associates developed several innovative solutions to ensure that the design responded to the building's architectural and engineering complexities. Steel played a significant role in facilitating the facility's strict usage requirements with sophisticated architecture. For example, the "honeycomb" structure is a dramatic focal point of the building that provides both support for the building and a stunning visual identity that helps the program and campus distinguish itself. The structural function of the honeycomb is to hang the floors from the roof and transfer the load to interior bays, thereby avoiding potential vibration transmissions to sensitive laboratory areas below the office spaces.

The characteristics of steel allowed several portions of the building to have generous cantilevers and transfer structures to allow for open spaces. Cantilever trusses occupy the roof and fifth floor of the mechanical penthouse. To support the floor structure below, one truss cantilevers over 7m to support the other truss, which spans over 21m.

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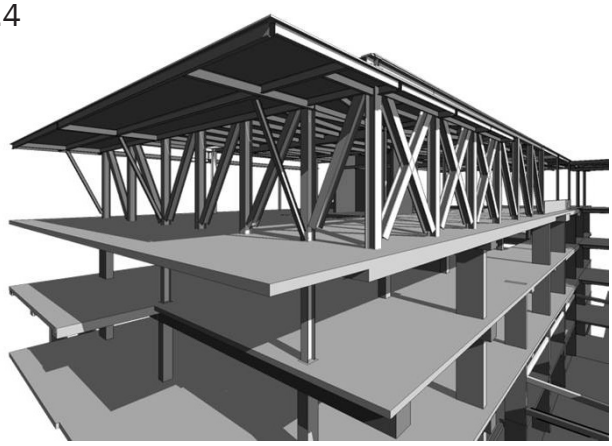

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Photo:
.3 Construction of the steel honeycomb structure
.4 Model of the cantilevered floors and trusses
.5 Construction of cantilevered floors and trusses

Additional innovations were implemented throughout the design of the floor structure. For example, many of the specialized laboratories were highly sensitive to electromagnetic interference and vibrations at quantum and nano scales. Glass fibre reinforcing elements were used in the floor structures to prevent electromagnetic interferences. Expansion joints were used to isolate areas of high vibration from the specialized laboratories, and waffle slabs were used in areas highly sensitive to vibrations. While it is uncommon to use steel for vibration sensitive areas, Halsall designed a two-way system using a steel structure, which in turn allowed for large column-free lecture rooms – a challenging architectural feature.

Often the architectural design of complex buildings of this nature is compromised due to the stringent technical requirements involved. The LQNC is innovative in that it fulfills its function as a world-renowned research and testing facility, while doubling as an architectural showpiece. Stephen Hawking described the LQNC as “a work of architectural genius,” and in 2010 the project was recognized by the Canadian Institution of Steel Construction with an Award of Excellence for its innovative use of steel.

Photo:
.6 Rendering (east exposure) c/o KPMB Architects

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Complexity

The design of the LQNC called for a number of complex engineering challenges, including open column-free spaces, large cantilevers and complex mechanical systems.

One of the biggest design and construction challenges was the mitigation of vibrations and acoustical transmissions. Due to the sensitivity of the research labs that accommodate “nano-scale” testing, everything from site selection to acoustical detailing to foundation and superstructure design was critical to the design. The vibration criteria (VC-E) needed for some of the laboratory spaces were extremely stringent. For example, the VC-E required for the clean room was 3 micrometer/ sec –that’s 162 times more stringent than what is required in office spaces

The LQNC consists of laboratories surrounded by circulation and office spaces that extend over laboratories on the second floor. The architectural and vibration limitations did not permit columns around the edge of the building, so the perimeter is hung from the roof structure, much like the structure of a mushroom.

The architectural “Parti” had different functions integrated within laboratory spaces to promote collaboration and diversity, so our mission was to design a structure that met the technical needs of the building and the architectural vision. Concrete waffle slabs mitigate vibrations like those caused by people walking in the hallways adjacent to the laboratories. These slabs provide incredible strength and stability to the structure, and are proven to be very effective in mitigating low-frequency vibrations. The ribs in a waffle slab also provide low floor deflections compared to other types of suspended floor structures.

Photo:
.7 Ground floor waffle slab
.8 Installation of steel cantilever trusses

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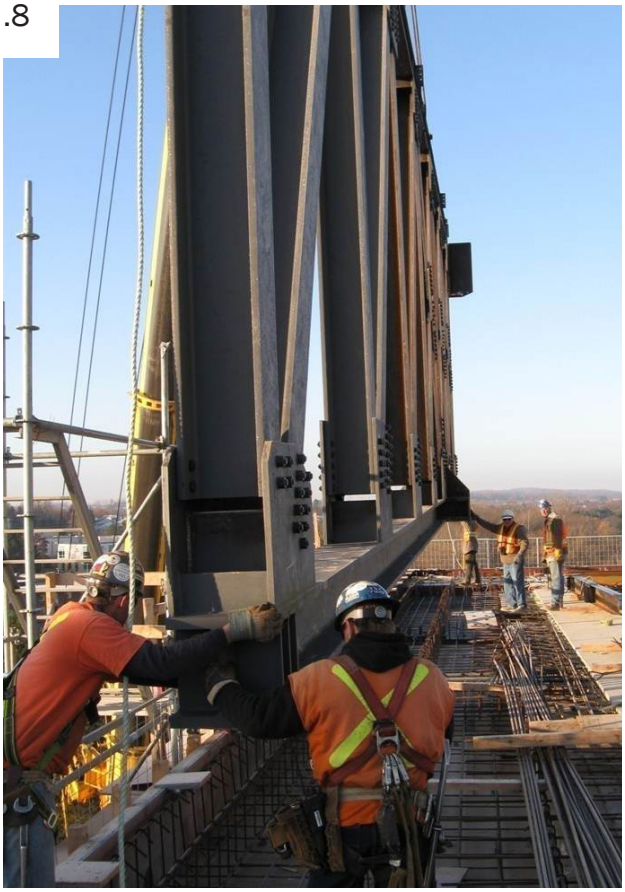

Social and Economic Benefits

The Lazaridis Quantum Nano Centre is home to one of the largest concentrations of quantum information researchers in the world. The research, discoveries and technologies that come from the LQNC will not only shape our generation, but many generations to come. As Stephen Hawking said at the building's grand opening on September 21, 2012, "this institution will advance our understanding of matter and movement, illuminating deep mysteries with the light of scientific discovery."

The discoveries and innovations of the quantum world, many of which will be discovered inside the Lazaridis Quantum Nano Centre, will fuel Canada's economy through technology, company and job creation. It will be at the heart of what Mike Lazaridis has described as "Canada's Quantum Valley". As Marianne McKenna, KPMB Architects founding partner and partner-in-charge of the Quantum Nano Centre project said, "Waterloo, Ontario has evolved into Canada's Technology Centre, the equivalent of Silicon Valley in California... With the opening of the Lazaridis Quantum Nano Centre, Waterloo has gained immense intellectual capital that will have a multiplier effect on the economy of the region and of Canada."

Photo:
.9 Rendering (southwest exposure) c/o KPMB Architects

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Environmental Impact

Although the structure needed to be strong and robust to ensure that the special laboratories vibration requirements could be met, several green building concepts were incorporated.

Key green features include:

- Large open spaces that enable flexibility in future changes to programing, which is fundamental to sustainable design
- Green roofs, which act as an extension of the landscape characteristic of the University of Waterloo campus and provide stormwater control
- Large vertical windows to provide significant natural lighting to portions of the building
- Bamboo finishes used for wall systems and flooring throughout the interior of the building
- Natural ventilation in the atrium to manage indoor air quality
- Heat recovery

Meeting the Client's Needs

The vision of the Lazaridis Quantum Nano Centre was to create a building that would facilitate world-leading research and education in the smallest, most sensitive areas of nature. The building needed to meet strict acoustic and electromagnetic interference requirements and provide a physical space for major discoveries to happen.

At the LQNC grand opening ceremony in September 2012, University of Waterloo President and Vice-Chancellor Feridun Hamdullahpur stated that the new facility adds "tremendous new capacity to the University of Waterloo's global impact in research and discovery." By attracting the greatest researchers and experimentalists from around the world, the new facility will enhance the university's long-standing reputation as an international hub of research and innovation, and will help transform the region of Waterloo into Canada's "Quantum Valley".

The Lazaridis Quantum-Nano Centre is truly of the highest international caliber. Doubling as an architectural showpiece, it has received the international attention it deserves. Halsall's structural engineering solutions enabled the ultimate goal of this facility to be met – the creation of an acoustic- and vibration-free research and testing centre – without compromising the architect's vision.

Photo:
.10 Construction of the cantilevered floors and trusses

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Photo:
.11 Construction of honeycomb structure
.12 Construction of honeycomb structure

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Photo:
.13 Construction (southwest exposure)
.14 Construction (east exposure)

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