One of my favorite hospital images captures the typhoid ward at the Royal Victoria Hospital in Montreal. The photograph, taken around 1894, portrays an environment buzzing with activity: bed-ridden patients in various poses; dignified doctors, nurses, and visitors; and even fresh-cut flowers. Spacious, multi-bed wards like this one were a signature architectural feature of the pavilion-plan hospital, where 30-some patients occupied narrow beds spaced regularly along the exterior walls. Photographs of these Nightingale wards (named for the famous nurse), which survive in huge numbers, nearly always show the large windows between beds cocked open, allowing us to almost feel the flush of fresh air that surrounded each patient. These were designed not simply to provide light and air, but to minimize contagion in an era plagued by typhoid and other deadly diseases. A fair number of extant photos were taken during Christmas parties, evidence that windows remained open through winter weather. Essentially, each patient housed in a pavilion-plan ward was enveloped in a protective bubble of fresh air, enabled by the hospital's distinctive massing. Pavilion-plan hospitals featured multistory, long, narrow wards, detached on three sides, with minimal connections to a main administrative block. This architectural arrangement maximized natural lighting and ventilation, and organized patients in orderly groupings.

The shape of the Nightingale wards facilitated surveillance by nurses, who often occupied desks at the entry end of the massive spaces. In my photo, the gleaming nurse's desk is at the center of the crowded yet orderly ward. The other end of the space, south facing and at some distance from the rest of the hospital (in this case 126 feet), was punctuated by a sun porch intended for patients well enough to leave their beds and go outside. Small adjacent and often semidetached structures, sometimes shaped like towers or turrets, accommodated toilets. These tiny towers of sanitary facilities separated the sights, sounds, and smells of defecation from the vulnerable space of the patient.

The Montreal hospital is not unique. In its golden age, the pavilion plan was considered the ideal arrangement for all sorts of large institutions—schools, orphanages, workhouses, asylums, prisons—adaptable to any scale, site, and context. Even today in Montreal, there are convents, a prison, a psychiatric hospital, and a general hospital based on the pavilion plan. Pavilion-plan hospitals became an international standard in the late 19th and early 20th centuries, with major examples in India, Iran, Russia, Australia, Canada, and the United States. The plan was an effective and flexible way to organize large numbers of people in space.

Ward ventilation was the parti of the pavilion-plan hospital. And despite working on the Royal Vic, as it is commonly called, for nearly 20 years, I never fully understood how the building, and hundreds others like it, *really* managed to suck in fresh air, sometimes warm it, circulate it around sick patients, and spit it out with perfect control. Known as "the union of natural and artificial ventilation" by architects like Henry Saxon Snell, who designed the Royal Vic, it hardly seemed natural to me. How did architects understand, design, and manage this hybrid form of ventilation?

In order to investigate, I immersed myself (and McGill architecture student Don Toromanoff) in dozens of stunning architectural drawings discovered in odd places in the hospital; we also came across a rich set of letters between the architect and hospital administrators, and mind-numbing specifications of mechanical equipment. Our presumption was that the complete record of the hospital's design and construction would allow us to picture air movement in the 1893 hospital, if only for the sake of illustration. We knew that hospital administrators began to alter the original system in around 1900, moving the boilers from the basement of the main building to a nearby powerhouse—so we sought clues as to how the hospital was ventilated for its first seven years. Secondary sources on the subject were surprisingly limited. Chief among them was Jeremy Taylor's excellent *The Architect and the Pavilion Hospital* of 1997, with considerable attention dedicated to the debate between natural and mechanical ventilation. Because the movement of air is dynamic, I asked Don to make a computer simulation of our findings.

Snell was something of a ventilation expert. A well-known British hospital specialist, he authored two important books on hospital design: *Hospital Construction and Management* (with physician Frederic J. Mouat) in 1883 and *Charitable and Parochials Establishments* in 1881. Snell was likely the architect of choice for hospital patron Lord Strathcona,

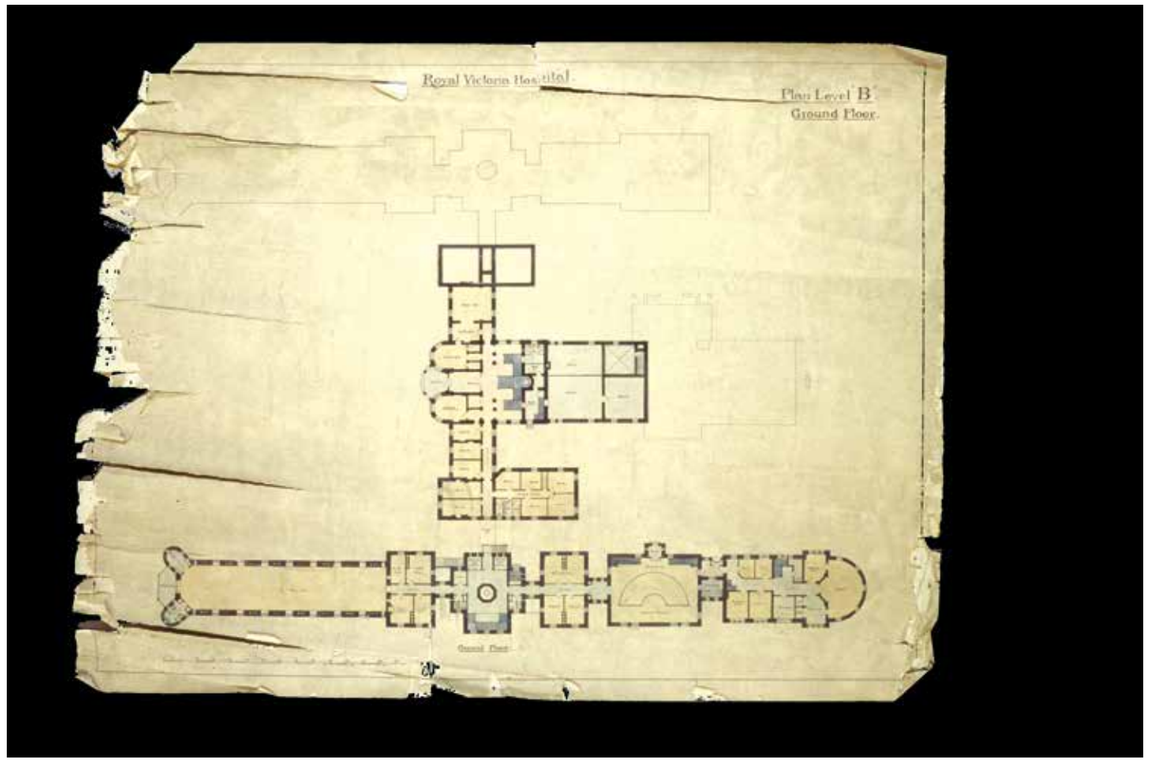
Postcard view of the Royal Victoria Hospital, Montreal, shows the massive south-facing sun decks fitted out with colorful awnings, ca. 1911–1925.

one of Canada's wealthiest men who lived part-time in London. He may have known some of Snell's British buildings such as the Casual Wards for the Marylebone Workhouse (1867) or the Holborn Union Infirmary (1877–1879). Six years before the opening of his Montreal hospital, Snell had converted the main building of the Aberdeen Royal Infirmary in 1887, and that same year he and Alfred Williams designed London's Kensington Infirmary. Snell was part of the small group of London-based architects who devoted their careers to improving upon the basic pavilion-plan model, described by Taylor as "orthodoxy."

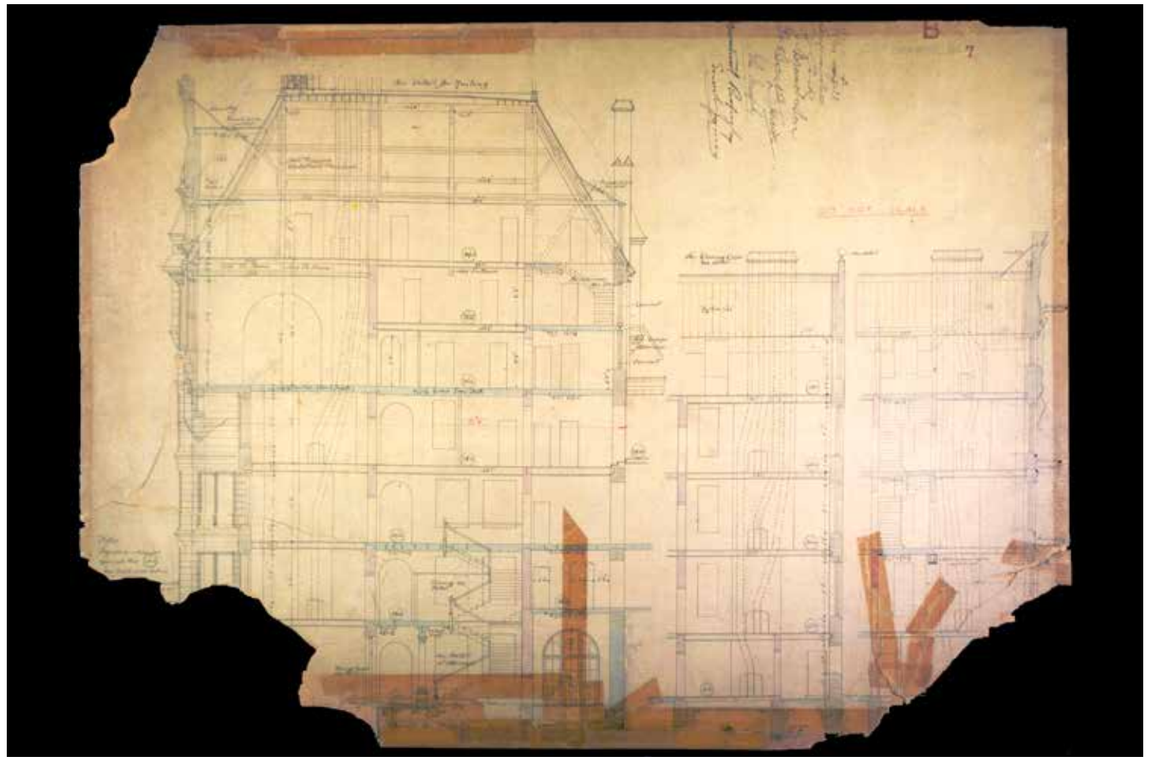
The other important figure in the correspondence we examined is John Abbott, essentially the chairman of the board of the hospital. Better known as the third prime minister of Canada from 1891 to 1892, Abbott had a highly conflicted relationship with Snell, perhaps exacerbated by the distance between his base in Montreal and Snell's in London. Ventilation was one of the really prickly issues between them, and their correspondence is thus a particularly rich source for unpacking pavilion-plan hospital ventilation. Abbott was impatient and clearly dissatisfied with the architect's services as early as 1889. From a letter dated June 9, 1891: "With regard to the decision upon your reports, I imagine on reflection you will perceive that no decision could be arrived at upon them. They appear to the Board to constitute rather an avoidance of any definite report than a statement of your opinions upon any of the matters submitted to you." Abbott also accused Snell of being out of touch with Montreal's progress in heating technologies: "You speak of the heating by steam as being practically universal in the City, and heating by hot water, as insufficient in our climate. For fact, steam heating has for some time been almost entirely abandoned in this City, and hot water is practically universal."[1]

Equally enlightening are Snell's stunning drawings of the hospital, now preserved at the John Bland Canadian Architecture Collection in Montreal. The exquisite presentation drawings were done on cardboard, perhaps to withstand the architect's trans-Atlantic travel. One set even still has the brass tacks precariously dangling from its top corners, which presumably allowed drawings to be viewed on top of each other, perhaps posted on a wall during a meeting with Abbott and the board. So complete are the drawings that they offer us an extraordinarily sharp snapshot of a two-way dialogue about hospital ventilation.

Don and I put the 66 Snell drawings in order and worked out a timeline based on the correspondence between Snell and Abbott, locating facts and conflicts in real time. We saw this as a way to start to disentangle multiple sets of drawings in the archives, which appeared to be more or less related to Snell's four visits to the Montreal site. As indicated in the letters and reinforced by the drawings, Snell wanted the hospital heated by fireplace while the board, on the advice of local architects, preferred hot-water heating. Reading the correspondence, drawings, and specs chronologically and systematically showed us that Abbott lost confidence in the architect just after a meeting in May 1889. Massive radiators are included in every photograph of ward interiors,



Henry Saxon Snell's ground floor plan of the Royal Victoria Hospital shows the open ward and its adjacent extraction tower, a key feature in the building's ventilation system.



Henry Saxon Snell's original drawings for the Royal Victoria Hospital were discovered in a closet. The heating system was a source of tension between architect and client.

evidence that Abbott won out in the great heating debate. By 1890, the fireplaces were gone from the plan, though the chimneys remained, a ghostly reminder of architecture's layered, iterative nature in this era.

Based on what we learned from the archival documents, we tried to show through Don's simulation model how air moved through the building. Just north of Snell's multistory open wards were two extraction towers. Cold air entered the hospital through apertures in the base of these towers. This air was heated by a boiler and circulated under the wards, brought upward through vertical tubes in the exterior walls and diffused into the ward interiors through small square vents located just below the ceiling. This warm air circulated among the patients and nurses, presumably cooling down while mixing with their breath and other interior ambiences. This same vitiated (often called "foul" or "impure" at the time) air from the wards was extracted back through outlets and sucked back down to the basement, pushed northward to the extraction tower, where it was reheated by the same boiler. Because heated air rises, this infected, problematic, used, foul, impure air naturally shot upward, over the rooftops (and nearby water supply) of central Montreal. The genius of the system was how the extraction of the germ-filled air created a vacuum, causing fresh air to enter the system in an endless loop.

Don's model allowed me to see that pavilion-plan hospitals resembled giant lungs. Without even trying, we inhale fresh air to supply oxygen to our body parts and exhale warm, moist air by exhaling. This breath-like air movement was illegible in architectural drawings of hospitals—hence my desire for a dynamic model—but for some reason was often depicted in drawings of houses. In fact, 19th-century physicians frequently drew cross sections with dashed lines and curving arrows, showing the movement of air through residential interiors. Physicians produced architectural drawings to show how houses were to blame for the spread of illnesses.[2] For example, Leeds-based surgeon Thomas Pridgin Teale included delightful cross sections showing how impure air moved through houses in his celebrated 1879 book, *Dangers to Health.*

Teale's book beautifully illustrates literary theorist Steven Connor's 2004 call to think of buildings as articulations of air and of air as the animator of buildings. In a lecture at the Bartlett School of Architecture, Connor said:

> Air has traditionally been, not the antagonist of the building, but its unobserved complement. Buildings, like utterances, are articulations of the air. No structure that contained no space, had no cavity in it, could qualify as a building. And yet, though buildings include, enclose and admit air, that air is not thought of as belonging to the building.[3]

It is my contention that the vast mechanical services of the pavilion-plan hospital, and the inclusion of lines and arrows in cross sections of houses, animated the graphic depictions and shaped the ways buildings were understood as technologies of healing. The air *belonged* to these buildings.

Piecing together how the pavilion-plan hospital's ventilation system worked has fed my own need for precision and accuracy within the historical record, underlining for me the essentially forensic nature of 19th-century architectural history. It has shown me how my beloved photographs depicting the social lives of hospital wards serve to disguise the technological wizardry housed in the basements, wall cavities, extraction towers, and power plants just beyond the walls they depict. These massive, shed-like—dare I say, simple—spaces (what Joe Esherick, my professor at UC Berkeley in the 1980s, would have called a "dumb" building) camouflaged an amazing culture of grates, flues, boilers, outlets, and tubes, working in symphony with the building's form.

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Opening spread: Photographs of Nightingale wards, like this one taken by Willam Notman & Son at Montreal's Royal Victoria Hospital, typically show open windows. Women's ward, Royal Victoria Hospital, Montreal, 1894.

[1] Letter from John Abbott to Henry Saxon Snell, March 26, 1889.
[2] See Annmarie Adams, *Architecture in the Family Way: Doctors, Houses, and Women, 1870–1900* (Montreal: McGill-Queen's University Press, 1996).
[3] Steven Connor, "Building Breathing Space" (lecture, Bartlett School of Architecture, March 3, 2004), http://www.stevenconnor.com/bbs.