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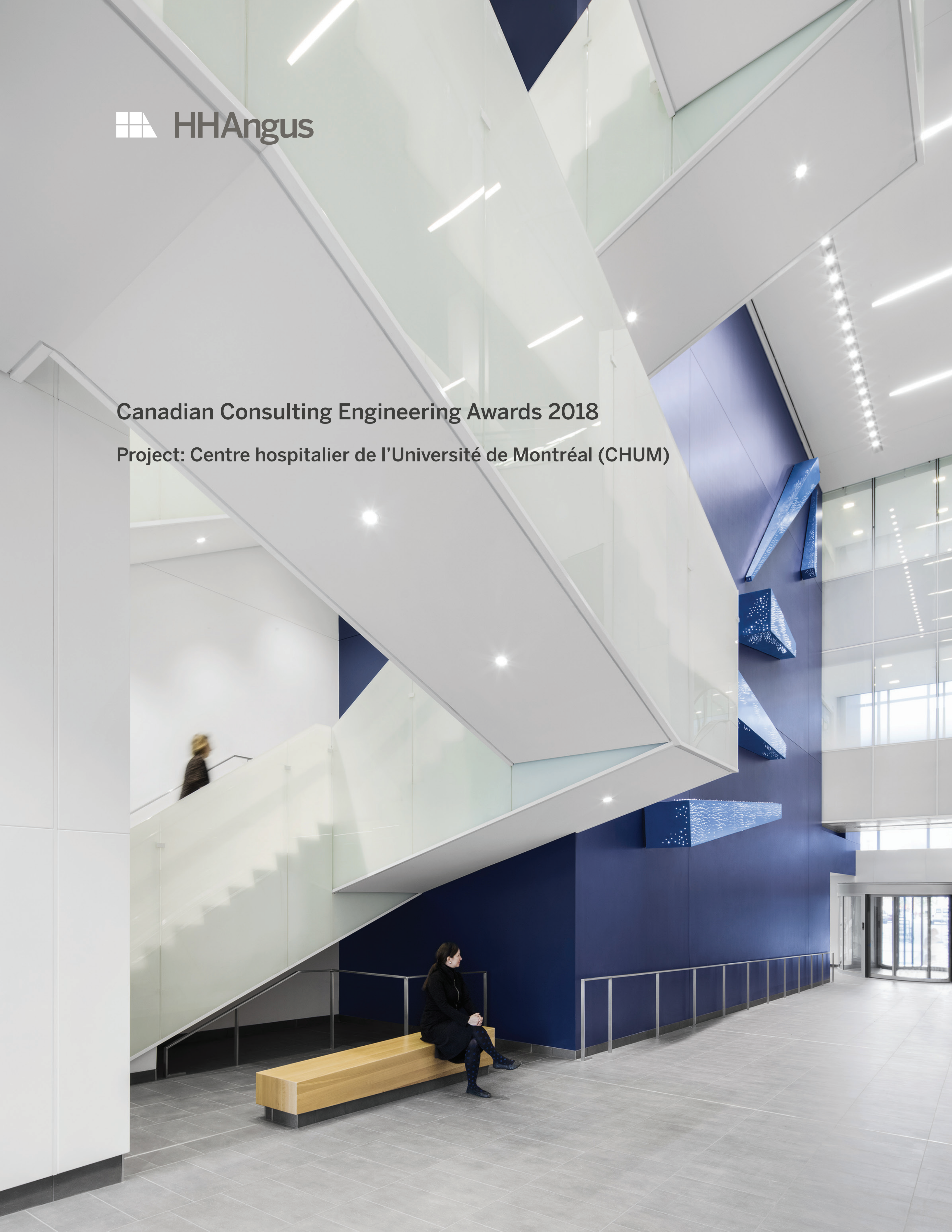

Canadian Consulting Engineering Awards 2018

Project: Centre hospitalier de l’Université de Montréal (CHUM)

HHAngus

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A. PROJECT INFORMATION

Project name: Centre hospitalier de l'Université de Montréal (CHUM)

Location: 1051 Sanguinet Street, Montreal, QC

Completed: 2017

Entering Firm: H.H. Angus and Associates Ltd.

Role: Mechanical, Electrical and Security Design and Engineering Consultants

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B. PROJECT OUTLINE

(1) Summary:

Centre hospitalier de l'Université de Montréal (CHUM)

CHUM is the largest hospital project in North America, and presented numerous challenges due to its vast size and complexity. Totaling 354,000 sm, it replaces three older sites in central Montreal.
HH Angus provided consulting engineering for all mechanical, electrical and security systems on behalf of Construction Santé Montréal. The P3 model challenged HH Angus to develop a series of innovations that together created a unique engineering solution with focus on air quality and energy performance.

CHUM campus

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(2) Project Highlights

Q.1 Innovation

CHUM demanded air quality levels exceeding current standards for filtration, compartmentalization and redundancy. Traditional engineering solutions meant that significant building areas allocated for health care delivery would otherwise be sacrificed.

Hospital ventilation systems require the most space, in terms of plant room floor area, vertical shafts and ceiling voids. The RFP required HEPA filters on all systems serving clinical areas, no air recirculation between departments, and a high level of redundancy — all with limited air handling unit size. Meeting these stipulations would have required two full intermediate mechanical floors and would severely compromise future flexibility. HH Angus worked with CSM and CHUM to develop alternatives.

- Where the RFP required an air handling unit for each department, we proposed 100% outdoor air units serving multiple floors of similar occupancy, and demonstrated the merits of this approach regarding infection control and future flexibility.
- To mitigate the energy penalty of 100% outdoor air systems, we proposed enthalpy heat recovery wheels. The RFP initially prohibited these, until we demonstrated that infection control concerns could be successfully mitigated.
- The RFP mandated a standby air handling unit for each critical care space, requiring higher capital and lifecycle operating costs, plus more space. Our alternative approach combined several air handling units into one duct system to share redundant capacity considerably increasing overall system reliability while reducing energy costs.
- Lastly we demonstrated that the restriction on air handling unit size could be raised to 33,000 l/s without practical impact.

These alternatives provided many benefits, including the ability to modify occupancies and enable future renovations. The result was that additional clinical floors could be constructed under the zoning height restriction.

Typically, heat wheels are operate at 100% when it is cold outside but, as it gets warmer, the wheel is slowed down so it does not overheat incoming air. We recognized that there were less obvious benefits by not slowing down the wheel and overshooting the temperature setpoint, then operating the cooling coil to generate a source of heat for heat pumping. Further benefits were derived by recovering moisture from of the exhaust air to humidify the incoming outdoor air.

Heat recovery wheels

We believe CHUM's HVAC systems are unique when all of these factors are combined. The combination of 100% outdoor air, high efficiency heat recovery, HEPA filtration, redundancy and room-by-room control of supply and exhaust are able to deliver unmatched air quality and performance.

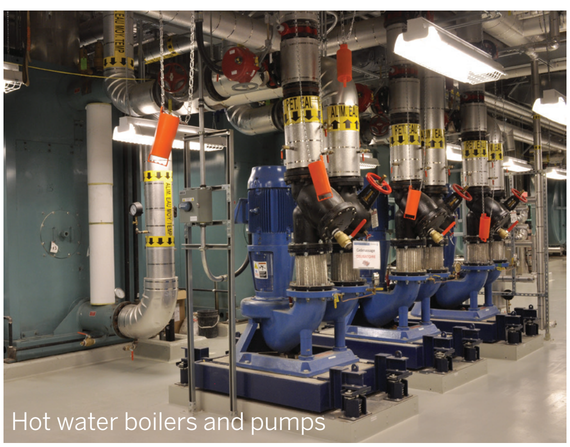
Q.2 Complexity

Reliability of the electrical power in a major hospital is paramount to continuing operations. With the ice storm of 1998 not forgotten, HH Angus developed a unique approach so that without utility power, the hospital's essential loads can be energized from two independent sources, a significant extra level of redundancy for the hospital's priority loads.

The incoming power supply for CHUM includes four Hydro Quebec 25kV lines with total capacity of 36 MVA. The normal distribution system feeds one 4160V and six 600V double-ended substations. The 600V emergency distribution system consists of four 2.5MW diesel generators supplying two 600V switchgear lineups and 36 automatic transfer switches. The distinct 4160kV emergency supply with another four 2.5MW diesel generators provides standby power through the normal distribution system by stepping up the generated voltage from 4160KV to 25kV via two step-up transformers.

Key to this complex arrangement is a Load Management System (LMS) comprising ten HMI panels connected in a self-healing ring network for redundancy and resiliency. HMI panels interface with the breakers, protective relays, ATS and generators to provide control, status and metering. The LMS sequences opening and closing of appropriate breakers whenever the utility fails, and restores power via the normal distribution. It quickly sheds large non-essential loads should any generator fail during utility failure, and automatically restores the power to the complex in sequence once released by operator.

The fuel oil supply to the 8 generators and 12 boilers is similarly unique and complex requiring custom controls and regulatory approval.



Hot water boilers and pumps

Electrical switch boards

Q.3 Social and/or Economic Benefits

High capital costs slow construction of hospital facilities, so providing cost-effective solutions is critical. CHUM serves a catchment area of half a million people. The traditional solution, following all project requirements, was unaffordable to the point the project would never proceed. By thinking innovatively and devising solutions others had not, HH Angus was able to make significant contributions to developing an affordable alternative approach.

Healthcare operating costs continue to escalate. By designing an energy efficient plant and distribution system, energy costs are minimized, freeing up funds to focus on delivery of healthcare.

Hospital acquired infections impose a significant cost to our healthcare system: ~200,000 patients per year acquire an infection in hospital, and 8,000 die annually*, costing Canadians an estimated $4 - $5 billion in direct treatment costs**. Infection prevention and control is an important aspect that, if not done well, contributes to hospital-acquired infections. While much depends on staff practices, the physical environment can have a major impact. Our ventilation solution, with 100% HEPA filtration, minimizes the movement of airborne contaminants between departments. Local control of supply and exhaust air volumes ensures air movement between clean and less clean spaces functions as intended, and can be monitored and maintained over time. Another aspect of infection control is domestic hot water systems that can cause Legionella which, if left untreated, carries serious consequences.
HH Angus implemented copper-silver ionization on the recirculation system to minimize the possibility of this occurring.

**https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/chief-public-health-officer-report-on-state-public-health-canada-2013-infectious-disease-never-ending-threat/healthcare-associated-infections-due-diligence.html*

*** Coalition for Healthcare Acquired Infection Reduction chaircanada.org*

Q.4 Environmental Benefits

Energy saving systems: The client mandated an energy consumption target of 40% less than the ASHRAE 90.1-1999 baseline — a very aggressive target for an urban acute care hospital. Every system that consumes energy was strategically assessed against possible alternative solutions. Several energy simulation programs had to be customized to model the complex energy recovery strategies employed by the central plant. The target was achieved using a multi-pronged approach that incorporated:

- space-by-space control of air volumes (both supply and exhaust) enabling variable air volume while maintaining room pressures and directional airflow over approximately 7000 zones
- enthalpy heat recovery wheels on virtually all air handling systems providing heating, humidification and cooling recovery from the exhaust air, and a source of heat pump energy during shoulder seasons
- reduced fan energy with variable speed drives by reducing air velocity through air handling units and ductwork, and by manifolding redundant air handling units to further reduce static pressure loss
- process cooling and chiller heat recovery systems as the primary source of low temperature reheat water
- condensing boiler stack economizer
- lighting power reductions coupled with occupancy and daylighting controls
- a fully networked building automation system with custom control strategies including supply air temperature reset

Energy Savings: The energy savings provide CHUM with a significant reduction in energy use and operating costs with corresponding environmental benefits. When compared to an efficient baseline building, the estimated annual natural gas use is reduced by two thirds, and there is a reduction in carbon emissions of 16,000 tons.


Air handling units


Public space

Q.5 Meeting Client's Needs

Ultimately, the goal of a hospital is to treat patient's health needs safely and cost effectively. The clinical program for a single hospital was ambitious, with 775 beds, 39 operating rooms, over 600 exam rooms, 7 MRIs and 12 radiation bunkers. Challenges such as reliability, redundancy, energy efficiency and air quality defined by CHUM pushed the requirements beyond a typical facility. On top of these, the downtown site, zoning restrictions and the cost ceiling imposed a number of other constraints that made compliance a series of inter-related equations that many did not think were physically, let alone economically, solvable. The mechanical, electrical and security engineering design for CHUM had to meet many challenges, not the least of which was the sheer magnitude of the project undertaken as a Public Private Partnership.

Meeting the client's needs required that HH Angus adopt a multipronged approach to the project management and design. The schedule required a compressed timeframe where design and construction had to proceed in parallel. HH Angus developed a strategy to deliver site wide systems packages using standardized mechanical and electrical products in conjunction with sequential contracts and installation contractors. Construction could not wait for refinement of the clinical design and selection of medical equipment, so a core and shell philosophy usually reserved for office buildings was adopted. Together, this allowed work to proceed on construction documents for the structure, envelope and plant services while design development was still occurring in the clinical areas of the building.


Operating room


Exam room

Nursing station


Meal preparation area