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**Innovations in  
commercial real estate**

Preparing for the city  
of the future



# Are your buildings future ready?

In last year's commercial real estate (CRE) outlook, we took a longer-term view of how the nexus of technology advancements and consumer behavior changes will disrupt and redefine the industry over the next decade. Considering that fortune-telling in the corporate world is at best an educated guess, the four themes comprising collaborative economy, disintermediation in brokerage and leasing, war for talent, and the last mile appear to be playing out well in the industry, some at a faster pace than the others.

At the same time, the corporate world, policy makers, and government agencies are increasingly challenged with significant demographic shifts, which include growing urbanization, longevity of Baby Boomers, and differentiated lifestyle patterns of Millennials. Added to those are security, climate change, and resource scarcity concerns. Collectively, these factors are stretching both government budgets and the aging physical infrastructure.

Consequently, urban policy makers are considering innovative ways to use technology to manage cities amid changing expectations of the expanding urban population. Many governments across the world are making budgetary allocations and considering public-private partnership models for developing smart cities, effectively cities of the future, as solutions to this conundrum.<sup>1</sup> Deloitte considers a [city to be smart](#) when investments in human and social capital, traditional infrastructure, and disruptive technologies fuel sustainable economic growth and a high quality of life, with wise management of natural resources, through participatory governance.<sup>2</sup> One such example can be seen in Chicago's launch of the Array of Things project, a collaborative effort with several academic and research associations. The project will use sensors to connect and provide location-based real-time data on the city's environment, activity, and infrastructure. The effort aims to equip decision makers with information that can enable specific actions to make the city more livable, efficient, and healthier.<sup>3</sup>

Naturally, the built environment plays a pivotal role and is an integral part of urban planning. With the heightened need and focus on the city of the future, the question you need to ask yourself is: as developers and owners of the built environment, are your *buildings future ready*? Are you deploying technology innovatively and effectively to prepare and respond to the rapidly changing ecosystem?

Many CRE owners may believe that smart cities or cities of the future are unlikely to impact the existing built environment, or that the timing is too far out to consider seriously. However, some evolving trends are likely to impact the CRE industry faster than expected. Growing government focus, rapid advances in technology, and innovative solutions to improve urban life should

compel the industry to prepare and respond to the changes in the ecosystem. As Rupert Murdoch, Founder, News Corporation, says, "The world is changing very fast. Big will not beat small anymore. It will be the fast beating the slow."<sup>4</sup>

With these thoughts in mind, we have identified five themes for this year's outlook that we believe CRE owners should consider integral to their business strategy.

Most of these themes are enablers, which if used strategically and timely, can equip CRE companies to make their physical space future-ready:

1. Future of mobility
2. Occupant health and wellness
3. Internet of Things
4. 3D printing technologies
5. Demographic data and predictive analytics

Going forward, CRE companies should recognize that their business models will need to evolve with the changes in their ecosystem. They will benefit from reimagining their business strategy and by considering innovative ways to execute it. According to Aaron Block, co-founder and managing director of MetaProp NYC, "The current wave of RETech innovation will not only replace some existing business models, but it will also make professional lives more profitable and more efficient for real estate owners, managers, developers, brokers, architects, engineers, and other practitioners."<sup>5</sup>



# Future of mobility

## Changing the CRE landscape

Mobility—the movement of people and goods—is undergoing significant change. A confluence of trends, most notably the rise of shared access of vehicles and the approaching reality of fully autonomous vehicles, is remaking the extended automotive industry into a new mobility ecosystem.<sup>6</sup> The emergence of “pay-per-use,” which is driving much of the collaborative economy, is also beginning to challenge the predominant model of personally owned vehicles. Today, there are a wide variety of options, such as on-demand ridesharing (Uber and Lyft), carsharing (Zipcar), and bike sharing (Zagster).

At the same time, the car is rapidly becoming a technology product. Innovations in powertrains and materials are expanding what vehicles are capable of, and increasing connectivity opens up new possibilities for safer, more efficient, and more enjoyable travel. However, it is the advent of fully autonomous or self-driving vehicles—cars, trucks, and drones—that will potentially bring the most transformative change not just to auto manufacturers, but to the entire mobility ecosystem. Our blog post [“Commercial real estate sector: Get set to be disrupted by driverless cars”](#) highlighted that self-driving

cars will enable many current non drivers, such as the elderly, adolescents, and the disabled, to use cars. Further benefits of self-driving cars are numerous, including:

- Ability to leverage connection technologies to communicate between cars, optimize traffic flows, and minimize congestion
- Enhanced collision avoidance
- More efficient use of vehicles; currently, autos are idle over 95 percent of the time, on average
- More efficient and effective parking, given that the cars can be parked outside of the city<sup>7</sup>

Given their economic incentives, on-demand ridesharing providers might be among the first to adopt this technology.<sup>8</sup>

While much remains uncertain, many companies are working to make driverless cars a commercial reality sooner than later—perhaps over the next five years.<sup>9</sup> In its recent forecast, IHS Markit suggests that global autonomous car sales will reach 600,000 by 2025 and that the USA will lead the way.<sup>10</sup>

**How will the future of mobility impact CRE?**

Historically, major advances in automotive technology and the related ecosystems have had a massive impact on CRE. The introduction of automobiles in the early part of the 20th century allowed personal freedom and mobility and accelerated the demographic shifts within cities and suburbs. The subsequent mid-century introduction of the interstate highway system connected cities, creating significant real estate development opportunities across all property types. Throughout history, real estate fortunes have been made by correctly anticipating and reacting to major advances in transportation technology, including automotive, rail, and air.

The evolving future of mobility has the potential to change both the use and supply-and-demand dynamics for CRE. For instance, there may not be a need for large parking spaces in central business districts (CBDs) in the future, as driverless cars can be “sent” to park in less-dense areas. As a result,

there could be significant redevelopment potential for existing parking structures in CBDs. Retail real estate owners may likewise have an opportunity to repurpose portions of existing parking areas in their large malls, including adding additional retail and entertainment space.

Sidewalks will likely be freer as the new mobility options would reduce curbside parking, and street widths could be reduced based on more efficient management of auto traffic. As a result, CRE owners will have access to large tracts of space in prime areas that can be put to use in different ways—space that commands very high prices. As an example, in New York’s Soho area, the cost of a parking space is about four times the cost of an average single-family home in the US.<sup>11</sup> Urban planners and CRE owners will have an opportunity to use the free space in CBDs and urban retail centers for greener spaces, thus promoting healthy living and in turn contributing to the broader climate-change agenda.<sup>12</sup> At the same time, urban areas bordering CBDs and well-located suburban properties may witness a change in terms of higher demand for high-density parking lots, recognizing that driverless cars will require less space per vehicle for parking.

Autonomous trucks will impact the delivery of goods from manufacturer to both retailer and the end-consumer, disrupting existing logistics networks and, consequently, the demand and location of warehouse properties. In addition, existing warehouse spaces may require design changes in the form of “standardization” for easier maneuvering.<sup>13</sup> Warehouse owners and

operators can also consider using driverless cars within warehouses to automate loading and unloading of goods, along with transporting them.<sup>14</sup> Equipped with advanced navigation capabilities, these cars will be able to maneuver through small spaces and around obstacles.<sup>15</sup>

CRE owners are also likely to witness a shift in their tenant demography. Victor Coleman, chief executive of a West Coast real estate investment trust (REIT), Hudson Pacific Properties Inc., recently noted that there is an increase in demand for space from both technology companies and traditional auto manufacturers, as they ramp up research and experimentation efforts on self-driving cars.<sup>16</sup> Tenants are also likely to redefine their use of physical space, depending on how this trend impacts their businesses. In our report, “Commercial real estate redefined—How the nexus of technology advancements and consumer behavior will disrupt the industry,” we highlighted retailers using different and flexible delivery options, such as same-day or next-day delivery, to create differentiation at the last mile. These same retailers may consider using driverless cars for same-day delivery when the vehicles are not otherwise being used.<sup>17</sup> In another scenario, demand for senior living facilities may change as Baby Boomers find a greater variety of mobility options. This in turn will likely impact healthcare property owners.

In summary, shifting mobility patterns will have a material impact on CRE valuations, location decisions, future real estate development, and tenant targeting strategies (see Figure 1).

**Figure 1: Future of mobility’s relative impact on different CRE focus areas\***

Location strategy	Tenant strategy	Develop/ (re)design	Operational efficiency	Revenue growth	Property valuations	Brand strength
High	Medium	High	Medium	Medium	Medium	Low

Source: Deloitte Center for Financial Services analysis

\*Please refer to the methodology section for details

### How could CRE companies respond?

In what may be considered early responses to this evolving trend, several CRE players are leveraging new mobility options to enhance tenant engagement. A few companies are offering reserved parking spots for car-sharing services, while others are collaborating with ride-sharing companies to offer on-demand travel services at subsidized rates as a tenant amenity.<sup>18</sup> Equity Residential, for one, has partnered with Zipcar to offer the latter's on-demand car service on a priority basis to its tenants.<sup>19</sup>

However, we believe CRE companies have an additional opportunity to be more strategic in analyzing the impact of mobility patterns and options on their businesses, to meaningfully effect their long-term revenue and profitability. To start, companies should evaluate the influence of

new mobility options on existing real estate investments, as well as on new development and investment underwriting decisions. Location and usability of physical space is expected to change rapidly with advances in mobility, which will create new development opportunities within cities of the future, and redevelopment opportunities for many existing spaces such as parking lots.

Going forward, as tenants, consumers, and residents increase their use of self-driving vehicles, CRE companies may need to make design changes to existing spaces to accommodate the use and impact of new mobility options. These companies should also revisit their existing tenant targeting strategies as their tenant mix is likely to change, and as tenants themselves evaluate the impact of the future of mobility on their respective businesses.

CRE companies have an additional opportunity to be more strategic in analyzing the impact of mobility patterns and options on their businesses.



## Lesson from the trenches

### Parkmerced Labs: Integrating changing mobility patterns into CRE development plans<sup>20</sup>

San Francisco developer, Maximus Real Estate Partners, has invested in Parkmerced, an upcoming 152-acre multifamily redevelopment in San Francisco. The developer has launched Parkmerced Labs (PM Labs) to develop transportation solutions that make it easier to live in cities, in light of growing urbanization and changing lifestyle patterns. Earlier this year, the developer, through its PM Labs, collaborated with Uber to offer residents a monthly stipend of \$100 for the services of Uber and Clipper (a transit card that offers access to many transportation options in the Bay Area) as an alternative to car ownership. Uber will also offer residents subsidized fares for its carpool service to major transportation hubs. Maximus aims to discourage car use and ownership, and ultimately reduce space for parking lots in its redevelopment project. The developer plans to use the space in a more creative manner, such as enhancing tenant amenities that could, for instance, include cycling tracks. Given the changing personal mobility patterns, this effort from Maximus' PM Labs could be a step in the right direction.



## Key takeaways: Future of mobility



### Trend overview

- Remaking the extended automotive industry into a new mobility ecosystem
- The emergence of “pay-per-use” is beginning to challenge the model of personally owned vehicles
- Many companies are working to make driverless cars a commercial reality sooner than later



### Impact on CRE owners

- Potential to change both the use and supply-and-demand dynamics
- Access to large tracts of space
- Opportunity to use the free space in CBDs and urban retail centers for greener spaces, contributing to the broader climate-change issue
- Urban areas bordering CBDs and well-located suburban properties may witness a change in terms of higher demand for high-density parking lots
- A shift in tenant demography



### What should CRE executives do to prepare for the future of mobility?

- Be more strategic in analyzing the impact of mobility patterns and options on their businesses, to meaningfully impact their long-term revenue and profitability
- Explore making design changes to existing spaces to accommodate the use and impact of new mobility options
- Leverage new mobility options to enhance tenant engagement
- Revisit existing tenant targeting strategies

# Occupant health and wellness

## Moving beyond resource conservation

In recent years, many Americans have become more conscious about health and wellness; that awareness is now spilling over into the built environment. Studies suggest that changes in the indoor air quality alone can result in productivity gains of about 8 percent.<sup>21</sup> Additional factors may include thermal comfort, daylighting and lighting, noise, interior layout, and biophilia. Biophilia essentially refers to the human need to connect with nature at physical, mental, and social levels, which in turn has an impact on well-being, productivity, and societal relationships.<sup>22</sup>

Millennials, now the largest cohort of the US population and labor force, have a particular lifestyle pattern, as the “live, work, play” mantra holds center stage for them.<sup>23,24</sup> A global 2016 Deloitte Millennial survey revealed that Millennials continue to place significant importance on well-being at workplaces.<sup>25</sup>

With that, companies are increasingly considering multiple ways to improve health and wellness to attract and retain employees, clients, and other stakeholders. Among many initiatives, they are considering making changes to the built environment. Many occupiers are studying the impact of the built environment and work patterns on human health, particularly as it relates to diabetes, cancer, and cardiovascular- and respiratory-related diseases.

To address this growing need, Delos Living LLC established the WELL Building Standard (WELL), which is “a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being.”<sup>26</sup> Introduced in October 2014, WELL aims to improve the health and well-being of building occupants, through controls for air, water, food, light, fitness, and physical and mental comfort.<sup>27</sup> WELL can be considered an extension of the Leadership in Energy and Environmental Design (LEED) certification, which focuses on environmental sustainability efforts.<sup>28</sup>

The WELL certification is gaining in popularity, with many countries now beginning to adopt the standards for their respective built environments. In the United States, the General Services Administration (GSA) and the Centers for Disease Control and Prevention (CDC) are researching the broader application of the Fitwel building certification program that will likely be launched publicly in 2017.<sup>29</sup> How the USA develops a common standard with existing WELL guidelines will be worth noting.

### How will the focus on occupant health and wellness impact CRE?

CRE players have so far focused largely on sustainability initiatives relating to resource conservation. Companies will now take their efforts to the next level by considering occupant health and wellness, with equal

emphasis on mental, social, and physical within the built environment. In a member survey conducted by the Urban Land Institute (ULI) in 2013, 95 percent of respondents agreed that “human health and the built environment are inextricably linked with real estate,” and 96 percent of respondents agreed or strongly agreed that the “real estate industry has to play a critical role in efforts to promote health and wellness.”<sup>30</sup>

Why should CRE companies pay attention to health and wellness? First, their tenants are increasing their strategic focus to help attract and retain quality talent. Further, biophilic design considerations can improve tenants’ financial performance by reducing operating costs through higher productivity and lower absenteeism. Lastly, tenants can also use such an enhanced environment to strengthen their corporate brand.<sup>31</sup>

Health and wellness features may impact CRE prices, especially for Class A properties, as sustainability measures such as energy conservation have now become a norm. There is the potential for an erosion of value for those buildings that do not offer the appropriate conditions for occupiers/users to be healthy and productive. The 2013 ULI-member survey revealed that a full 92 percent of respondents agreed or strongly agreed that health and wellness features in a real estate property can impact its market success and economic value.<sup>32</sup>

Figure 2: Occupant health and wellness initiatives’ relative impact on different CRE focus areas

Location strategy	Tenant strategy	Develop/ (re)design	Operational efficiency	Revenue growth	Property valuations	Brand strength
Low	High	High	High	High	High	Medium

Source: Deloitte Center for Financial Services Analysis

### How could CRE companies respond?

Certainly, heightened tenant focus on health and wellness requires CRE owners to implement requisite features in new and existing buildings. Similar to resource conservation measures, CRE owners should consider adopting design elements that promote health and wellness when retrofitting existing buildings and developing new ones. For instance, in consideration of the disruptive influence of technology, including demographic and lifestyle patterns, real estate firm Hines Interests Limited Partnership has established the Hines 2025 Working Group, which has laid down the vision and roadmap for “Hines Building of the Future.”

The company plans to use collaborative design thinking to (re)develop future buildings, and one of its focus areas includes promoting occupant health and wellness in its built environment.<sup>33</sup>

Further, to enhance tenant loyalty and satisfaction, CRE owners should consider collaborating with existing and prospective tenants to understand their requirements and appropriately incorporate design elements that can help promote health and wellness.

As highlighted in our research report [“Smart buildings: How IoT technology aims to add value for real estate companies,”](#)

CRE companies can use environmental (temperature and air quality) and occupant movement, together with health data captured by sensors in IoT-enabled buildings, to understand the optimal ventilation and temperature levels, and then make the necessary adjustments in space conditioning to provide a healthier environment for occupants. Tenants can also use the data about the movement of individuals through open spaces to boost the productivity of workers by better designing tasks and breaks to facilitate collaboration and even socializing among employees.



## Lesson from the trenches

### Cadillac Fairview and TD Bank: Landlord-tenant partnership driving occupant health and wellness<sup>34</sup>

With the intent to reduce costs, promote employee health and wellness, and position itself as an “extraordinary place to work,” Toronto Dominion Bank (TD Bank) partnered with both its landlord, Cadillac Fairview Corporation Limited (Cadillac) and wellness strategy consultant, Delos Living LLC, to refurbish 25,000 square feet of its corporate headquarters in Canada’s Toronto-Dominion Centre (TDC).

First, the team tore down the walls and created a mix of open office spaces to encourage collaboration and small enclosures for private meetings. Secondly, they considered various

elements that impact different parameters of building performance such as air, water, light, nourishment, fitness, comfort, and mind, while redesigning the office space. As a result, the building was WELL certified in May 2016. The building has other wellness features such as biophilic artwork, adjustable height workspaces, nutritious food options, and a wellness library, among others. TD Bank is now extending wellness features to its customers by getting WELL certification for a new retail bank branch in Bethesda, Maryland.

TD Bank’s efforts highlight the growing importance of health and wellness features in driving occupant satisfaction and the benefits of collaboration between landlord and tenant.



## Key takeaways: Occupant health and wellness



### Trend overview

- Many Americans have become more conscious about health and wellness; that awareness is now spilling over into the built environment
- Millennials have a particular lifestyle pattern, as the “live, work, play” mantra holds center stage for them
- The WELL Building Standard aims to improve the health and well-being of building occupants, through controls for air, water, food, light, fitness, and physical and mental comfort



### Impact on CRE owners

- Take sustainability efforts to the next level by considering occupant health and wellness, with equal emphasis on mental, social, and physical, within the built environment
- Tenants are increasing their strategic focus to help attract and retain quality talent, and strengthen financial performance and corporate brand
- Upside potential for CRE prices, especially for Class A properties



### What should CRE executives do to enhance occupant health and wellness?

- Adopt design elements that promote health and wellness while retrofitting existing buildings and developing new ones
- Collaborate with existing and prospective tenants to understand their health and wellness requirements
- Use IoT technology to track, adapt, and optimize resource usage
- Share IoT sensor data with tenants to help the latter enhance employee productivity



# Internet of Things (IoT)

## Transforming building management and tenant experience

Technology innovations have found their way to the center of every business as they are increasing connectivity among humans at an exponential pace. Now, technologies such as the IoT are enabling interactions among machines as well, bringing another layer of change to the business ecosystem.

By definition, IoT is a suite of technologies and applications that equip devices and locations to generate all kinds of information—and to connect those devices and locations for instant data analysis and, ideally, “smart” action.<sup>35</sup> (For more information on the technologies that power the IoT, see our primer, [Inside the Internet of Things](#).<sup>36</sup>)

For the CRE sector, an IoT-enabled building management system (BMS) offers higher-order benefits compared to existing automation efforts. In an IoT-enabled BMS, various types of IoT devices can track features such as motion, air pressure, light, temperature, and water flow and then—with the Internet backbone—enable the BMS to autonomously sense, communicate, analyze, and act or react to people or other

machines in a non-intrusive manner.<sup>37</sup> The potential for IoT in CRE is vast, as suggested by Allied Market Research, which expects the global market for smart homes and buildings to grow to \$35.3 billion by 2020, or at a compounded annual growth rate of 29.5 percent between 2012 and 2020.<sup>38</sup>

### How will IoT technology impact CRE?

Commonly known as smart or intelligent buildings, IoT-enabled physical space will impact CRE owners in multiple ways. The technology has the potential to allow CRE companies to improve margins through cost savings and operational efficiency as superior building performance lowers operating costs, facilitates predictive maintenance, and increases security. IoT technology can also enable CRE companies to create competitive differentiation and improve topline growth through service innovation to tenants. This can include leveraging sensor data to offer tenants more customized design and experience by capturing and analyzing end-user behaviors. For instance, footpath technologies can enable office property owners to provide

key insights to employee interactions and movements, and help design more customized and comfortable workspaces. In another scenario, mall owners can use the same technology to personalize shopping experiences by tracking shopper movement patterns through signals from their cellphones.<sup>39</sup>

Industrial CRE owners can likewise use IoT to enable faster and accurate shipments by using smart cart-like robots and meticulous tracking through sensors.<sup>40</sup>

From a valuation perspective, there is a possibility that tenants may soon come to expect IoT features, implying that buildings lacking them may trade at a discount. (For more information on the applicability and impact of IoT on CRE, please read our detailed report, [“Smart buildings: How IoT technology aims to add value for real estate companies.”](#))

Figure 3 summarizes the impact of IoT technology on various aspects of the CRE business.

Figure 3: IoT technology’s relative impact on different CRE focus areas

Location strategy	Tenant strategy	Develop/ (re)design	Operational efficiency	Revenue growth	Property valuations	Brand strength
Low	High	High	High	Medium	Medium	High

Source: Deloitte Center for Financial Services analysis

**How could CRE companies respond?**

Many CRE companies are currently in the initial stages of adopting IoT technology; they have been installing sensors and automating activities with their sights on low-hanging fruit such as cost savings and operational efficiency through improved energy management and reduced personnel costs.<sup>41</sup>

But to realize the full benefit of IoT technology, CRE companies should determine the types of IoT applications that would be most beneficial to them. Once they have evaluated and selected the appropriate IoT applications, CRE companies should find ways to monetize their IoT investment. CRE companies can record, aggregate,

and analyze sensor data to offer analytics as a service to tenants and third parties, generating revenue from new sources. For instance, owners can use data on occupant movement within their properties to entice advertisers and generate new or enhanced revenues.<sup>42</sup>

Having said that, as CRE companies plan IoT technology adoption, they will potentially have to ascertain ways to ensure seamless integration and interoperability with existing technology systems. They will need appropriate analytic tools and visualization capabilities to analyze the large sets of diverse data collected from sensors and traditional sources. For instance, CRE

companies can leverage service providers that aggregate and analyze anonymous wireless signaling data to provide insights on movement and flow of traffic and consumer behavior.<sup>43</sup> These insights can then be combined with demographic factors such as population and job growth, crime, pollution, noise, and climate patterns, to enable more-informed decision making. Finally and perhaps equally important, CRE companies should consider and adopt appropriate cyber security measures as data privacy and cyberattack concerns are magnified in an IoT-connected world.



**Lesson from the trenches**

**CBRE: Leveraging IoT to differentiate its real estate space<sup>44</sup>**

CBRE, one of the world’s largest CRE services and investment firms, is leveraging IoT to enhance occupant experience and operational efficiency by improving building responsiveness and performance while reducing building management costs. For clients, the company is particularly focused on remote-sensor capabilities that can optimize environment comfort, reduce energy usage, and decrease building-performance-related risk. In its own offices, CBRE is using smart LED fixtures that automatically adjust their levels based on natural daylight and is deploying utilization-sensing technologies. Further, in collaboration with Johnson Controls, CBRE is investing in the Building Innovation Lab, with the goal of innovating and piloting new building technologies to improve client building performance and occupant experience. The firm is also highly focused on using building intelligence and data analytics, with data generated from building

management activities and building automation systems to identify trends and spot improvement opportunities at the individual building and portfolio levels.

The company is also focusing on employee health and experience to further differentiate itself. For instance, CBRE’s “Workplace360” initiative aims to ease and support the way its employees work and collaborate across locations. To promote health and productivity, the company has deployed smart heating, ventilation and air conditioning (HVAC) systems at several of its properties to infuse fresh air from the outdoors, as and when carbon dioxide levels rise indoors.

Finally, CBRE plans to drive common standards and better cyber risk management practices through its innovation lab. While there is still some time before CBRE can maximize the value of IoT-enabled buildings, the company is on the right track to create value for itself and for its clients.



## Key takeaways: Internet of Things



### Trend overview

- Enabling interactions among machines and bringing another layer of change to the business ecosystem
- Offers higher-order benefits compared to existing automation efforts
- Various types of IoT devices can track features such as motion, air pressure, light, temperature, and water flow and then—with the Internet backbone—enable the BMS to autonomously sense, communicate, analyze, and act or react to people or other



### Impact on CRE owners

- Can improve margins through cost savings and operational efficiency
- Create competitive differentiation and improve topline growth through service innovation to tenants
- Higher property values as there is a possibility that tenants may soon expect IoT features, implying that buildings lacking them may trade at a discount



### What should CRE executives do to adopt the Internet of Things?

- Determine the types of IoT applications that would be most beneficial
- Find ways to monetize IoT investment
- Record, aggregate, and analyze sensor data to offer analytics as a service to tenants and third parties, generating revenue from new sources
- Ensure seamless integration and interoperability with existing technology systems

# 3D printing technologies

## Driving construction innovation and tenant personalization

Humans today have a growing desire for personalization, with consumption patterns tilting toward more customized goods and services. 3D printing is one such technology that is likely to enable and address customization requirements. Also known as additive manufacturing, 3D printing “refers to a group of technologies that create products through the addition of materials (typically layer by layer) rather than by subtraction (through machining or other types of processing).”<sup>45</sup>

3D printing technologies have found applications across several industries, including consumer products, automobiles, and life sciences, with the main advantages being speed to market, design customization, and waste reduction.<sup>46</sup> In the CRE industry, 3D printing can be used in construction activities for faster and

higher quality construction.<sup>47</sup> Given its many benefits, global 3D printing industry revenues are expected to more than double to \$35.4 billion by 2020, from \$15.9 billion in 2016.<sup>48</sup> (For more insights to 3D printing technologies, please refer to [our Deloitte University Press collection](#).)

### How will 3D printing impact CRE?

3D printing technologies will impact the CRE industry in both direct and indirect ways.

Directly, the technology has more relevance for engineering and construction (E&C) companies. As highlighted in our blog, [3D-printed commercial buildings: Faster, cheaper, better](#), 3D printing is likely to reduce construction costs, drive operational efficiency, and enhance the quality of construction. A few companies in China and Dubai have already developed low-

rise CRE buildings with large 3D printers and have reported benefits around the aforementioned areas.<sup>49</sup> In these initial use cases, building construction time has been reduced by 50-70 percent with increased automation using 3D printers.<sup>50</sup> Construction costs have also been lower due to a 50–80 percent decrease in labor expenses, with less wasted material. Quality has been superior due to customized and intricate designs, built-in insulation in 3D-printed walls, and a higher sustainability footprint due to the use of recycled waste as part of the raw material and concrete.<sup>51,52</sup> Despite the clear benefits, there is a general sense that a broader adoption of 3D printing in building construction could take longer in developed markets such as the USA, as it will take time for safety standards and building codes to evolve.



Going forward, CRE owners are likely to be impacted by tenants' use of 3D printing technology, as it will influence both the demand for space and the way it is used. Demand for retail and industrial CRE spaces will likely be particularly affected, due to the potential use of these technologies for more customized and on-demand production and delivery, reducing the need to hold inventory in large warehouses or retail stores. At Lowe's, a home improvement and appliances retailer,

its customers have the opportunity to design and 3D print their home furnishings with an option to ship the goods directly to customer locations.<sup>53</sup> In contrast, a few retailers are using 3D printing technologies to enhance shopper engagement and experience, driving more traffic into their stores. For instance, Macy's is using 3D printers to cater to Millennial shoppers, providing personalized products ranging from jewelry to jeans.<sup>54</sup> But in the industrial space, 3D printing of goods will likely bring

more reshoring of manufacturing facilities and could disrupt some of the existing supply chains and logistics systems.<sup>55</sup>

Bottom line, 3D printing offers an opportunity to E&C companies to innovate current construction practices. At the same time, it's important for CRE owners to consider the impact and usage of this technology by tenants when making their location and development decisions.

**Figure 4: 3D printing technology's relative impact on different E&C & CRE focus areas**

**E&C companies**

Location strategy	Tenant strategy	Develop/(re)design	Operational efficiency	Revenue growth	Property valuations	Brand strength
Low	Low	High	High	Medium	Low	Medium

Source: Deloitte Center for Financial Services analysis

**CRE owners**

Location strategy	Tenant strategy	Develop/(re)design	Operational efficiency	Revenue growth	Property valuations	Brand strength
Medium	High	High	Medium	Medium	Medium	Medium

Source: Deloitte Center for Financial Services analysis

3D printing offers an opportunity to E&C companies to innovate current construction practices.

### How could CRE companies respond?

Currently, most E&C companies and developers are using 3D printing to make 3D models, and are potentially in the research and testing phase for 3D printing of buildings and the underlying components. Going forward, E&C companies can invest in firms that focus on building large 3D printers or partner with leading universities, to be at the forefront of 3D printing innovations in the construction sector. For instance, researchers at Singapore's Nanyang Technological University are studying the feasibility of using giant 3D printers that can print an entire floor of a high-rise building in one go.<sup>56</sup> As more use cases emerge, companies should analyze financial, physical, and regulatory feasibility of 3D-print buildings.

CRE owners can use 3D-printed models for their development decisions. In fact, institutional investors are beginning to use them to enable more informed real estate investment decisions.<sup>57</sup>

Retail CRE owners should collaborate with tenants and understand their differentiated space design requirements as tenants increase their use of 3D printing technology to attract customers. Industrial CRE owners will have to re-strategize and reposition existing warehouses as on-demand production and faster delivery will likely increase demand for smaller distribution and fulfillment centers, which are located well within city limits and closer to the end consumer.<sup>58</sup> At the same time, companies will also have to consider space requirements for 3D printers and related inputs. In addition, CRE companies can improve space utilization and tenant service through alternative leasing strategies like multi-tenant solutions and use of smart technologies.<sup>59</sup>



## Lesson from the trenches

### Tishman Speyer: 3D-printed models enabling more sophisticated investment decisions<sup>60</sup>

In what some considered an initial use of 3D printing technologies by real estate companies, developer Tishman Speyer partnered with Autodesk and Steelblue to create one of the largest 3D-printed scale models of San Francisco.

The model, printed with a 16-micron resolution, showcased over 115 blocks of the Financial and South of Market neighborhoods in San Francisco with great precision. These included some well-known developments such as San Francisco Museum of Modern Art and the Ferry building. In addition, it represented fully developed versions of currently under-construction buildings to provide an idea of the future landscape of the area. With dynamic lighting and projection from the top of the model, it simulated different conditions such as natural daylight patterns for different buildings and traffic movements across the district. In addition, the model allowed easy replacement of existing buildings or blocks with new forms to understand different design options or make updates as per the actual developments.

The 3D model thus helped Tishman Speyer to better understand the current and future development scenario in San Francisco, and potentially added more rigor to its future investment decisions around location, building design, and construction.



## Key takeaways: 3D printing technology



### Trend overview

- Growing desire for personalization as consumption patterns are tilting towards more customized goods and services
- Enables and addresses customization requirements
- Can be used in construction activities for faster and higher quality construction



### Impact on CRE owners

- Reduce construction costs, drive operational efficiency, and enhance the quality of construction
- Tenants' use of 3D printing technology influence both the demand for space and the way it is used, particularly in the retail and industrial space



### What should CRE executives do to adopt 3D printing technology?

- Invest in firms that focus on building large 3D printers or partner with leading universities, to be at the forefront of 3D printing innovations in the construction sector
- Analyze financial, physical, and regulatory feasibility of 3D-print buildings
- Use 3D-printed models for their development decisions
- Restrategize and reposition existing warehouses
- Improve space utilization and tenant service through alternative leasing strategies and use of smart technologies
- Be aware that broader adoption of 3D printing in building construction could take longer in developed markets such as the USA, as it will take time for safety standards and building codes to evolve

# Demographic data and predictive analytics

## Enabling smarter decision making

In today's hyper-connected world, there is an overload of information and data waiting to be used in meaningful ways to enable smarter decision making.

Demographic data make up one such information set, which is now widely used due to the distinct preferences of different age cohorts such as Millennials and Baby Boomers. Unlike traditional methods, data captured through the Internet, satellites, and sensors include people's preferences and behaviors, often going beyond standard information such as age, income, and gender to include parameters like relationship status, career history, home ownership, past travel destinations, and immigration, among others.<sup>61</sup>

While the increased volume, velocity, and veracity of the available data provide more information to businesses, companies are also challenged to make sense of all that data. Companies can benefit significantly from the use of predictive analytics tools to analyze the past data and use algorithms and machine learning techniques to predict the future. Some of the tools that combine consumer lifestyle segmentation data and analytics capabilities are Experian's Mosaic USA and Esri Tapestry.<sup>62</sup> Existing applications include predicting demand for consumer products at a store level by using web-search data linked to that store, along with the traditional time-series sales data.<sup>63</sup> In the public sector space, entities such as the Fire Department of the City of New York (FDNY) have started using predictive analytics to identify buildings that are most likely to catch fire.<sup>64</sup> The FDNY plans to use advanced algorithms to track trends across

the city and analyze nearly 7,500 factors from data accumulated by different city agencies.<sup>65</sup>

### How will a combination of demographic data and predictive analytics impact CRE?

CRE owners can make more informed decisions by using predictive analytics on the expanded sets of demographic data. For instance, it will be useful for companies to know the unique and detailed future demographic profile of a region in which they are either present or plan to invest in the future. Once companies get an idea of the needs and preferences of the prospective inhabitants of a region, they can potentially assess whether the existing CRE infrastructure will align with the requirements of those inhabitants. These insights along with other considerations, such as property ownership and management costs, upcoming developments in the region, and transportation infrastructure, can help decide the location and scale of new developments and redevelopment or redesign needs for existing properties.

Enodo Score, a startup that recently launched its predictive analytics platform for CRE, is working in a similar direction. The platform uses advanced analytics, including machine learning algorithms, on real-time market data, large sets of census data, and past property information, to enable more informed investment decisions about multifamily properties.<sup>66</sup> For example, the platform can help assess the impact of new and upcoming developments on rents and

vacancies, and can even calculate the impact of renovating or adding new amenities to an existing building.<sup>67</sup> It has also developed a quantitative solution to compare properties in different US markets with the introduction of a property-level composite score.<sup>68</sup>

Companies can further use demographic data and predictive analytics for their leasing activities as well as for driving tenant engagement and loyalty. Take the case of a mall owner looking for the appropriate tenant mix. Advanced data analytics tools can help aggregate and analyze unconventional and unstructured data, such as online enquiries and purchases, website clicks, location check-ins, shopper traffic patterns, and shared social media content. The insights from this data combined with other traditional demographic factors can lead to more accurate forecasting of consumer buying patterns.<sup>69</sup> This in turn can be used to decide the appropriate tenant mix and optimal tenant locations within the mall, and plan the sales and marketing strategy.

CRE companies can also use data and analytics to add rigor to existing property valuation methodologies by building in more nuances around location dynamics, building usage by occupants, and so forth, allowing CRE owners to eventually make more data-driven portfolio decisions. This type of analysis can also enable institutional investors in their investment decisions, as they will have more granular information about buildings.

**Figure 5: Demographic data and predictive analytics’ relative impact on different CRE focus areas**

Location strategy	Tenant strategy	Develop/ (re)design	Operational efficiency	Revenue growth	Property valuations	Brand strength
High	High	Medium	Medium	High	Medium	High

Source: Deloitte Center for Financial Services analysis

**How could CRE companies respond?**

A few CRE owners have already started on the analytics journey. French shopping mall owner and manager, Klépierre, uses demographic analysis in its property acquisition and disposition decisions.<sup>70</sup> However, many CRE owners and developers still make key location and tenant decisions based on experience and intuition. While experience does count, there exist many new tools to leverage data and enhance decision making today.

To expedite the adoption of data-driven decision processes, CRE owners and developers can consider different approaches to using predictive analytics capabilities in their business. They can potentially partner or hire the services of consultants and startups that specialize in these capabilities, due especially to a shortage of analytical talent in the marketplace.<sup>71</sup> Companies in other industries are also teaming with multiple service providers from the advanced analytics domain.<sup>72</sup>

CRE companies can only benefit from enhancing the analytical capabilities of existing talent, so that they can use the data provided by external service providers in a more meaningful manner.



**Lesson from the trenches**

**Westfield Corporation: Investing in data and analytics technologies and partnerships to improve tenant engagement and enhance shopper experience<sup>73</sup>**

Westfield Corporation, one of the largest mall owners in the world, is significantly focused on using analytics to enhance tenant and shopper experience and engagement. In November 2015, the company announced its intent to design and execute a comprehensive data strategy by establishing a separate big data and analytics function and leadership appointments. As part of this strategy, the company will work through its digital innovation arm, Westfield Labs, and also increase collaboration with tenants.

Along these lines, Westfield Labs has partnered with RetailNext, a leading retail analytics firm focused on physical stores, to provide in-store analytics and useful shopper data to tenants.

Westfield is exploring additional data analytics opportunities and aims to use its tenants’ large repository of customer data. As Westfield’s co-CEO, Steven Lowy says, “We’re building the best customer experience for each customer. With the power of our collective IT, we can make the experience even better than anything they can get online.”



## Key takeaways: Demographic data and predictive analytics



### Trend overview

- Widely used for smarter decision making due to the distinct preferences of different age cohorts
- Used to make sense of the increased volume, velocity, and veracity of the available data
- Predictive analytics tools analyze the past data and use algorithms and machine learning techniques to predict the future



### Impact on CRE owners

- Informed decision-making—investments, location, leasing—through use of predictive analytics on the expanded sets of demographic data
- Drive tenant engagement and loyalty
- Add rigor to existing property valuation methodologies
- Enable sophisticated decision-making for institutional investors



### What should CRE executives do to leverage demographic data and predictive analysis?

- Use tools for more informed location, investment, and tenant decisions
- Partner or hire the services of consultants and startups that specialize in predictive analytics capabilities
- Enhance the analytical capabilities of existing talent



# Building of the future: Too far, yet too close

## Transforming building management and tenant experience

Technology advancements have lowered the cost of hardware, innovation, and prototyping to such a large extent that new startups are developing products and services at a fast pace.<sup>74</sup> Consequently, technology and innovation are challenging and changing traditional business models. CRE companies need to realize that changes that seem far out are not really so. As governments experiment with shaping the cities of the future, innovations in the automotive sector transform personal mobility patterns, and tenants emphasize promotion of occupant health and wellness, so will CRE owners have to re-invent their strategy to prepare and respond to the anticipated changes to the built environment.

Coincidentally, technology is the enabler for companies looking to reinvent themselves. CRE companies have an opportunity to use technologies such as IoT, 3D printing, and advanced analytics to be innovative with

respect to locating future developments, (re)designing the physical space, and aligning with the changes in demographic and consumption patterns. As these technologies generate more data, CRE companies can consider using predictive analytics to make more informed data-driven decisions. This would allow them to garner competitive advantage and drive topline and bottom-line growth by enhancing every aspect of their business: location decisions, property development and valuations, as well as tenant attraction, engagement, and loyalty.

The question now is how should companies drive these innovations? As highlighted in our recent blog, [“Startup accelerators are driving innovation in CRE,”](#) the typical growth approaches—whether organic or acquisition of similar types of companies or businesses—may not be enough. Many CRE companies would benefit from investing in the tools and talent to respond or react to

the changes in their ecosystem at a desirable pace. Companies should consider an outside approach to accelerate their operations and decision-making processes, in order to keep pace with the rapid changes in their ecosystem. Some of the approaches can include partnering with existing startups or establishing research and innovation labs, or corporate accelerators. And increasing collaboration with tenants and other stakeholders will provide CRE companies with additional insights on the impact of innovation and disruption, and perhaps also provide early warnings and valuable insights to shape innovative strategic responses.

The truth is that CRE companies need to act now and be experimental, rather than only plan for the future. As Joichi "Joi" Ito, Director of MIT Media Lab, mentioned in one of his TED talks, “Don't be a futurist, be a now-ist.”<sup>75</sup>

# Methodology

The heat maps in each section represent our assessment of the relative impact (high-medium-low) of each theme across different focus areas for CRE companies.

## Details of the focus areas:

- Location strategy includes site selection and other location decisions
- Tenant strategy includes selection, attraction, satisfaction, and retention
- Brand strength includes differentiation and brand enhancement
- Develop/(Re)design includes new developments, space design, and redesign
- Operational efficiency includes process improvements and cost savings
- Revenue growth includes a positive change in rentals and occupancy rates
- Property valuations includes a positive change in capital values and net asset values



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# Endnotes

1. Doug Peebles, "Need a Hand With Your Smart City Project? Government Help May Be On the Way," Smart Cities Council, August 2, 2016; "Smart Cities: Background Paper," Department for Business, Innovation & Skills, [www.gov.uk](http://www.gov.uk), October 9, 2013
2. Rob Dubbeldman and Stephen Ward, "Smart Cities: How Rapid Advances in Technology Are Reshaping Our Economy and Society," Deloitte Gov Lab, The Netherlands, November 2015
3. "Array of Things," [arrayofthings.github.io](http://arrayofthings.github.io), Accessed August 29, 2016
4. "Top 20 Inspirational Business Quotes from Famous Founders," Despreneur, May 20, 2013
5. Olga De Benoist, "Interview with Aaron Block: How to Encourage Innovation in the Real Estate Industry," Global Real Estate Experts, March 30, 2016
6. Scott Corwin, Joe Vitale, Eamonn Kelly, Elizabeth Cathles, "The Future of Mobility: How Transportation Technology and Social Trends Are Creating a New Business Ecosystem" Deloitte University Press, September 24, 2015; Simon Ninan, Bharath Gangula, Matthias von Alten, Brenna Sniderman, "Who Owns the Road? The IoT-Connected Car of Today—and Tomorrow," Deloitte University Press, August 18, 2015
7. Scott Corwin, Joe Vitale, Eamonn Kelly, Elizabeth Cathles, "The Future of Mobility," Deloitte University Press, September 24, 2015
8. Alison Griswold, "Uber's Self-Driving Cars Are on the Road," Quartz, May 19, 2016, <http://qz.com/688003>
9. Max Chafkin, "Uber's First Self-Driving Fleet Arrives in Pittsburgh This Month," Bloomberg, August 18, 2016
10. "Annual Autonomous Car Sales to Hit 21 Million by 2035," *Autocar*, June 10, 2016
11. Candace Jackson, "The Race to the \$1 Million Parking Spot," *The Wall Street Journal*, August 25, 2015
12. Jason Henderson and Jason Spencer, "Autonomous Vehicles and Commercial Real Estate," *Cornell Real Estate Review*, 2016
13. Ron Derven, "Driverless Trucks," *NAIOP Development Magazine*, Summer 2015
14. Dr. Markus Kückelhaus, "Self-Driving Vehicles in Logistics," DHL Trend Research, 2014
15. Ibid
16. Eliot Brown, "Real Estate for Autonomous Car Facilities Gains Movement in Silicon Valley," *Wall Street Journal*, May 5, 2016
17. Taylor Mammen and Brandon Beck, "RCLCO futuRE Series: A Driverless Vehicle Roadmap for the Real Estate Practitioner—Part 2," RCLCO, December 22, 2015
18. Carisa Chappell, "Office REITs Cater to Commuters With Electric Vehicles," REIT.com, September 11, 2012
19. Jane Tindall, "Zip Car in Your Building," Equity Residential blogs, June 12, 2012. Accessed August 14, 2016
20. The case study is based on the following secondary sources: "Parkmerced Announces Exclusive Partnership With Uber," Maximus Partners Company press release, May 18, 2016. Michael Cabanatuan, "Parkmerced Plans to Subsidize Residents' Use of Uber, Muni, BART," SFGate, May 18, 2016
21. ParkJS and Yoon CH, "The Effects of Outdoor Air Supply Rate on Work Performance During 8-h Work Period," Department of Architectural Engineering, Hanyang University, Seongsong-gu, Seoul, 2011
22. "The Economics of Biophilia: Why Designing With Nature in Mind Makes Financial Sense," Terrapin Bright Green LLC, 2012, [www.terrapinbrightgreen.com](http://www.terrapinbrightgreen.com)
23. "Millennials Outnumber Baby Boomers and Are Far More Diverse, Census Bureau Reports," press release, United States Census Bureau, June 25, 2015
24. Richard Fry, "Millennials Surpass Gen Xers as the Largest Generation in U.S. Labor Force," Pew Research Center, May 11, 2015
25. "The 2016 Deloitte Millennial Survey: Winning Over the Next Generation of Leaders," Deloitte, 2016
26. "International WELL Building Institute announces enhanced options to the WELL Building Standard," Blue Building Institute, October 23, 2015
27. "CaGBC is bringing the WELL Building Standard® to Canada," Canada Green Building Council, [www.cagbc.org](http://www.cagbc.org)
28. "The Next Frontier in Sustainability: The WELL Building Standard," Green Building Education Services blog, <http://www.gbcs.com/blog/the-next-frontier-in-sustainability-the-well-building-standard/>
29. Leigh Stringer, "FITWEL and the Center for Active Design, an Interview with Joanna Frank," Leigh Stringer website, accessed June 17, 2016
30. Kathleen McCormick, "Intersections: Health and the built environment," Urban Land Institute and Building Healthy Places Initiative, 2013
31. "Health, well-being & productivity in offices: The next chapter for green building," World Green Building Council, September 2014
32. Kathleen McCormick, "Intersections: Health and the built environment," Urban Land Institute and Building Healthy Places Initiative, 2013
33. Hines Sustainability website, [www.hines.com/about/sustainability](http://www.hines.com/about/sustainability), accessed on August 26, 2016
34. LEED Spotlight: TD Bank Group's Toronto Office Certifies WELL Gold, Marking the First WELL Certified™ Project under WELL v1," Canada Green Building Council, [www.cagbc.org](http://www.cagbc.org), 2016. Peter Fabris, "TD Bank Group's Renovated Toronto Office Is First WELL-Certified Project Under WELL v1," Building Design+Construction, June 8, 2016. "TD Bank's New Store in Bethesda is Committed to Your Health," Obesity, Fitness & Wellness Week, April 22, 2016.
35. Surabhi Kejriwal and Saurabh Mahajan, "Smart buildings: How IoT Technology Aims to Add Value for Real Estate Companies," Deloitte University Press, April 19, 2016
36. Jonathan Holdowsky, Monica Mahto, Michael E. Raynor, Mark J. Cotteleer, "Inside the Internet of Things (IoT), a Primer on the Technologies Building the IoT," Deloitte University Press, August 21, 2015
37. Surabhi Kejriwal & Saurabh Mahajan, "Smart buildings: How IoT Technology Aims to Add Value for Real Estate Companies," Deloitte University Press, April 19, 2016
38. "Smart Homes and Buildings Market to Reach \$35.3 Billion, Globally, by 2020," press release, Allied Market Research, <https://www.alliedmarketresearch.com/press-release/smart-homes-and-buildings-market-to-reach-35-3-billion-by-2020.html>

39. Surabhi Kejriwal & Saurabh Mahajan, "Smart buildings: How IoT Technology Aims to Add Value for Real Estate Companies," Deloitte University Press, April 19, 2016
40. Ibid
41. Ibid
42. Ibid
43. [www.airsage.com](http://www.airsage.com), accessed on September 1, 2016
44. The case study is based on certain primary information on CBRE's IoT initiatives and the following secondary sources: Michelle Ervin, "Inside CBRE's latest workplace transformation," REMI Network, July 11, 2016, <https://www.reminetwork.com/articles/inside-cbres-latest-workplace-transformation/>. Billy Fink, "5 Insights into the Workplace of Tomorrow from CBRE," Hightower Blog, March 29, 2016
45. Mark Cotteleer, Jonathan Holdowsky, Monica Mahto, "The 3D Opportunity Primer: the Basics of Additive Manufacturing," Deloitte University Press, March 6, 2014
46. Ibid
47. Michelle Starr, "World's First 3D-Printed Apartment Building Constructed in China," *CNET*, January 19, 2015
48. "Worldwide Spending on 3D Printing Expected to Surpass \$35 Billion in 2020, According to IDC," press release, August 11, 2016
49. Michelle Starr, "Dubai Unveils World's First 3D-Printed Office Building," *CNET*, May 25, 2016
50. Michelle Starr, "World's First 3D-Printed Apartment Building Constructed in China," *CNET*, January 19, 2015
51. Ibid
52. Ibid
53. Katie Armstrong, "Lowe's Offers Bespoke 3D Printed Designs," 3D Printing Industry, September 8, 2016
54. Debra Thimmesch, "Macy's Goes Millennial with High-Tech Offerings, Including 3D Printed Selfies," [3DPrint.com](http://3DPrint.com), September 30, 2015
55. Surabhi Kejriwal, "Commercial Real Estate Redefined: How the Nexus of Technology Advancements and Consumer Behavior Will Disrupt the Industry," Deloitte Center for Financial Services, October 2015
56. Barbara Eldredge, "Can 3D Printing Create Massive Legos for High-Rise Construction?," *CURBED*, April 7, 2016
57. "Unveiling the Largest-Ever 3D-Printed Model of San Francisco," Autodesk, May 28, 2014. "Stratasys 3D Printing Gives Architects Finer Details and More Display Options for 2017 San Francisco Skyline," *Stratasys Blog*, October 11, 2014
58. Surabhi Kejriwal, "Commercial Real Estate Redefined: How the Nexus of Technology Advancements and Consumer Behavior Will Disrupt the Industry," Deloitte Center for Financial Services, October 2015
59. Ibid
60. The case study is based on the following secondary sources: "Unveiling the Largest-Ever 3D-Printed Model of San Francisco," Autodesk, May 28, 2014. "Stratasys 3D Printing Gives Architects Finer Details and More Display Options for 2017 San Francisco Skyline," *Stratasys Blog*, October 11, 2014
61. "Bringing Predictive Analytics to Real Estate," The Swanepoel T3 Group, November 19, 2015
62. Mosaic® USA consumer lifestyle segmentation, Experian website, <http://www.experian.com/marketing-services/consumer-segmentation.html>. Esri Tapestry Segmentation, Esri website, accessed August 25, 2016
63. Jacob LaRiviere, Preston McAfee, Justin Rao, Vijay K. Narayanan, Walter Sun, "Where Predictive Analytics Is Having the Biggest Impact," *Harvard Business Review*, May 25, 2016
64. Brian Heaton, "New York City Fights Fire with Data," *Government Technology*, May 15, 2015
65. Ibid
66. "Enodo Score, A Predictive Analytics Platform for Commercial Real Estate, Launches and Seeks Beta Testers," *Marketwired*, May 23, 2016
67. Ibid
68. Ibid
69. "Predictive Analysis Is Transforming Commercial Real Estate: Are You Ready?," Goldin Peiser & Peiser, LLP, February 2016
70. Kate Allen, "Why Real Estate Investors Should Follow Global Population Trends," *Financial Times*, April 10, 2015
71. "Analytics Trends 2016: The Next Evolution," Deloitte, 2016
72. Ibid
73. The case study is based on the following secondary sources: Sharon Edelson, "Westfield's Lowy Looks to Mall's Future," *WWD*, January 20, 2016. "Westfield Hires Chief Data And Analytics Officer," *Retail TouchPoints*, October 26, 2015. RetailNext company website
74. Joi Ito, "Want to innovate? Become a 'now-ist'," TED Talk, March 2014
75. Ibid



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