

# **Creating Simplicity Out of Complexity**

## **Ensuring a Seamless Passenger Experience for Vertical Transportation At the Dawn of the Fourth Industrial Revolution**

by Stephen R. Nichols

Technological innovation is transforming the world at a dizzying pace, radically disrupting every aspect of our lives. Often referred to as the Fourth Industrial Revolution, these new developments include the internet-of-things (IoT), artificial intelligence (AI), blockchain, robotics, virtual reality, big data, quantum computing, the cloud and more — with new buzz words constantly entering the mix. These innovations are driving the development of a wide range of new businesses and new products. They are playing an increasingly important role in their own right but even more so when they are connected and working together.

However, do people really yearn to speak with a robotic hotel concierge or receive cloud-enabled reminders triggered by AI algorithms running on data lakes streamed from their in-building equipment? Perhaps not. All of these things are already possible, but what people simply want is advances that can make their daily lives *easier, less demanding and more enjoyable*. In other words, they want *seamless improvements* to their daily routine, which could be something as simple as improving the experience of riding an elevator.

Great companies and great products are successful when innovators focus on people, business and technology, in that order, not the other way around. Elisha Otis did not invent the elevator safety brake to create the elevator industry and grow his company into the \$13-billion global enterprise it is today. His son Charles did not conjure

the world's first service contract for building equipment in order to make money. Both men were simply solving problems that people had in their everyday lives.

Elisha focused on safety. He connected his knowledge of leaf springs and mechanical devices in order to make safer hoisting equipment for a furniture factory (Goodwin, 2001). After solving that problem, he realized that he could build a business around this new technology. Charles wanted to increase the trust that customers had in the new business, so he gave them worry-free service at a reasonable price.

By understanding the habits and expectations of their customers, the two Otis men enabled a new company to emerge that dramatically reshaped the world we live in. Likewise, the new economy of mobile apps, internet-enabled devices, ubiquitous connectivity and unlimited computing power is not emerging from technology alone. Instead, it is growing out of the remarkable experiences that those technologies create.

The mature, highly regulated elevator industry has already moved far beyond the initial focus on safety, which is now a given. Today, vertical transportation systems aim to interact naturally with a building's whole ecosystem. The idea is to balance advances in both elevator and building performance to provide a smooth, convenient, carefree ride every time (Gulan, 2016). Improving the experience involves the art and science of matching an elevator ride to passengers' expectations. It requires advanced technology, a keen understanding of human behavior and the smooth integration of the two.

In most cases, that means matching the habit loops that people have already developed as they go about their everyday lives. These habit loops — cue, routine and reward — enable us to negotiate daily life free from undue stress and strain (Duhigg,

2014). As human beings we yearn for convenience and unobtrusive assistance. We hope to have things appear when we want and need them, with minimal interaction on our part.

## **Technological Innovation & Habit**

We are already in the habit of using technology to make it easy to negotiate everyday life. Smartphones, email, video and text messaging apps connect us in real time with family, friends and coworkers all over the globe, regardless of time zone or geography. We have online orders delivered to our home or workplace seemingly instantaneously. These advances did not appear by themselves: They are built on, extend and improve existing habit loops, and are enabled by new technologies.

For example, moving through our urban landscape is becoming easier with ride-hailing services. Their success is not necessarily because these new services are *better* than what came before, such as taxis, but partly because we are *already* in the habit of using our smartphones to connect us to what we want and need. So it is only natural to expect that vertical movement through our homes and offices should be as frictionless as calling an Uber or DiDi car or ordering from Amazon or Alibaba.

Imagine that as you approach an elevator you learn which car to board, and then that elevator takes you to your destination without any additional input. A simplified experience makes the journey both more natural and more personal. You will be automatically guided to the right elevator that will be ready just as you arrive, with no wait (see Figure 1 on page 4).



Figure 1 Future Elevator Experience Journey Map

The elevator will know who you are and where you are going. It will automatically select the floor, and you will be off quickly and safely to your destination. Perhaps the lighting, music or infotainment in the elevator cab will be tuned exactly to your preferences. Maybe a convenient coupon for the tasty treat you didn't realize you wanted will appear on the screen. Or perhaps you'll see a reminder about an event on your calendar that you might have forgotten.

## Seamless Elevators

These personalized experiences are only possible with the integration of new technologies. Destination dispatching and the advances of the Otis CompassPlus™ system have changed the paradigm. No longer do passengers press *up* or *down* on the building landing and then choose a floor after they enter whichever elevator car arrives. The interface on the landing provides the information passengers trust to get them to their destination in the most efficient way possible.

Now we've moved beyond even that scenario, as the interface becomes the smartphone that passengers carry with them. The Otis eCall™ smartphone application allows people to call for the elevator while en route to the elevator lobby. Upcoming advances to this technology platform will only improve the experience and make the journey even more seamless.

Elevators are both a place and a space between places. Many people don't realize elevators are the safest, most reliable transportation that they use every day. Elevators are an essential feature of any dense urban area and, when designed well, they complement the buildings in which people live, work or play.

But how do you create the perfect, personalized seamless experience? We consider four key areas when evaluating any solution, whether it is pressing a button, talking to an elevator operator or a virtual assistant, or using a smartphone to call the elevator (see Figure 2):

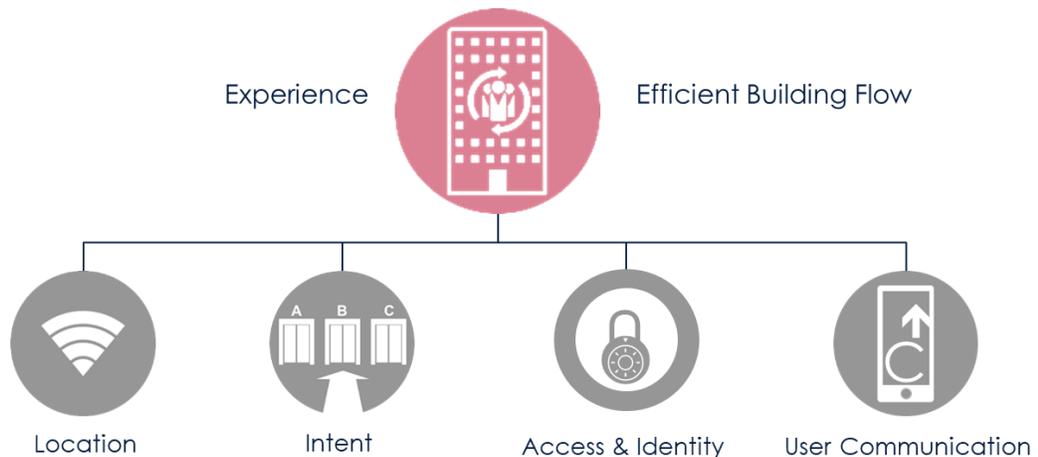


Figure 2 Passenger Experience Themes to Balance Experience & Efficient Building Flow

- **LOCATION:** Where is the passenger in the building? Are they in the lobby? Are they in the elevator?
- **INTENT:** Is the passenger ready to ride the elevator? As they pass through the lobby, are they getting into an elevator car? Are they getting off a car? Are they walking past the elevator to meet a colleague?
- **ACCESS CONTROL** and **IDENTITY:** Who is riding in the elevator? Are we linking the elevator to a security system? Does the elevator or the building know who the passengers are and where they want to go? Are they authorized to go there? How does the elevator know these things and communicate with other building systems?
- **COMMUNICATION:** Finally, we must communicate to the passengers. Which elevator should they enter? When will their elevator arrive? Where should they go next after they get off?

We can develop journey maps for any potential experience. There are four basic parts to any elevator journey (see Figure 3 on page 7): 1) entering the building and approaching the elevator; 2) calling the elevator; 3) riding the elevator; and 4) arriving at the destination. In each of these categories, the passenger must take a variety of active and passive steps. Each of these steps may require a different level of mental or physical engagement, and we aim to make all of these basic steps as simple and easy as possible.

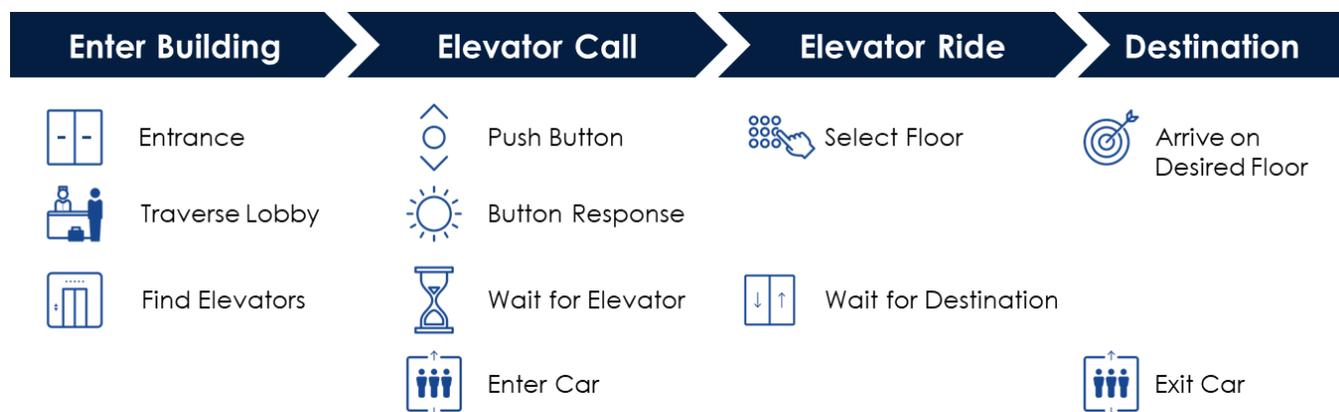


Figure 3 Basic Elevator Experience Journey Map

## Simplicity in Complex Building Ecosystems

Each of these steps becomes more of a burden on passengers as buildings grow larger and more complex. High-rise buildings often create increased demands due to access control requirements, multiple tenants and multiples uses. For instance, higher-rise buildings often feature multi-step entrances, sky lobbies and multiple elevator banks.

Your passenger journey begins as you approach the building. Your intent and location must be understood with increasing accuracy as you traverse the lobby. You may be directed up escalators or to different elevator groups, especially in buildings with double-deck elevators. For larger buildings, you may pass through turnstiles and access control as you approach the first elevator banks. Up-peak traffic at the beginning of the day or down/peak traffic at the end of the day become important pinch points with many thousands of people passing through key intersections. The journey continues on the first elevator ride. Passengers might pass through sky lobbies and take a second elevator to their eventual destination. Egress from the building can

be as complex as entry, especially in the case of emergency evacuation or if the elevators are used to shuttle people to refuge spaces in the building.

These personalized experiences do not constitute a new era for elevators. For much of the early history of elevators, the experience was simple and very personal. Passengers would communicate directly with elevator operators who guided traffic, opened and closed doors, and directed the movement of the elevator car (Nichols, 2017). Technologies have always been introduced to lower anxiety and increase convenience and efficiency. This could be adding something as simple as a mirror to create the feeling of more space or elevator music to provide a pleasing distraction and a bit of ambiance.

Otis continues to innovate, using emerging technologies to improve the overall elevator experience that it helped create more than 167 years ago.

Privacy is a primary consideration. Elevators and building systems need to understand some information about who you are, where you want to go, and why; but the design must minimize the use of identifying information to that which is necessary to accomplish the desired impact to the individual experience. Elevators are a trusted, safe mode of transportation, and that will not change as new technologies are added. However, augmenting elevator technology with the cloud, identity management, biometrics and other complex sensing refinements must be done with absolute respect for privacy and cybersecurity.

The best way to respect the identity of passengers is to design systems that don't require personally identifiable information. In the best scenarios we can enable seamless experiences based merely on sensing a person's presence or the abstracted

understanding of that individual. It may be sufficient to know that a specific group of individuals is moving together as a social group and wishes to call the elevator together. We don't always need to know the identity of each person.

Ideally these services will be provided by an opt-in method to allow each person to choose whether to take advantage of the additional benefits. It is also important to add these features in close collaboration with the security systems that control access and provide other protections for personally identifiable information.

Considerations of privacy and cyberphysical security have become essential in how we introduce any new technology. Otis is committed to always strengthening both privacy and the cybersecurity resiliency of our products by adopting comprehensive cybersecurity processes, best practices, continuous discipline health improvement and a risk-based approach.

Complex buildings do not require complex experiences. Calling and riding an elevator is a simple, scalable process that has been in place for decades: You call, your ride comes, and it takes you where you want to go. Destination entry terminals improve on *up/down* buttons. They give the system advance warning of where you want to go, so it can send the elevator — even if not the first available — that will get you to your destination in the most efficient way. But as the internet-of-things, mobility and sensing technologies become more widely available and cost-effective, we have an opportunity to do even better.

Seamless experiences help building tenants and passengers more easily handle complex buildings. By concentrating on making the experience simple and letting the technology assist people in improving their everyday routine, people can focus on

enjoying their work and play rather than becoming overwhelmed by complexity. The idea is to expose the user to what is really important, minimizing unnecessary complication.

## Roadmap to the Ultimate Experience

As technology progresses, we are moving toward the ultimate experience. The omniscient elevator system that knows where everyone is and where everyone wants to go may not yet be a reality. However, we are adding appropriate levels of AI and sensing technologies, tuned to passenger preferences and choices, to offer distinct levels of the seamless experience. Imagine the following four tiers in the seamless pyramid (see Figure 4 below). At each tier, less interaction is required. The vertical transportation system and building ecosystem take on more of the cognitive load to make things simpler and more seamless for the passenger.

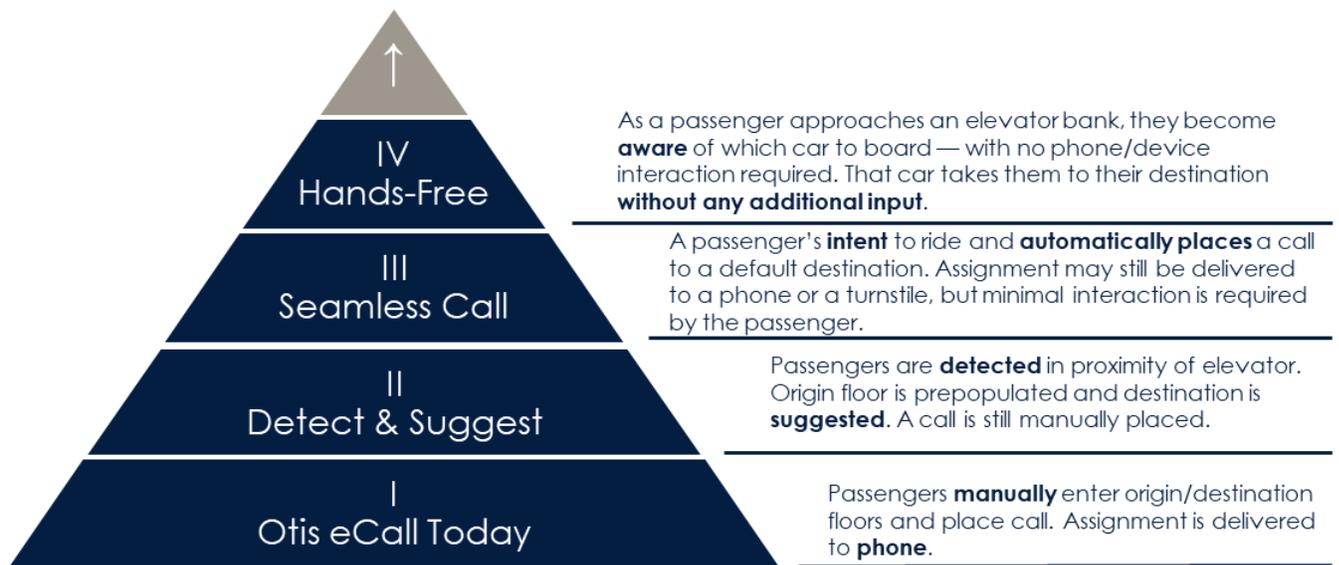


Figure 4 Tiers of the Seamless Pyramid

## I. **Otis eCALL TODAY**

Passengers can **manually** enter origin/destination floors and call the elevator, either from the fixture on the wall or from their personal smartphone or wearable device. Assignment is delivered to the **phone** or wearable. This solution has been available for several years in elevators with Otis eCall or where the Otis eCall technology platform has been integrated with other building systems or a building app. This provides an experience tailored to that building's ambiance and unique character. Calling at a distance and the added convenience of Otis eCall increases options for a variety of passengers.

## II. **DETECT & SUGGEST**

With the addition of some simple indoor location sensing, passengers can be **detected** in proximity to the elevator. Origin floor is prepopulated, and the destination is **suggested**. A call is still manually placed and confirmed by the passenger. However, intelligence built into the building and the app take the burden off the passenger and make calling the elevator just that much easier. This can be achieved with a variety of indoor location sensing technologies such as BLE beacons or integration with other systems already present in the building.

## III. **SEAMLESS CALL**

Fully seamless calls are achieved when the system detects a passenger's **intent** to ride and **automatically places a call** to a default destination floor. Assignment may still be delivered to a phone or a turnstile, but minimal interaction is required by the passenger. Seamless calls were first introduced by Otis at a major commercial building in New York City in 2006. RFID access cards in concert with the access control system seamlessly deliver car assignments via Otis

CompassPlus™ destination dispatching system to displays integrated in the turnstiles more than 45 meters from the elevators. As access cards and identification continue to move away from physical credentials like cards to digital smartphone-based credentials, seamless calls will be available from wherever the user wishes to initiate the call. Users will no longer be required to engage with turnstiles as they enter the building. Moving the calling terminal from a screen on the wall to a screen that passengers carry with them enables a whole new level of freedom. There are other more recent examples. Mixed use development and the creation of “cities within the city” that combine a variety spaces into one connected “smart” neighborhood is a major trend in most regions of the world. For one customer, biometric access systems at the entry to the building integrate with Otis CompassPlus™ intelligent dispatching technology and coordinate personal assignments that are delivered seamlessly to an Otis-enabled smartphone app. The app makes seamless intuitive calls as passengers pass through the sky lobby on their way from the street to their office, no matter where they started in the building.

#### IV. **HANDS FREE**

The ultimate experience is completely hands free. As a passenger approaches an elevator bank, they become **aware** of which car to board — with no phone/device interaction required. That car takes them to their destination **without any additional input**. In this case, the system handles all of the worry for the passenger. Passengers no longer need to wonder if they have boarded the right elevator car or even if they are in the right place. The elevator and building systems will adapt to who is there and whisk them to where they want to go.

Passengers can simply board the elevator. It will sense them and connect them to their destination, seemingly with no interaction on their part.

The possibilities are limitless. Simple journeys become more delightful, and complex journeys become simpler. An easy-to-use, frictionless experience enables people to more easily move about buildings and their day. Digital connections between the elevator and other building systems provide for even more powerful routines. Facial recognition and biometrics enhance security and enable personalized micro-experiences for each person.

Our lives are becoming increasingly seamless, with technology connecting every moment, from when people get up in the morning through every touch point in their day. As additional services and possibilities are added to the ecosystem and menu of choices, more connections, some not yet imagined, are possible.

For example, hotel guests will not just be able to check in and choose their ideal room. They can choose to have their entire experience curated: from entering the hotel to automatically calling their elevator, having their personalized entertainment choices automatically cued and more. Think of the day when you not only call the elevator seamlessly, but the elevator calls your urban air taxi (Shah, 2019). This was recently demonstrated at the CoMotion LA event in November 2019. Urban residents will be able to seamlessly call not just the elevator but their ride from where they are to any point in the city, by any mode of transportation. Seamless mobility in horizontal, vertical and diagonal directions seems like science fiction, yet it's on the horizon.

But we don't need to wait for future urban air transportation in order to improve people's lives. Application programming interfaces (APIs) and the digital connections

that underlie these experiences will power both the complex and the simple. Imagine that your smart coffee machine knows two minutes after you pick up your freshly brewed cup in the morning to seamlessly trigger your elevator call, because it realizes you are on your way to your morning commute. With smart-connected elevators and the smart-connected systems-of-systems that surround them, the limitation is not the technology but how expansive your imagination is. The elevator and its technology platforms will enable whatever seamless experiences your heart desires.

The coming years and decades will feature an unprecedented acceleration in new technologies, the new business models enabled by those technologies and the overall speed with which everything moves. We are at the dawn of the Fourth Industrial Revolution, entering an ever more connected world (Poniewierski, 2019). Amazing experiences will be the driving force shaping this new economy, as all that is new improves the routine habits of daily life. This will allow people to get on with their lives, free of mundane concerns.

By focusing on *people* to create seamless experiences, elevator companies and those that create smart building systems will offer differentiated value that places them far ahead of the competition. In a world that is growing taller, faster and smarter by the day, success will go to those who simplify what is complex — providing elegant, easy solutions that surprise, delight and empower everyone to thrive.

## About the Author

**Stephen R. Nichols** is a systems engineer with cross-functional interest in product development, architecture and innovation. Stephen is interested in finding simplicity in complex systems as well as the intersection of human experiences and people-centered-design with vertical transportation technology, building ecosystems, and urban environments. He is based at Otis's engineering center and world headquarters in Farmington, CT. He is a two-time National Academy of Engineering Frontiers of Engineering alumni and received the 2019 Gilbreth lectureship. He has earned degrees mechanical engineering degrees from Tufts University and RPI and a professional certificate in systems engineering from MIT.

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