R

evolving doors have been manufactured for over a century. Theophilus Van Kannel was granted U.S. patent 387,571 on August 7, 1888 for a “Storm-door Structure” that was a three-partition revolving door. Since then, their general benefits have remained the same—creating comfort, saving energy, improving traffic flow, and enhancing security. The design of these doors eliminates drafts and keeps debris from entering the building.

A revolving door is essentially a freestanding vestibule. What makes these doors unique is they are always open and receptive to pedestrians, but simultaneously always closed to the outside elements. This second point means less escape of the building’s conditioned air or penetration by the exterior. Empirical studies (discussed later in this article) demonstrate revolving doors are approximately eight times more energy-efficient than slide or swing-door systems.

They are viewed as a cold-climate solution, but heightened awareness of the need to conserve energy has increased their use in warmer regions—it is just as important to keep air-conditioning in the building. Over the past two decades, revolving doors have also been sold to meet security requirements in both Fortune 500 companies and airports.

By Bob Augustine and Elias Campos

Specifying a more energy-efficient, secure opening
Typically, revolving doors are made up of the components illustrated in Figure 1. The products generally come in four, three, and two-wing configurations; each offers advantages the architect typically matches to the building use and design. Additionally, the specifier has the ability to select either a segmented or round drum. Various benefits to the designs are listed in Figure 2.

For both Canada and the United States, revolving doors are designed, manufactured, and installed per American National Standards Institute (ANSI) A156.27, *Power and Manual Operated Revolving Pedestrian Doors*. For manual systems, the primary safety control is to limit the rotating speed with canopy or floor-mounted controls. The maximum allowable speed is 12 rotations per minute (rpm).

Automatic revolving doors are furnished with a series of active and passive sensors. These are similar to those used in automatic swinging and sliding doors. For wing safety, ANSI A156.27 Section 16.1 requires the sensors to detect a 28-in. (711-mm) tall person.

**Figure 1**

Revolving door terminology.

**Figure 2**

Number of wings and drum construction options.

**Figure 3**

The active wing sensor pattern is shaded in red.

**Figure 4**

Active entry point sensor.
in the rotating path a minimum of 10 in. (254 mm) from the wing (Figure 3).

Automatic revolving doors also require entry-point sensors to prevent entrapment at the intersection of the rotating wing and the approaching drum wall. The ANSI standard calls for these sensors to detect the presence of a person or object when the door wing approaches, and stop the rotation (Figure 4).

In addition to the wall sensor, the drum edge farthest from the rotating wing is furnished with a contact safety edge. This edge, according to ANSI A156.27 Section 17.1, is required to detect any 10-lbf (44.5 N) obstruction (or greater) and immediately stop the door rotation. This redundant protection ensures enhanced safety to pedestrians and peace of mind to business owners and overall traffic (Figure 5).

The bottom rail of the wing is typically furnished with a ‘toe-guard’ sensor. Under ANSI A156.27 Section 17.2, sensors are designed to detect an obstruction no more than 4 ft (1.2 m) from the floor and with less than 44.5 N of pressure, and then stop the door rotation. It is intended to eliminate the possibility of a person’s heel being trapped under the wing (Figure 6).

Further, Section 20.1 of ANSI A156.27 requires the furnishing of emergency buttons. These are designed to remove the power of an automatic door; they must be located on both sides of the door and stop its rotation until reset (Figure 7).

Revolving doors connect to the surrounding infrastructure either at the ‘throat’ or at the
accommodate gurneys. It offers the largest compartment size and the best airlock. In a hospital application, this assembly can move larger items like golf clubs and skis, but they are also used in healthcare applications as well as in hotels, casinos, airports, and universities. These doors can accommodate large volumes of traffic in both directions. The choice between a three or four-wing design depends on the application and the people using the entrance. The latter option provides a slightly larger throughput as four people in each direction can pass through the door with each revolution; additionally, the throat opening is larger. Consequently, it is recommended on higher-volume applications where capacity is a concern such as a conference center or university.

A three-wing design is preferable in a hotel application where the larger compartment size is more critical. Guests at a hotel typically have more luggage and the larger compartment size is more suitable. Some grocery stores and restaurants use three-wing doors to accommodate a parent with a child conveniently in the same compartment. Most manual doors are supplied in diameter sizes of 6½, 7, or 8 ft (1.9, 2.1, or 2.4 m).

Automatic doors are installed when one needs to conveniently move larger volumes of people through a front entrance while maintaining high energy efficiency standards. Choices in automatic revolving doors are two, three, and four-wing; they are typically 10 ft (3 m) in diameter and larger.

The two-wing design offers the largest compartment size and the best airlock. In a hospital application, this assembly can accommodate gurneys. It offers the largest compartment size as there is no center shaft or core. The entire door, including the ceiling, rotates on a channel installed in the canopy.

It offers the best airlock because in lieu of a single, center core there are two—one on each of the wings. These cores completely close the throat opening to outside elements and are desirable in cold climates to prevent ice and snow from entering the throat opening during non-operating hours. When the wings completely close the throat opening, this is the only revolving door that is not ‘always open and always closed’ during part of its rotation.

Due to the increased mechanical components necessary for this configuration, including the rotating ceiling, the two-wing is typically more costly than comparable three or four-wing alternatives.

The most common automatic revolving door is a three-wing design; this style offers convenience and energy efficiency while maintaining a lower cost to install. Since it has a larger compartment size than the four-wing, one can move large volumes of people through. A 3 ft diameter revolving door in a three-wing design allows an unassisted wheelchair to pass through the door. (An assisted wheelchair requires a diameter of 12 ft [3.7 m].) The standard sizes of both two- and three-wing doors are from 10 to 16 ft (3 to 4.9 m) in diameter.

The four-wing design is very seldom used in an automatic configuration, as the compartment sizes become small. The required wing sensors take up too much of the usable compartment size, causing the door to stop or slow too frequently in a two-way traffic situation. As a result, several manufacturers have discontinued offering this product, especially with viable options in two and three-wing designs.

Security doors

Revolving doors have been used to provide a secure entrance for more than 20 years. When a swing or slide door is equipped with a card reader and the necessary magnetic lock or electric strike, it is assumed to be a secure entrance. The deficiency with this philosophy, however, is once the door is open there is nothing to prevent multiple people from entering with the authorized person and breaching the intended security. A two-way security revolving door will address risk scenarios like tailgating (i.e., unauthorized entry attempt while an authorized person is entering or exiting) and piggybacking (i.e., unauthorized entry [forcible or collusion] in the same compartment with an authorized person).

A revolving security door turns one compartment at a time, allowing only a single person to enter the secure area. A four-wing design is ideal to provide two-way control. Security revolving doors have also been specified for dormitory and office building applications where they function as standard openings by day, and security areas by night.

Airport exit lane turnstiles

All airports have secure and non-secure sides (sometimes called ‘airside’ and ‘landside’). Exit lane turnstiles keep these two areas separated. Entering through security has become routine for experienced travellers. People are required to place many of their personal belongings on a conveyor belt and pass through the metal detectors. After arriving at the destination, they pass by a security guard and leave the airport through
For the past 15 to 20 years, many airports have installed a physical barrier that takes the passengers and employees from the secure side back to the non-secure side through a one-way security revolving door. Typically supplied in a three-wing design, this door allows passengers to leave the airport through a secure one-way exit. It can eliminate the need for a security guard to be stationed at this door, and enable the guard to be deployed to make roving patrols (Figure 9).

In the past five to seven years, some airport authorities have requested an additional level of security to prevent objects from being thrown or placed into the revolving door and ‘pushed’ through to the secured side. Light curtains and volumetric sensors prevent anyone from having an object swept into the secure side. They are installed in the same secure quadrant (Figure 10).

Efficiency and savings
Empirical studies by Massachusetts Institute of Technology (MIT) and American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) have demonstrated revolving doors to be a significant source of energy savings. Therefore, they can also be contributors toward points under Canada Green Building Council’s (CaGBC’s) Leadership in Energy and Environmental Design (LEED) program. The study concluded the amount of energy to cool or warm a building is directly related to the amount of air exchanged to/from the building. Since revolving doors keep a better airlock than traditional swing or sliding doors, it follows the energy needs to keep the building at a preset temperature is lower than using a traditional entrance.

Naturally, in determining the savings, there are several factors involved. They include:
- entrance location (i.e., weather conditions are a key factor);
- number of hours the entrance is in operation, along with the number expected to enter and leave (i.e., traffic);
- building’s desired indoor temperature;
- humidity and wind speed;
- building height; and
- energy cost per kilowatt.

Figure 11 illustrates the example of a 60-ft (18-m) tall Toronto building equipped with a three-wing, 10-ft (3-m) revolving door instead of a vestibule entrance with two 9 1/2-ft (2.8-m) sliders. According to one analysis, the results would be:
- cooling equipment savings of 1267 tons;
- heating savings of 394,358 Btu/hr;
- reduced carbon dioxide (CO₂) emission of a barrier-free walkway.

For the past 15 to 20 years, many airports have installed a physical barrier that takes the passengers and employees from the secure side back to the non-secure side through a one-way security revolving door. Typically supplied in a three-wing design, this door allows passengers to leave the airport through a secure one-way exit. It can eliminate the need for a security guard to be stationed at this door, and enable the guard to be deployed to make roving patrols (Figure 9).

In the past five to seven years, some airport authorities have requested an additional level of security to prevent objects from being thrown or placed into the revolving door and ‘pushed’ through to the secured side. Light curtains and volumetric sensors prevent anyone from having an object swept into the secure side. They are installed in the same secure quadrant (Figure 10).

Efficiency and savings
Empirical studies by Massachusetts Institute of Technology (MIT) and American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) have demonstrated revolving doors to be a significant source of energy savings. Therefore, they can also be contributors toward points under Canada Green Building Council’s (CaGBC’s) Leadership in Energy and Environmental Design (LEED) program. The study concluded the amount of energy to cool or warm a building is directly related to the amount of air exchanged to/from the building. Since revolving doors keep a better airlock than traditional swing or sliding doors, it follows the energy needs to keep the building at a preset temperature is lower than using a traditional entrance.

Naturally, in determining the savings, there are several factors involved. They include:
- entrance location (i.e., weather conditions are a key factor);
- number of hours the entrance is in operation, along with the number expected to enter and leave (i.e., traffic);
- building’s desired indoor temperature;
- humidity and wind speed;
- building height; and
- energy cost per kilowatt.

Figure 11 illustrates the example of a 60-ft (18-m) tall Toronto building equipped with a three-wing, 10-ft (3-m) revolving door instead of a vestibule entrance with two 9 1/2-ft (2.8-m) sliders. According to one analysis, the results would be:
- cooling equipment savings of 1267 tons;
- heating savings of 394,358 Btu/hr;
- reduced carbon dioxide (CO₂) emission of
258,250 lb (117,140 kg) annually; and
• a return on investment (ROI) of a revolving door of 20 months.

Conclusion
Beyond security, energy efficiency, and traffic performance, one must also consider the esthetic impact of a revolving door. Will it give the intended look of a building’s entrance and will it architecturally meet one’s needs?

Major airports, hotels, hospitals, and casinos have all chosen revolving doors for an ‘enhanced’ appearance. While enjoying the energy-efficient benefits previously discussed, revolving doors meet high architectural demand and appeal. The finish can be furnished to match adjacent construction and the wing/drum design can match important sight lines. Although revolving doors have been around for more than a century, it is quite likely that the next 10 years will bring about major increase in demand and acceptance as a preferred entrance solution.

Notes
1 For more, visit mit.edu/~slanouwww/shared_documents/366_06_REVOLVING_DOOR.pdf.
2 In terms of LEED, possible credits to which revolving doors can contribute include Energy and Atmosphere (EA) Credit 1, Optimizing Energy Performance, Materials and Resources (MR) Credit 4, Recycled Content, Indoor Environmental Quality (EQ) Credit 4.2, Low-emitting Materials, and EQ Credit 6.2, Controllability of Systems: Thermal Comfort.
3 Building height is important because of stack pressure—the hydrostatic pressure caused by the weight of an air column located inside or outside of a building. Stack pressure is caused by the temperature difference between the inside and outside—the taller the building, the greater the pressure differential. In other words, if a manual door is opened in the summer and the building is air-conditioned, there is a column of air inside. If the building is 30 ft (9 m), it is not as heavy as it would be in one that is 60 ft (18 m). The heavier column of air will leave the building faster.

Bob Augustine is the Vice-President of sales for Horton Automatics. A 20-year veteran of the industry, he manages the company’s architectural development programs and works with distributors throughout the Americas. Augustine can be reached at bob_augustine@overheaddoor.com.

Elias Campos is Horton’s Vice-President of marketing and product development. He has extensive experience in infrastructure project management, marketing, and sales. Campos’ experience includes stints with PDVSA-Citgo, Emerson Electric, and Overhead Door Corp. He can be contacted via e-mail at elias_campos@overheaddoor.com.