33: REVOLVING DOORS:
A SUSTAINABLE SOLUTION

By: Amanda Gibney Weko

DEVIL'S DETAIL

INTRODUCTION

Devil's Detail 31: Touchless Entries covered the basics of revolving doors, including system types, factors that impact system selection, and concerns related to design and installation. Beyond the capacity for touchless operation, revolving doors offer numerous benefits. Customization is the norm; custom options for revolving doors are virtually unlimited, from entry position and aesthetic choices to functional and security integrations such as one-way rotation and card access. Revolving doors generally take up less space than other entry systems. Revolving doors also have low maintenance requirements and offer durability over time. But perhaps the most significant advantages to revolving doors are their sustainable design benefits.

All images © dormakaba

BRIEF HISTORY

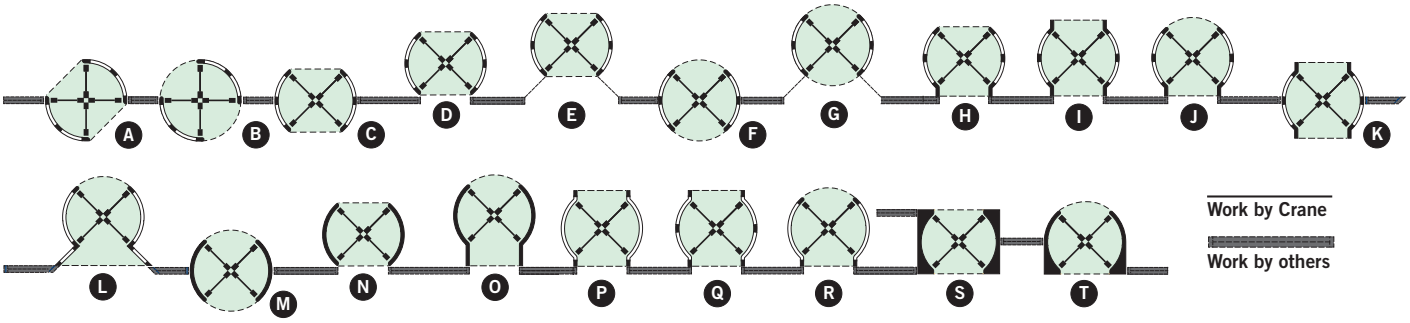
Patented in 1888 by Philadelphian Theophilus Van Kannel, the revolving door became popular in early skyscrapers. The German name for revolving doors, 'Tür ohne Luftzug' literally means 'door without draft of air,' because of the airlock design. Passing through the revolving door's rotating vestibule to reach a building's lobby also offered an architectural feature that accentuated early skyscrapers' dramatic interiors. Van Kannel's invention was so successful that in 1907, International Steel bought his business, which continues today as the International Revolving Door Company.

START AT THE BEGINNING

A starting point for revolving door selection should be ANSI/BHMA A156.27-2019: Power and Manual Operated Revolving Pedestrian Doors. The standard offers specific requirements based on type of door for diameter, height, forces, and behaviors to ensure consistent behavior. For example, a door that's oversized might have wings that oscillate or present difficulties with breakout. Design professionals should start with this standard to understand what revolving door types best meet their performance needs.

ENERGY EFFICIENCY

The U.S. Green Building Council (USGBC) reports that American buildings account for 41 percent of overall energy use, 73 percent of electricity use, and 38 percent of all CO2 emissions. Selecting a revolving door can be a simple switch to significantly reduce energy. Most revolving doors do not require electricity. According to studies by MIT and ASHRAE, a revolving door may offer eight times more energy efficiency than the best sliding or swinging door. MIT's 2006 study equates the energy saved by one person using a revolving door to 36 watt hours of energy – enough to light a 60-watt bulb for 30 minutes. Extrapolating this based on every user can lead to as much as 80,000 watt-hours of energy savings.



Typical revolving door attachment plans

ENERGY ADVANTAGES

Thomas Chaney, dormakaba AVP of Customer Experience for Access Automation Solutions and Interior Glass Systems, believes the main advantage to revolving doors is limiting air transfer. "Think of a revolving door like a rotating vestibule," he explains. "Because a revolving door is always closed, it dramatically decreases the air exchange vs. swinging or sliding doors."

By functioning as an airlock, a revolving door allows entry and exit but restricts outside air flow, typically with air seals and/or weather sweeps, while compensating for the "stack effect." This pressure difference is created when a large column of warm inside air meets cold outside air. The effect also explains how air flow into a building fluctuates based on humidity and pressure. Hot air rises while cold air sinks. When the outdoor climate is cold and a door opens, the cold outdoor air will displace the warm indoor air. If doors are continually opened in these environments, such as in high-traffic buildings, the heating system will need to work overtime to compensate, while occupants will feel colder interior conditions. Warmer climates can appreciate similar benefits in the reverse, as revolving doors also help preserve air-conditioned interior air when doors are opened to hot outdoor temperatures.

When the HVAC system's stack pressure is not balanced, or in the case of a high-rise building with Energy Star air recovery systems, sliding or swinging doors can be affected. Swing doors may become heavier or swing faster depending on the air balance. Sliding doors can become obstructed and remain open, due to internal safety measures for pedestrian obstruction, or can blow open. In either case, air will escape or allow debris into the building with every opening.

"The key differentiator is practicality," Chaney adds. "In high-traffic buildings, swinging doors might be open continuously, putting enormous strain on the HVAC system and leading to uncomfortable drafts."

BENCHMARKING ENERGY

The key to earning LEED points and meeting sustainable energy goals with revolving doors begins with meeting the requirements of ASHRAE Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings. For 35+ years, the standard been a benchmark for commercial building energy codes. It provides the minimum requirements and compliance criteria for energy-efficient design, offering detailed requirements for design and construction of new buildings and their systems, new portions of buildings and systems, and new systems and equipment in existing buildings. The 2019 edition includes new energy recovery requirements for high-rise residential buildings and several updates to the building envelope category, including upgrades minimum criteria for SHGC and U-factor across all climate zones, revised air leakage details, and refined exceptions related to vestibules and air curtains.

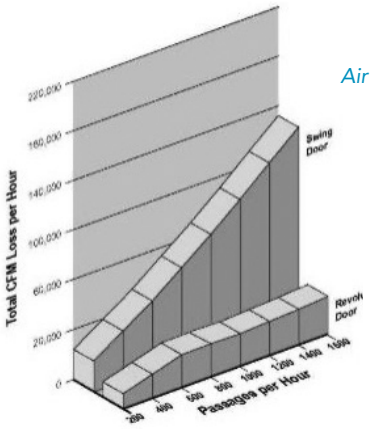
According to industry experts, the key for revolving doors being green is really about their environment – and performance relative to the building envelope. For the highest-traffic environments, revolving door sections can be designed to accommodate groups of people, limiting congestion and further decreasing air exchange. Egress requirements impact air infiltration requirements so the two must be considered carefully and in context.

POLLUTION MITIGATION

Mitigating air pollution is another advantage to revolving doors. Revolving doors not only prevent temperature variations but also minimize airborne pollutants from entering buildings. This can reduce energy loads on HVAC and air filtration systems while offering health benefits to building occupants.

MEASURING ROI

Manufacturers find it difficult to quantify return on investment (ROI) related to revolving doors and associated energy savings. Standard tests for measuring air leakage through windows and doors provide a glimpse at savings but do not consider context.



Air infiltration comparison between a revolving door and a swing door

ASTM E783-02 (2018) is the Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors. The test measures only leakage associated with the assembly and not leakage through openings between assemblies and adjacent construction. ASTM E283/E283M-19 is the Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen. The standard laboratory test incorporates constant temperature and humidity across the specimen but does not measure leakage associated with the assembly.

Neither standard ASTM test measures contextual air leakage based on high or low traffic through a door system or the associated energy expense savings.

OPTIMAL FUNCTION

To create the most energy efficient application for revolving doors, radiused floor grilles that match the door system should be installed. Manufacturer compatibility between door and floor system will minimize resistance as the door turns and ensure a proper airtight seal. Below the floor grilles, even if they are 360-degree, there should be a break installed to block air infiltration. In addition to supporting an airtight entry, floor grilles can collect water, dirt, snow, and slush for a clean aesthetic and safe egress path. Floor grilles that collect dust and debris can be counted toward LEED credits.

Consider also how a revolving door will intersect a building. The attachment plan can mitigate air flow based on wind and weather conditions and traffic patterns. Openings flush with facades may create weatherization issues related to wind or driving rain. According to Chaney, partially recessed entries are often the best-case scenario, but once again, context makes all the difference. Properly sizing a revolving door for its application will also minimize unnecessary air infiltration.

REVOLVING DOOR HABITS:

MIT STUDY RESULTS

A 2006 study conducted at the Massachusetts Institute of Technology (MIT) investigated revolving door usage and associated habits. The study authors chose the topic after noticing that people seemed to ignore signage asking them to use revolving doors. The use of a swing door vs. a revolving door is often an issue of habit. The study looked at whether habits could be reversed, and if having people change one habit might have a large impact on the environment, such as the energy efficiency benefits of revolving doors.

The MIT study began with a survey in which 64 percent of respondents indicated they preferred a swing door because revolving doors are "stressful," swing doors are "quicker and require less effort," and revolving doors are "dangerous," "cramped," or the respondent is "afraid of getting stuck in them." Observational recordings indicated the percentage of swing door users was actually much higher.

The study used large signage to encourage revolving door use, and showed that substantial energy could be saved when people used the revolvers – "the smallest of habit changes contributes to energy conservation." The study also showed that habits could be reinforced by effective design. Door design recommendations included:

- Revolving doors must be easy to push.
- Door maintenance is more important that new or stylish revolving doors (reinforcing ease of use).
- Large signage with simple messages (e.g., Please use the revolving door.) roughly doubles the number of people who use the revolvers.
- Revolving doors should be used in moderate traffic areas (e.g., 100-300 people/hour). In high traffic areas, people perceive swinging doors as faster.
- Revolving doors should be located close to the most traveled traffic path.
- Swing doors should be hidden behind revolvers or set for exit-only.

Read the MIT study: https://web.mit.edu/~slanou/www/shared_documents/366_06_REVOLVING_DOOR.pdf

MAINTENANCE ISSUES

A revolving door's weather strip presents the biggest maintenance issue. As doors cycle, the strip may wear down. It should be replaced with some regularity based on variable usage conditions, including the cycle count (how often the door revolves), climate, and if and how much salt treatment may affect the door. Manufacturers such as dormakaba advise an annual summer inspection to ensure service can be scheduled before winter. Routine maintenance should always be conducted by an authorized technician or service team.

Kevin Albert is an American Association of Automatic Door Manufacturers (AAADM) certified inspector and Project Manager with AGI member Synergy Glass & Door Service. His service team sees bearing or gear failure due to improper or no maintenance as a common issue. "Generally, we recommend following the minimum inspection requirements according to ANSI standards, but our service agreements include four inspections per year." Inspectors review wear strips and weather seals as well as the emergency catches and collapsible safety features that must be maintained to ensure life safety.

Albert adds that automatic revolving doors are much more complex than manual revolvers due to the electrical and electronic components employed in the movement and safety systems. "As you can imagine, transferring signals and power through a moving object isn't easy." The transfer device, a commutator, and ball contacts allow signals to reliably move with the door, but the transference of electrons creates a static charge that attracts dust and builds carbon, which should be cleaned regularly. The AAADM recommends at least two planned maintenance visits per year to be sure these connections remain clear of debris, which can cause pitting in the conductors and signal loss.

COLLABORATE EARLY

To maximize the benefits of revolving doors, engage with the manufacturer and glazing contractor during design development. These subject matter experts can talk through options related to design and performance while reviewing perimeter and elevation designs. A good early discussion about project objectives will help ensure those goals are met. "I always recommend talking to experts as early in the design process as possible," says Chaney. "If you engineer it on your own, you may end up on your own. If you collaborate, we can help you create something absolutely bespoke and appropriate to your application."

Special thanks to Synergy Glass & Door Service and dormakaba for providing images and input on this article

Synergy Glass & Door Service is an NACC-certified AGI member glazing contractor: http://synergyglassanddoor.com.

dormakaba is one of the top three companies in the global market for access and security solutions: https://www.dormakaba.com.

ADDITIONAL RESOURCES

gb&d magazine: 6 Benefits of Revolving Doors https://gbdmagazine.com/dormakaba/
Blue & Green Tomorrow: Revolving Doors are the Most Eco-Friendly and Practical Option: https://blueandgreentomorrow.com/features/revolving-doors-most-eco-friendly-practical-option/
Facility Management (AU): Revolving Doors for Healthier Building Environments: https://www.fmmedia.com.au/sectors/revolving-doors-for-healthier-building-environments/
ASTM E783-02 (2018): https://www.astm.org/e0783-02r18.html
ASTM E283/E283M-19: https://www.astm.org/e0283_e0283m-19.html
ASHRAE Standard 90.1: https://www.ashrae.org/technical-resources/bookstore/standard-90-1
Vox.com: Use a Revolving Door, Save Planet Earth https://www.vox.com/ad/16773704/revolving-doors-environment
ANSI/BHMA A156.27-2011: https://webstore.ansi.org/Standards/BHMA/ANSIBHMAA156272011

About the Devil's Details

The AGI educational series illustrates and describes common glazing challenges as a means to communicate best practices for the design and construction industry, not as a sole source for design guidance. AGI recommends design professionals consult with an AGI contractor regarding specific project challenges. AGI contractor profiles may be accessed at www.theagi.org. To suggest a devilish detail of your own, contact info@theagi.org.