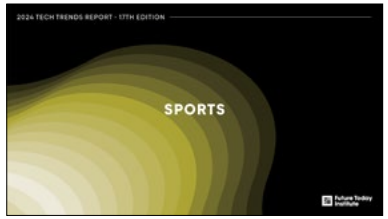
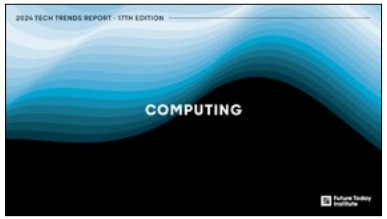
BUILT ENVIRONMENT

FUTURE TODAY INSTITUTE'S 2024 TECH TREND REPORT

Our 2024 edition includes nearly 700 trends, which are published individually in 16 volumes and as one comprehensive report with all trends included.

Download all sections of Future Today Institute's 2024 Tech Trends report at **http://www.futuretodayinstitute.com/trends.**





THE YEAR AHEAD: TECH SUPERCYCLE

The theme for our 2024 report is Supercycle. In economics, a "supercycle" refers to an extended period of booming demand, elevating the prices of commodities and assets to unprecedented heights. It stretches across years, even decades, and is driven by substantial and sustained structural changes in the economy.

We believe we have entered a technology supercycle. This wave of innovation is so potent and pervasive that it promises to reshape the very fabric of our existence, from the intricacies of global supply chains to the minutiae of daily habits, from the corridors of power in global politics to the unspoken norms that govern our social interactions.

Driving this seismic shift are the titans of technology and three of their inventions: artificial intelligence, biotechnology, and a burgeoning ecosystem of interconnected wearable devices for people, pets, and objects. As they converge, these three macro tech segments will redefine our relationship with everything, from our pharmacists to our animals, from banks to our own bodies. Future Today Institute's analysis shows that every technology—AR/ VR/ XR, autonomous vehicles, low Earth orbit satellites, to name a few—connects to the supercycle in some way.

The ramifications are stark and undeniable. As this tech supercycle unfurls, there will be victors and vanquished, those who seize the reins of this epochal change, and those who are swallowed whole. For business leaders, investors, and policymakers, understanding this tech supercycle is paramount.

In this 17th edition of FTI's annual Tech Trends report, we've connected the supercycle to the nearly 700 trends we've developed. Our research is presented across 16 technology and industry-specific reports that reveal the current state of play and lists of influencers to watch, along with detailed examples and recommendations designed to help executives and their teams develop their strategic positioning. The trends span evolutionary advancements in well-established technologies to groundbreaking developments at the forefront of technological and scientific exploration. You'll see emerging epicenters of innovation and risk, along with a preview into their transformative effects across various industries.

We've visually represented the tech supercycle on the report's cover, which is an undulating image reminiscent of a storm radar. Vertical and horizontal lines mark the edges of each section's cover. When all 16 section covers converge, the trends reveal a compounding effect as reverberating aftershocks influence every other area of technology and science, as well as all industries.

It's the convergence that matters. In isolation, trends offer limited foresight into the future. Instead, the interplay of these trends is what reveals long-term change. For that reason, organizations must not only remain vigilant in monitoring these evolving trends but also in cultivating strategic foresight—the ability to anticipate future changes and plan for various scenarios.

Our world is changing at an unprecedented rate, and this supercycle has only just begun.

Amy Webb
Chief Executive Officer
Future Today Institute

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TOP HEADLINES

As some cities face the dual challenges of aging infrastructure and urban decay, compounded by sinking, new technologies are emerging to tackle these issues along with other concerns like housing and sustainability.

01 Sensors Are Predicting Structural Failures

Sensors are increasingly relied on to keep tabs on the aging and repair needs of buildings.

02 The Empty Office Crisis Persists

Office conversion and adaptive reuse are turning spaces back into functional assets rather than relics of traditional 9-5, in-person workdays.

03 The Alarming Reality of Urban Areas Rapidly Sinking

Many cities are reporting that, just like Venice, their foundations are eroding. Jakarta, Indonesia, is ranked as the fastest sinking city in the world.

04 Pigmentless Paint Becomes a Sustainable Solution

University of Central Florida's plasmonic paint uses new ways to produce colors that can keep buildings cooler.

05 World's Largest 3D Printed Neighborhood Is Underway

A new property development outside of Austin, Texas, is set to become the world's largest additively made community.

STATE OF PLAY

Focusing on Responsible and Responsive Buildings, Structures, and Construction

As the built environment struggles to deal with a dwindling talent pool and rising costs related to supply chain shortages, built environment professionals are facing their own existential crisis. They're trying to hold onto their relevancy amid heightened interest to adopt artificial intelligence, robotics, and new construction practices that deliver projects faster and more efficiently. They're also unsure what skills will be most in demand for their industry in the future, and are considering how they can bring human-centric behaviors to the forefront in the meantime.

The industry is further looking in the mirror amid an increase in environmental activism and calls for more responsible practices—as it is, the built environment industry is widely known as one of the leading causes of waste and consumption in the world. New practices such as rewilding and deconstruction are gaining prominence and even regulatory backing from regions and municipalities. This shift is building off the focus on fostering health and wellness to create places where people want to spend their time.

New technologies for power generation, infrastructure, and data collection offer ways for projects to last longer, which then raises questions about what that future longevity looks like. Completely connected projects that use sensors, drones, and other tools are providing real-time data that is also being leveraged to generate drawings, models, business strategies, and practices that enable better-informed decisions by both companies and clients. All of these developments highlight a push to challenge outdated practices and move into a new era for this industry.

KEY EVENTS

FEBRUARY 15, 2023

Earthquake-Resistant Tower Completed
In Tokyo, a new supertall skyscraper was specifically designed and built to resist the impacts of earthquakes.

MARCH 31, 2023

India's 3D Printed Bridge
Thanks to a new process, India now has its first 3D printed bridge using indigenous materials.

JULY 21, 2023

Self-Healing Metal Discovery
Researchers investigating cracks at a microscopic level observe metal self-healing under a process called cold welding.

SEPTEMBER 9, 2023

ICC Code Updates Bring Necessary Changes
Finding building code updates will be easier with the use of QR codes, while waste management also gets more attention.

OCTOBER 3, 2023

Tallest Timber Building Approved
Developers in Perth get the OK to start working on what will be the world's tallest building using timber construction.

LIKELY NEAR TERM DEVELOPMENTS

CLIENTS HAVE NEW REQUIREMENTS EXPECTATIONS

Integrated data and the output from models that use that data are becoming more of a requirement, allowing for greater manipulation and understanding in the preconstruction and documentation phases. Clients will continue to want proof that a project will perform financially, and to interact and engage with that data on a more routine basis. More regions and municipalities will also want plans that extend beyond the structure itself, including options for what to do with the materials once the life cycle of the project is complete, as well as plans for how to convert entire blocks or just rooftops into functional spaces. The upfront planning process will become even more important as technology will more clearly show what should be prioritized, such as a road to be fixed or a new sewer system to be installed.

Deconstruction Plans Become Required

Many areas already have deconstruction requirements, aiming to reduce waste heading to a landfill. These types of requirements will likely only continue to increase, which will change permit and construction planning.

Immersive Design Leads to Spatial Relevancy

As the world becomes more immersed in technology, screens and devices are continuing to shrink. This means that spaces will need to accommodate for more immersive experiences in their design.

Built Environment Develops Data Markets

With a vast pool of human-centric data, the built environment is sitting on untapped revenue streams of information that could benefit many business sectors. Past client contracts may prevent this from occurring, but newly developed contracts would allow firms to sell this data.

Cities Organize Themselves

Urban planning and development requires long-term strategy and planning, which can be complicated by sudden societal shifts and needs. AI and digital twins will be able to help accommodate for these shifts, increasing the chances of automated planning directing where developments should take place next.

Jurisdictions and Developers Require Second-Life Designs

Just as deconstruction will likely be regulated, so will adaptive reuse projects that address housing shortages. New mixed-use zoning or urban zoning developments will likely enable this change.

Smart Green Infrastructure Combats Eco-Anxiety

The urgency of climate change could lead to an increase in eco-friendly infrastructure that allows for power sharing and carbon-free transportation. These updates could bring resilience to areas where people worry about being displaced due to climate change.

11 MACRO SOURCES OF DISRUPTION

Technology | Media & Telecom | Demographics | Environment | Government | Public Health | Education | Geopolitics | Infrastructure | Economy | Wealth Distribution

WHY BUILT ENVIRONMENT TRENDS MATTER TO YOUR ORGANIZATION

Additive Manufacturing

Additive manufacturing will speed up construction, reduce costs and inventory needs, and increase material efficiency. The customization enabled through this process will also change the way designs come to life. This type of manufacturing has the potential to create new opportunities for on-demand and on-site selling.

IoT Data Collection

As cities and spaces collect more data, this information will continue to reveal what should be prioritized and what is unnecessary, enabling real-time management and decision-making. This will also help reduce upfront costs and costs over time as the data will help companies make better decisions.

Predictive Maintenance

Unexpected costs for buildings, bridges, roadways, sewers, factories, and other structures will continue to be a headache for facility managers and city workers. New tools for predicting maintenance will enable better budget planning and help developers estimate yearly upfront costs with greater accuracy.

Smart Urban Planning

For developing regions, planning and development takes massive partnerships and relies heavily on outside expertise. New tools for automating this process could provide cost savings to those regions, which would shift the types of business partnerships they might seek. For established regions, these automated tools will allow for longer planning initiatives but may also be unsettling for residents.

Regenerative Infrastructure

Regenerative and greener infrastructure will ultimately lead to cost savings for businesses, cities, and residents—as well as help address risks due to location and climate change. Investing in this infrastructure will also build bonds to communities and help investors see progress on declared sustainability goals.

Inclusivity

As younger generations consider where they want to live and work, creating places that are more inclusive will ultimately attract these future workers to regions that prioritize this type of design. This can help bring in new talent and prepare companies for new regulations that require greater accessibility and diversity.

OPPORTUNITIES & THREATS

Threats

Scaling new technology and practices will continue to be a hurdle due to a lack of long-term planning.

The need to evolve traditional design and business practices as the industry becomes commoditized is urgent.

Communities will resist the necessity of new technologies due to a lack of exposure and understanding of what they are.

The tech gap in de-prioritized cities and communities will continue to widen.

New data privacy requirements will be a barrier as the industry begins to rely on even more data collection sensors and tools.

Opportunities

Cutting-edge automation will unlock efficiency to combat the talent shortage.

Expanded practices can provide new revenue streams—if the right experts are in place to manage new offerings.

New sources of data can empower clients with insightful, decision-enhancing analytics.

Niche markets offer an opening to prominence in the industry, if innovative services are brought along.

State-of-the-art materials and technology plus time for upskilling encourage dynamic career growth.

INVESTMENTS AND ACTIONS TO CONSIDER

1

Consider investing in creating or finding LLMs specific to the built environment industry. Currently, there is a lack of an industry-specific model that can become an industry standard. The first to market with this development will set the tone for how AI will be used in the future.

2

Returning to more natural processes will require considerable investment in new details, strategic plans, and communications. These investments should be planned out to determine when their impact will be most relevant to clients and when strategic partnerships can be used to leapfrog competitors.

3

Reconstruction and deconstruction will require investment in new equipment and monitoring of regulations. Lobbying for and adapting to regulations that do not completely disrupt the industry, but are still proactive for the environment, could require diverse strategies.

4

Cities will need to create investment strategies that align with chrono-urbanism requirements, meaning more mixed-use site investments and planning will be required. This, along with necessary smart city investments, could tie up budgets for many cities over the next decade.

5

As water scarcity continues, investments in water monitoring will become more crucial. This will allow residents to feel safe, and potentially attract more mobile residents to shore up tax bases within municipalities and regions suffering from people moving away.

6

Additive manufacturing construction practices will continue to grow and scale. Investing in these technologies now will acquaint companies with how these technologies work as they evolve. Consider starting with smaller forms of equipment that facilitate creating pieces and parts that can bolster supply chains.

CENTRAL THEMES

Still Working Toward Automation

Finding the right balance between automation and human intervention and design is a work in progress. Tension comes into play when looking at what automation could mean for rising costs and labor shortages—depending on whether you see it as a boon or a threat. Researchers are studying the use of artificial intelligence in planning, such as in automating the iteration, validation, and selection processes. While other industries are focusing on AI automation throughout the value chain, for the built environment, the focus for automation is mainly on the front and back end of a project or process: This presents opportunities that could be captured and developed.

Data for Decisions

Data collection and modeling will keep increasing, with digital twins expanding what building information modeling can mean for projects and decisions. Besides allowing leaders, officials, developers, and clients to study the effect of their decisions on an overall project, these intelligent models can contain sensors and other devices that collect more data and allow project components to speak for themselves in new ways. But because digital twins require a higher degree of modeling, the quality of the models and their reporting require more accuracy. This data is now becoming a requirement for the front end of projects, even before construction documentation gets underway.

Material Intelligence

Materials are becoming smarter and more capable of self-management, so our understanding of how they work needs to evolve. Self-managing, self-assembling, and self-healing are just a few of the newer attributes becoming more mainstream. Documentation practices are changing as a result, and investments are gaining longevity—buildings could potentially last longer with less maintenance for developers and cities. The development of material intelligence is likely to continue to grow, and so will the need for new staffing positions and updates to performance and code restrictions.

CENTRAL THEMES

Climate Change Responsibility

As more communities deal with extreme weather, cities and companies increasingly want their infrastructure and buildings to be prepared for a crisis. Planning for climate change requires heightened awareness of the materials used and the structure that's created. Developers require more upfront data on how and where materials were manufactured and shipped. The long-term aftereffects need to be modeled to ensure the surrounding area will not be harmed over the life of the project. More mixed-use developments are occurring because of these changes, with amenities being implemented in more condensed, neighborhood-like buildings and shifting what was usually found in urban centers to neighborhoods. Returning processes back to their natural way of functioning is also changing how land is developed and what designs are considered.

New Forms of Monitoring

Aging is a big consideration for what new technology and products can monitor and predict. The wear and tear on existing places, spaces, and infrastructure is a concern especially in areas trying to compete with neighboring regions implementing smart infrastructure. Areas dealing with urban decay or failing infrastructure have tough choices on where to allocate their capital improvement budgets and will expect technology to provide more insight into when these failings could occur. This includes new tools for monitoring resources, especially dwindling natural resources. For smart cities, new advances are allowing for detailed monitoring of residents.

Scaling Disruptions

Ready to upend the built environment industry, additive manufacturing, mass timber construction, modular construction, and regenerative design are all advancing but have yet to scale. This trend can already be seen with new uses for modular construction for mobility, regenerative buildings giving back to their community, the use of additive manufacturing to create more efficient builds and parts, and new possibilities for structure and use types. Watching these indicators to see how they develop and are regulated will provide useful information when these technologies scale to prominence and become more of a practice than a novelty.

ONES TO WATCH

Dr. Mohammad Taha, researcher at University of Melbourne, for researching nano inks to change how buildings use energy.

Othmane Zrikem, chief data officer at A/O Proptech, for backing climate technology startups.

Namratha Kothapalli, principal at Speedinvest, for their backing of industrial technology.

Kaj Casén, CEO at Meyer Floating Solutions, for his work on floating housing.

Andrew Binet, assistant professor at University of British Columbia, for their work on ownership in neighborhoods for community engagement and health.

Luca Staricco, associate professor at Politecnico di Torino, for his work on 5-, 10-, and 15-minute cities.

Rainey Shane, social sustainability director at JLL Americas, for her work on the SEAM certification for social equity.

Hu Tengyun, Zhang Xiaodong, Xie Pengfeil, Li Xuecao, Liu Han, and **Sun Daosheng** of the Beijing Institute of Urban Planning & Design, for their work on automating the analysis of vacant lots within cities.

Dr. Ki-Tae Park, lead researcher at Korea Institute of Civil Engineering and Building Technology, for his work on technologies to predict maintenance needed for aging bridges.

Hiroshi Ishii, associate director at MIT Media Lab, and Ozgun Kilic Afsar, a graduate research assistant at MIT Media Lab, for their research on new fabric fibers that promote healing.

Nathan Daix and **Augustin Monfret,** co-founders at SonarVision, for using 3D sound to help those who are visually impaired to navigate a city.

Georgina McDonald, lead of creative and partnerships at SPACE10, for her collaboration project to use AI to design a flat-pack couch.

Antonin Yuji Maeno and **Kelsea Crawford,** co-founders at Cutwork, for their work on PolyRoom, which allows for Lego-like modular construction.

Pavan Akula, assistant professor of civil engineering at the Oregon State University College of Engineering, for his work on creating new materials for 3D printing from CO2.

K.V.L. Subramaniam and his research group at the Indian Institute of Technology Hyderbad's Department of Civil Engineering for their work on developing new methods for 3D printing bridges.

Neri Oxman, for fusing design, technology, and biology for Oxman, the company she leads.

IMPORTANT TERMS

Additively made
Products, materials, or items made from 3D printing or additive manufacturing.

BIM (building information modeling)
This digital model is used for creating planning and construction documents. It is similar to a digital twin but typically does not evolve after the project is completed.

Biodiversity
The integration and preservation of various biological life-forms and ecosystems.

Built environment
This encompasses projects and practices within architecture, interior design, civil engineering, MEP engineering, structural engineering, landscape architecture, product design and manufacturing, construction, experiential design, and urban planning.

Circular design
A design practice that focuses on creating products and spaces that, once they reach the end of their life cycle, can be repurposed or reused.

Digital twins
A dynamic digital version of a physical object such as a city, roadway, building, or door, a digital twin uses real-time data to produce reports for the object's performance.

Environmental, social, and corporate governance (ESG)
A framework many companies are using to establish their policies for how they address each category.

Experiential design
This is a design practice for creating interactive and sensory experiences.

Extended reality (XR)
A technology that can augment the physical world through either virtual or augmented reality.

International Code Council (ICC)
The council develops model codes and standards for the built environment and is used by over 50 countries.

Internet of Things (IoT)
Devices that are connected through a network to send and receive data.

Large language models (LLMs)
Used to train AI models, LLMs are trained on vast amounts of text data, enabling them to perform a wide range of language-related tasks.

Mass timber construction
A construction process and design technique that uses large or solid engineered wood products for its structural components.

MEP
An abbreviation for mechanical, electrical, and plumbing services.

Metaverse
The underlying technologies that create a more digitally augmented physical world and reality.

Modular construction
A construction process that uses prefabricated components to create a space, building, or other structure.

NAIOP
The US-based Commercial Real Estate Development Association.

Net zero
Projects that are designed so that their use of energy consumed over a year is balanced out by the renewable energy they produce.

Urban center
Traditionally refers to the central downtown area of a city.

ADAPTIVE URBAN ENVIRONMENTS

1ST YEAR ON THE LIST

CHRONO-URBANISM

WHAT IT IS

Chrono-urbanism refers to municipalities seeking to contain everything residents need on a daily basis within a 5-, 10- or 15- minute walk. This is evolving as urban planning studies are utilizing multiple technologies like AI and data mapping.

HOW IT WORKS

Chrono-urbanism studies the layout of current and future planned amenities within a certain time-based restriction. In Melbourne, a pilot program found that 20 minutes is the farthest people were willing to walk for their daily needs, according to C40 Knowledge. Other cities have experimented with this type of urban planning, including Barcelona's "Superblocks," Bogota's children priority zones, Buenos Aires' car-free zone, Paris' direction to create "capitals" in neighborhoods, and more.

In Barcelona, the city has been implementing Superblocks for the past decade, reclaiming urban areas used by cars for people, retail, and social activities. In 2021, a study found a decrease in both air and noise pollution in these areas, while residents also reported a better sense of safety and higher interactions between neighbors.

Technology is now enabling chrono-urbanism planning for such developments, which increases the efficiency of the planning process. Digital Blue Foam worked on its own LLMs that can propose feasible 15-minute city design ideas, so planners can create neighborhoods that will give other residents a similar experience to the Superblocks. Now, 15-minute cities are evolving into chrono-urbanism, informed by a 2022 study that evaluated denser urban areas with tighter time-based circumferences, like 5-, 10-, and 15-minute neighborhoods.

WHY IT MATTERS

Chrono-urbanism can help improve accessibility and walkability for municipalities. As urban centers struggle to retain residents, a focus on chrono-urbanism can make them more inclusive, by attracting new people and widening the demographic. This type of planning can also enable greater sustainability and change transportation methods—both of which will become increasingly important. Localizing services to neighborhoods within these time-centered areas will offer more niche consumers, giving opportunities to businesses looking to break into markets. As these regions grow and shift, population centers will be fluid, and may result in new geographic centers being prioritized. Planners will face the challenges of determining various necessities while also needing to encourage cultural synching within neighborhoods and regions. But ultimately, by understanding the temporal patterns of a city, developers can make more informed decisions about where and what to build. This can lead to more profitable investments, as developments become better aligned with the times when people are most active in certain areas.

1ST YEAR ON THE LIST

SELF-ORGANIZED PLANNING

WHAT IT IS

Technology is automating planning, site selection, and infrastructure deployment around cities. It can now also be used to suggest where vacant sites can be converted for a new purpose.

HOW IT WORKS

Site selection and verification can be a costly and time-consuming process; before any structure is built, real estate developers have to do a lot of upfront work to analyze both the location and market. As cities integrate more technology, the organization and development of neighborhoods, streets, and regions are becoming self-automated.

Now, AI is providing ways to reduce much of the lift in urban planning and development. Software company Deepblocks has released tools for developers and investors to help pick the best site for their projects, including information on zoning and ways to test build through a virtual platform. It also allows for exports of reports based on its analysis. Other companies are looking to take that automation even further. A recently filed patent claims to use AI modeling of a city for automatic site selection based on a set of criteria, to help cities understand how they can utilize underutilized areas. Another patent claims that it can use data to assess vacant areas in a city to see if they are suitable for residential use. With housing shortages around the world, such developments could help cities more efficiently plan.

WHY IT MATTERS

Zoning has been a barrier for many cities as they look to provide infrastructure and amenities to both attract new residents and support existing ones. This technology and planning methodology could help accomplish both goals—aiding both cities looking to address urban decay and developers looking to maximize their investments. Underdeveloped areas or rural regions could identify which investments could help them be more stable or leapfrog a neighbor. More established cities and locations could achieve more resiliency. Some of these new capabilities will shift stakeholder integration and interactions, as residents will still want a say in how their cities are planned, but greater localized data could help provide better insights that reflect the communities' preferences. For businesses, this technology could either end up enabling or disrupting the area around them. If the tools identify that an area is better off zoned for a different function, that could either disrupt the location or bring new customers. And as office spaces are left vacant in cities around the world, automation could help decide how to best replace them.

1ST YEAR ON THE LIST

REWILDING

WHAT IT IS

Urban planners, designers, engineers, and architects are using nature-inspired interventions to restore natural processes and environments in cities. Besides being good for the ecosystem, these enhancements are increasingly in demand by consumers.

HOW IT WORKS

Since the COVID-19 pandemic, the concept of rewilding has gained renewed attention and importance. As lockdowns and restrictions prompted people to reconnect with nature and seek outdoor spaces, there has been a growing recognition of the mental and physical health benefits of green spaces and natural environments. Rewilding efforts, which emphasize restoring and preserving ecosystems, are seen as a way to address some of the planet's inherent environmental challenges, and to build more resilient and sustainable communities.

Cities globally have been incorporating some of these concepts into their urban landscape. In Singapore, towering, artificial "supertrees" serve both aesthetic and ecological functions. These structures are covered in a variety of plants, and the vertical gardens create microhabitats for insects and birds, enhancing local flora biodiversity. The vertical gardens and elevated positions of the supertrees also attract birds, providing roosting sites and potential nesting areas.

Elsewhere, startups are focusing on increasing and enhancing trees. Living Carbon is experimenting with genetically modified trees designed to capture more carbon and absorb greater quantities of heavy metals from the soil than their natural counterparts. And GoPlant.me is leveraging the principles of crowdsourcing to encourage financial support and volunteerism for urban tree planting initiatives.

WHY IT MATTERS

Increased efforts in rewilding is a direct aftereffect of the pandemic that will continue to grow as people prioritize being outside and look to nature to help address mental health challenges. This trend could benefit people and companies in multiple ways, such as by reducing long-term costs like air purification and lowering water use. Restored ecosystems can also act as a natural barrier that developing cities and economies could look to use for protection from climate change effects. Interest in their use will affect urban planning and structural engineering of areas within cities where people want to spend their time.

Companies that prioritize nature may also want to capitalize on this demand by encouraging similar rewilding efforts in the areas they inhabit. Eventually, we could see sponsorships for rewilded areas crop up just as we see parks and roads sponsored by groups wanting to make a statement. But the type of rewilding that's right for both companies and geographic areas should be entertained on a case-by-case-basis because each area will have different needs. As leaders work to prioritize which needs should be met first, expect some tension among residents, developers, and local officials.

REGENERATIVE PRACTICES

1ST YEAR ON THE LIST

ADAPTIVE REUSE AND DECONSTRUCTION

WHAT IT IS

As urban decay threatens many cities, developers and practitioners are giving new life to often-abandoned buildings and areas—converting them into livable and workable areas and spaces.

HOW IT WORKS

Repurposing existing buildings, a sustainable practice, reduces construction waste by up to 40% and cuts the carbon emissions associated with new construction and building material production. Increasing interest in reuse can be found around the world: from the AMP Centre in Sydney, which was one of the first upcycled buildings; to a Dutch engineer's efforts to recycle and reuse all materials in a 14-story office tower; to decommissioned wind turbine blades in Ireland finding new life as footbridges. Such projects could be aided by studies using AI to analyze what is inside a building or structure to know what those materials could be used for in the future.

Beyond AI, other technologies are supporting this effort—specifically sensors and digital twins. These tools are being used to make real-time adjustments as these buildings grow or change, and can also be helpful in maintaining structural integrity, and for knowing where to place additional support. As municipalities are frequently starting to require new developments to have a deconstruction plan, these models could be helpful in the long run.

Adapting interior spaces can also help give buildings a second life. One compelling option for abandoned office buildings is vertical farming. Another is converting offices to other uses: A study by NAIOP has identified medical offices and labs as promising candidates for office conversions, as they have less remote work potential. Several firms are using AI to model out which of these conversions would meet economic and infrastructure constraints. This shift, if it continues, will impact the design of building systems to allow for greater flexibility.

WHY IT MATTERS

Second-life projects can help reinvigorate areas of urban decay—and could also become a major factor to plan for and consider on the front end of a project. This would shift the design process to include planning for both today's and tomorrow's space, which could ultimately lead to a new service offering. It could also mean continual projects that require a partner or project manager dedicated to them for life, beyond facilities personnel.

With global office vacancy rates increasing and as remote work becomes the norm, office vacancies are expected to keep growing, leaving an increasing number of empty office spaces. Converting these vacant offices serves a dual purpose: It addresses the vacancy issue and tackles shortages for other uses including housing. At the same time, it also promotes upcycling and reduces construction waste while cutting construction costs and time. Remodeling can be a cost savings mechanism until items are uncovered that were not originally planned for. With new forms of models and AI, these hurdles could become things of the past.

1ST YEAR ON THE LIST

METAMATERIALS

WHAT IT IS

Emerging materials are on the horizon that are notable for their responsive and programmable nature, along with capabilities that enable greater sustainability and self-repair.

HOW IT WORKS

Metamaterials are smart materials that are enabled with various technologies; they can self-heal, self-assemble, change color, become lighter, or regulate temperature. Stimuli-responsive materials, such as shape memory polymers, are flexible sheets that can continuously change shape under external forces like electromagnetic or thermomechanical stimuli, with the ability to return to their original form. These metamaterials promise to create adaptable structures that respond to their environment, such as self-healing concrete for autonomous repairs and smart windows and building facades that adjust to weather conditions, enhancing energy efficiency.

Researchers have contributed much to these new types of materials lately. Researchers from Boston University have created a new kind of material that blocks sound while allowing for airflow, which could transform building facades in urban and noisy areas. Researchers at the University of Central Florida have developed a new textile that changes color and appearance on demand. And 3D printing and additive manufacturing continue to offer many inroads for metamaterials, including a breakthrough from MIT researchers to 3D print materials that can sense and react to environmental changes.

Additive manufacturing has even built an entire house: The BioHome3D, constructed by the University of Maine, is a 3D printed house that uses scrap lumber, sawdust, and construction debris, combined with biopolymers sourced from plants, animals, bacteria, and fungi to create 3D printed wood. Taking innovation further, 4D printing enables 3D printed smart materials to respond to external stimuli by expanding, contracting, bending, and more. These materials find applications in self-assembling furniture and regenerative systems for infrastructure, like self-repairing piping systems and bridges.

WHY IT MATTERS

Using a single material and a single 3D printing process, this technology has the potential to transform the construction industry by enabling structures that adapt to changing conditions.

The longevity of built elements will become even more important of a consideration as buildings can potentially have multiple—and longer—lives. With new, more responsive materials, even stagnant elements and furnishings can take on a second life, which gives a space more functionality and use. These metamaterials will also change the performance standards for roadways and other essential infrastructure, and can be used to protect structures that provide water and other necessary resources. Developing and integrating more metamaterials should be a priority, especially for regions that lack stability, as they'll help protect against extreme conditions and allow infrastructure to maintain itself. This could be a cost saving for many areas that currently lack manpower during construction and inclement weather.

Moreover, as more people move to urban environments and growth continues, noise is increasingly a factor. As acoustic comfort becomes more elusive, metamaterials can play a key role by changing the comfort rating of spaces based on unique stimuli. While new products are manufactured that include metamaterials, the price point will initially increase. But the enhancements the technology brings to these spaces will be very valuable going forward.

1ST YEAR ON THE LIST

RESILIENT DESIGN

WHAT IT IS

New practices and technologies are helping us plan for future climate change and crises. New spaces for safety, respite, and resiliency are also being created to promote better health and wellness.

HOW IT WORKS

Threats to a region often prompt new strategies for the built environment. Flood-prone areas like New Orleans and Maasbommel in the Netherlands are responding by constructing amphibious homes with buoyant foundations, allowing them to float during floods while maintaining sewer and utility connections through flexible piping. Dutch company MVRDV's Sea Level Rise Catalogue explores other similar ideas, such as floating habitat islands, adaptive structures, and mixed-use high-rises on stilts. Inland developments are addressing water surges with permeable ground coverings and rainwater buffers.

The devastating impact of earthquakes in places like Turkey, Syria, and recently Morocco underscores the importance of anti-seismic construction methods. Buildings are already using flexible foundations and shock absorbers to withstand earthquakes, but so called seismic invisibility cloaks, which use deflectors to protect buildings, making them appear "invisible" to seismic forces, offer new avenues. And where cities are sinking, there's a need for new resilient solutions like artificial recharge and deep soil mixing, requiring careful planning and investment. Scientists are also studying lightweight building materials and foundations to reduce the risk of subsidence.

Resilient design also encompasses creating spaces for respite. Many workplaces are piloting emotion-sensing technology to understand the mental state of their employees, and finding ways to create places for them to decompress—a field that researchers are also studying in educational spaces. A new patent for furniture looks to use sensors that can tell users when they are stressed and should take a break.

WHY IT MATTERS

Given the recent pandemic and ongoing climate change, providing safety and security in structures is top of mind. New forms of resiliency, for both the design and construction of buildings, will be expected to address the potential effects of war, severe storms, wildfires, droughts, and rising sea levels. Managing and analyzing the weaknesses in a region will provide actionable recommendations and strategies that can combat these future issues.

In addition, resilient design can lead to significant cost savings by reducing the damage and economic disruptions caused by disasters. By investing in resilient infrastructure and buildings, communities and businesses can avoid or minimize costly repairs and downtime following a disaster. This stability is crucial for economic growth and investor confidence.

Eventually, public projects could increasingly mandate safety of spaces as area residents require more stability. And with the growing focus on mental health, resilient spaces that create areas to de-stress could become a basic infrastructure requirement—as essential as electricity and water are today. This shift could change building codes and planning, and be helpful in developing areas.

1ST YEAR ON THE LIST

ADDRESSING HOUSING SHORTAGES

WHAT IT IS

With rising homelessness and housing shortages around the globe, cities and companies are creating new forms of housing.

HOW IT WORKS

Homeownership costs are soaring around the globe, and there's not enough housing to meet demand. A Moody's Analytics study found the US is grappling with its lowest housing availability in 30 years. In many countries, housing costs are outpacing income growth, resulting in a severe shortage of affordable options. By 2030, the World Bank predicts that 3 billion people will require new access to adequate housing.

To facilitate new housing construction, cities are exploring rezoning or "upzoning" policies. Japan's flexible zoning and incentives have increased affordable housing through effective supply management. Vienna's social housing model strives to offer quality, affordable homes to all residents; over 60% of its population are in municipally-supported apartments, reducing inequality and promoting social integration.

Innovative data mining is also crucial for new urban planning. Yeme Architects' Community Data Platform helps identify deficiencies in British neighborhoods, information developers can use for deciding whether more schools, shops, or green spaces are needed. MySidewalk, a comprehensive community data library, reveals insights from various data sets, including the US Census and Centers for Disease Control and Prevention to address issues like healthy food access and income inequality, guiding targeted solutions for land development.

Supply chain disruptions and higher labor costs exacerbate the housing affordability problem. A possible solution is what ICON and 14Trees are doing by leading 3D home printing construction technologies, potentially paving ways to reduce costs and emissions.

WHY IT MATTERS

Housing conversions will be a prime focus in the built environment for the next several years. Attainable housing—residential units that are affordable for a wide range of people, especially those with middle-income levels—will also help address social issues. But as civil engineers continue to be tapped to study what could be developed, these types of data mining platforms become more relevant. More adaptable and responsive construction practices and studies are needed, and businesses and companies can help them scale by educating stakeholders in their region and providing case studies to try new forms of implementation. As investors and banks look to place their capital with more responsible companies, those that focus on solutions will be seen as places for goodwill investments. Such funding will bring stability to areas that have seen exponential growth of people experiencing homelessness, or are trying to develop strategies for residents becoming unhoused due to unforeseen conditions. Adequate housing is a foundation for stable employment and economic participation. When people have secure and affordable homes, they are more likely to engage effectively in the workforce—and contribute to overall economic growth and stability.

1ST YEAR ON THE LIST

REGENERATIVE DESIGN

WHAT IT IS

Comprising sustainable and circular design, regenerative design includes spaces, structures, products, real estate practices, and places that are working to give back to the community they sit within and benefit the environment.

HOW IT WORKS

Companies are exploring alternatives to traditional materials that are more sustainable than their counterparts. The K-Briq, created by UK-based startup Kenoteq, is an eco-friendly brick made from 90% construction waste; it matches the appearance and weight of regular bricks but emits just 10% of the carbon and provides improved insulation. Berlin startup Made of Air developed an organic waste-based, carbon-negative bioplastic, storing the equivalent of about two tons of carbon dioxide for every ton of plastic. The bioplastic can be used in building facades, furniture, interiors, transport, and urban infrastructure, sequestering carbon dioxide and aiding in climate change mitigation.

Plantd's proprietary technology transforms rapidly growing perennial grass into carbon-negative structural panels for walls and roofs materials that are stronger and more moisture resistant than competitive products. Developed by MIT chemical engineers, 2DPA-1 is a self-assembling, lightweight polymer that's stronger than steel, offering versatile applications for building materials and structures. Norwegian startup Carbon Crusher repairs roads with recycled asphalt and a plant-based adhesive, which is faster, cost-effective, and carbon-sequestering.

Dutch startup Energy Floors utilizes kinetic harvesting, or energy scavenging, to capture energy from mechanical motion, like foot traffic, converting it into electricity for diverse indoor and outdoor applications. Researchers are also exploring new types of furniture that use algae that can produce energy through a grow light at night.

WHY IT MATTERS

Regenerative design goes beyond reducing harm to actively improving the environment. This approach aligns with growing consumer and stakeholder expectations for companies to be not just environmentally neutral but positively impactful. The built environment is becoming more than just what it can house: New spaces, structures, products, and buildings are becoming more responsible to the community where they reside. That benefits everyone: Companies that embrace regenerative design often lead in innovation, and by adopting regenerative practices, they can ensure the long-term availability of the resources they rely on. This approach also reduces dependency on external and potentially unstable sources, mitigating risks associated with resource scarcity and environmental degradation.

As more regions push for carbon sequestration requirements and energy resilience, they will start to prioritize these products and materials that give back as well. They can start with methods that offer respect on a cultural level and do not have to become homogenized. Tax incentives will surely become one path forward to accelerate this practice, which can help with further research and development within the built environment industry.

SCENARIOS

SCENARIO YEAR 2050

Amphibious Cities

The gentle sound of water moving has become quite common in Singapore, Helsinki, Jakarta, Miami, and Sydney in 2050, and it's not because its residents are relaxing by the water—rather, water is rising and falling over their homes. Embracing the fact that climate change was unavoidable, these cities were some of the first to implement mixed-use amphibious areas, ultimately leading to completely amphibious cities.

These areas started out as regular neighborhoods but were built using modular components that, as the waters rose, allowed portions of buildings to be submerged without needing to be relocated. In fact, most of the buoyancy comes from the walking spaces under the buildings, which started off as crawl spaces and became an underground tunnel system connecting the amphibious sectors. Above the water, kinetic harvesting wave generators power the areas and have become their own form of public art. Most residents have porches on top of their homes now, so when they venture out for fresh air, they can sit and take in the expansive oceanic view. It works out well for everyone—except some local governments. Many of these amphibious cities face property tax debates with local authorities, seeing as there is now less land or property to tax.

AUGMENTED PRACTICES

1ST YEAR ON THE LIST

SENSORIAL ELEMENTS

WHAT IT IS

Technology is allowing for more immersive experiences and design within the built environment. This includes 3D billboards and other types of digital signage and art.

HOW IT WORKS

Cities like San Diego are experimenting with using 3D billboards and holographic displays to create more visual immersion on sidewalks, retail fronts, and around the city. Individual companies are exploring their options too: brands like Nike and Coach have utilized massive 3D billboards for promotional campaigns in Tokyo and London, and McDonald's used a weather-responsive billboard in the UK for personalized ads.

Artist Refik Anadol is taking this visual, sensorial immersion to another level. He gained fame for using AI in a Museum of Modern Art installation that projected shapeshifting images from the New York museum's vast art collection onto a 24-foot screen. This kind of transition to increasingly kinetic places and spaces is also seen in architecture, where building parts can move without compromising integrity, as they respond to changing human and environmental conditions. The Al-Bahr towers in Abu Dhabi is an example: The buildings have a protective skin of 2,000 glass elements that automatically adjust based on sunlight, offering sustainability benefits as well.

A recent sensory exhibit in Australia looks to move past the visual into touch and play, highlighting ways spaces can be more inclusive for those who are a part of the neurodivergent community. Many retail centers are also looking to infill their vacant spaces with these multi-sensory experiences that use interactive screens to display art and color. Recent displays at the retail show NRF had Samsung displays where you could hear coffee being poured and smell donuts.

WHY IT MATTERS

Visual engagement in the built environment can have the same effect as it does on social media: It prolongs the retention of the memory of that moment, which could help boost desire to return to those places. As many are looking for ways to draw employees, visitors, and residents back into the built environment, these types of immersive experiences can provide an answer.

But there are many other benefits as well. Shared, immersive experiences form social cohesion, and offer branding and cultural engagement that extends beyond traditional community events. They can be bolstered through shared data, which offer ways to curate the content based on who is in the room, which can make these experiences even more meaningful. As wearable technology scales, and users opt in to share their data, this new information provides fodder for community content and preferences.

On the flip side, regulation for visual safety and viewers' data privacy needs to be considered. People passing through public spaces should be made aware if their presence and their data is being used to generate the art, and the art should be representative of all as well.

1ST YEAR ON THE LIST

AUTOMATED DESIGN

WHAT IT IS

AI integration is increasingly prevalent, from automating the design practice and tools, enhancing iterations of drawings, and generating specifications and purchase orders to synthesizing customer insights and enabling decisions on sustainable implementation processes for construction and manufacturing.

HOW IT WORKS

From optimizing traffic planning to ensuring efficient code checking for building permits, city officials and developers are harnessing AI to automate the ways urban spaces can be smarter and more sustainable. They're also using AI to automate understanding of future damage and aging infrastructure. The Korea Institute of Civil Engineering and Building Technology has created D.N.A. (Data, Network, and AI) technologies for forecasting bridge wear and aging, to facilitate proactive and possibly automated upkeep. In a similar vein, data science company Concrete.ai's system allows for the automation and optimization of concrete mixes, with a specific focus on reducing carbon emissions.

AI is also being used to accelerate and improve the construction life cycle. It can automate deliveries and source materials more efficiently, which helps with construction execution planning and updating of construction sequences. Software company IFS offers planning and scheduling optimization products using AI to ensure real-time construction schedule optimization and on-time project completion, while Hypar automates designs by providing a cloud-based platform for integrating predesigned systems into projects.

AI's impact on automating design can also be seen in other ways. AI tools like Maket.ai and Archi.ai are helping to automate plans and design ideas. WINT, or Water Intelligence, is combining AI and IoT to manage water flow and promptly detect anomalies, enhancing water conservation in construction. And two Florida Tech researchers—Hamidreza Najafi and Benjamin Kubwimana—have published a paper proposing a new method for optimizing building energy models (BEMs) using Python EnergyPlus for energy optimization, which would be of benefit to MEP engineers.

WHY IT MATTERS

Automation is already part of urban planning and development, which means that it will increasingly play a larger role in other steps of the process, from design to construction. Already, automating multiple parts of the design process and overall project is becoming more normalized. For companies and industry affiliates, they should expect some portion of their process to be automated soon, if it hasn't been already. The new tools increase efficiency and actually do not stifle creativity: They let built environment professionals see multiple iterations they may not have considered.

When partnered with augmented forms of construction, automation can help scale built environment projects to grow faster, provided that the funding is in place. Clients will ultimately need to provide more data for these types of projects, and the practitioners will need to understand and iterate through the process faster. These changes ultimately require more reliance on technology—not necessarily leading to a reduction in staff but an increase in augmentation practices. This will push traditional design process thinking, something that the entire built environment could take a moment to consider.

1ST YEAR ON THE LIST

METAVERSE ENABLING

WHAT IT IS

While the metaverse is still up in the air—literally and figuratively—many architects and designers are exploring the possibilities of what they can create within it and figuring out how to enable collaboration and accessibility.

HOW IT WORKS

Metaversal technologies include any technology that augments the physical world, and collaboration is one of the main ways many companies are looking to harness the metaverse for the built environment and design process. Some are using virtual reality (VR) for immersive design experiences, while others are experimenting with using augmented reality (AR) to overlay digital information onto the physical world, aiding architects, engineers, and designers in 3D visualization. The RAD Lab at the University of Miami is using mixed reality to offer immersive experiences for its architecture students and enable innovative design collaborations in the metaverse. In the commercial world, Hyve-3D is integrating virtual reality and holographic displays, enabling user interaction with the full project for review and collaboration without a headset.

In 2021, the metaverse's top benchmark was enabling users to overcome real-life obstacles, including disabilities, allowing them to experience places and spaces that they previously could not. That main purpose now extends to others, such as, letting art lovers experience museum exhibitions via AR and VR from afar. Cities are also using the metaverse to enable safety and creativity. Tuvalu aims to become the first digital nation by re-creating itself in the metaverse to safeguard its culture and society amid ongoing threats from rising sea levels and climate change. And Zaha Hadid Architects created "Liberland Metaverse," a virtual unrecognized libertarian state featuring the firm's signature architectural style marked by curves and rounded corners.

WHY IT MATTERS

Use of the metaverse for the built environment is not for living but for experiencing elevated physical interactions. Virtual tourism, already in progress, can be augmented through this technology, with cities, sites, and other experiences being built in the metaverse. For cities looking to attract new residents, they could offer pre-experience city living before a family moves to a new home. For developers, this try-before-you-buy experience in the metaverse will become more important as new properties compete with one another, and the higher the fidelity, the more likely it will resonate with potential tenants. This will also require firms to continue to expand their BIM models with more realistic modeling, which could create larger file sizes and extend the project timeline. Firms could look for ways that other technologies like AI could assist in preventing these complications, or work to reuse components already in the metaverse to their advantage. As public projects go before communities and other decision-makers, digital twins in the metaverse could become a requirement for approval and voting. For the industry itself, metaversal technology offers education opportunities and a more extensive global reach that can help firms achieve their upskilling and diversity goals.

1ST YEAR ON THE LIST

INCLUSIVE DESIGN

WHAT IT IS

Inclusiveness has become a top goal in this industry, and meeting the minimum requirements is no longer palatable. Using technology to address disabilities includes using more participatory design to include the community as part of the design process.

HOW IT WORKS

Enhancing accessibility in public spaces involves working to understand and accommodate diverse neurological and physiological conditions. It can also entail designing public spaces to enable greater mobility and creating novel apps like South Korea's "Dagachi Naranhi" and France's SonarVision to help visually impaired residents navigate their spaces.

Aging is included here. The World Health Organization has released guidelines for age-friendly cities, covering key domains like housing, transportation, and social inclusion; this in turn is driving civil engineers to enhance accessibility with wider sidewalks, ramps, elevators, and improved senior transportation. Brunel University London, in collaboration with Meta and the University of Cambridge, is researching ways to enhance the metaverse's accessibility for disabled and older individuals.

The 2021 Built Environment Social Equity Survey, conducted in collaboration with over two dozen organizations, found that 65% of employees consider increasing racial and gender diversity in the built environment—and within its leadership—important, reflecting a growing emphasis on an inclusive environment's potential to spur innovation and new solutions. The survey further highlights efforts to boost diversity in the built environment, such as youth education. An example is a pilot project in Riga that uses a game environment for local exploration and architectural awareness for kids to learn about the industry.

WHY IT MATTERS

As cities look to prevent urban decay, providing greater accessibility will increase resident satisfaction and use of spaces. For now, most of the technologies are app-based, but greater accessibility would be achieved without the need for an app. Updates could also lead to the redesign of codes and governing statutes that impact how places and spaces are laid out and designed. In an aging world, older demographics will only continue to push for this type of inclusivity, which can impact the products created to be incorporated into spaces and the infrastructure needed to support those products. More inclusive living centers will become more attractive as the aging population continues to grow, which will force developers to consider new unit types, new forms of retail spaces, and new places of care. At a time when mobility is increasing, inclusivity will need to be rethought along roadways, terminals, and lodging locations.

1ST YEAR ON THE LIST

REAL-TIME DATA COLLECTION FOR DECISION-MAKING AND PLANNING

WHAT IT IS

Data collection through sensors and other platforms is now being used for cost estimation, to understand use and behavior patterns, and to make more informed real estate and built environment decisions.

HOW IT WORKS

Due to the pandemic, companies are increasingly adopting occupancy sensor technologies—including passive infrared and ultrasonic and utilization tools to inform space planning and cleaning, as well as to enhance workplace safety and experience. JLL offers a tech service using data analytics for insight-driven real estate decisions, improving areas like energy efficiency and tenant satisfaction. Digital models and other tools are enabling real-time decisions, but these require built-in sensors and other visualization tools to provide the data to model. Gensler's Graph product suite is an example: Its spatial analytics toolkit analyzes and visualizes data from various sources to provide insights for design and space planning.

This data collection and modeling applies to urban planning as well. Rotterdam, Netherlands-based MVRDV has developed RoofScape, a tool using the growing ecosystem of urban municipal data to suggest concrete use cases for underutilized rooftops. For civil engineering, UK water utility company Anglian Water offers a real-time mapping system, which utilizes geospatial technology to prioritize where work is needed. In the system's first six months of operation, it reduced blockages by over 51%, cleaned 112 kilometers of sewers, and removed 8 tons of debris.

Parking is one area heavily invested in data capturing and modeling. Visionful, a US startup, provides cloud-based predictive analytics for parking and also includes a mapped database for faster crime response. France-based Mytraffic uses advanced analytics to provide location insights such as space utilization and traffic management, real estate portfolio performance, and potential locations of business expansions.

WHY IT MATTERS

Data has always mattered, but it has taken on an increased importance. Now, collecting data can lead to better-informed decisions and provide a way to model potential actions before financially committing to plans. But collecting data the right way also matters. Understanding sensor technology will become a critical factor for companies in the built environment industry, along with properly integrating them into projects. Developers and retailers can use sensor technology to implement better amenities and direct targeted use and interactions within their space, and also in preparing for aging infrastructure. This type of preparedness could also help allocate resources during times of crisis or climate change shifts, meaning cities can and should use this type of data collection and plan now to prepare for the future. When people and products are enabled to contribute their data for planning purposes, healthier spaces and products can result. Firms should prepare for more sensor integration and data analyzation on both the front and back end of projects going forward.

SCENARIOS

SCENARIO YEAR 2025

Instant Permitting

Getting building permits used to take weeks if not months. But now, thanks to automated design and real-time optimization, they can take minutes—that is, if the residents approve and the digital model says it's ready to be built. The shift in permitting was partially due to the increased use of registered digital BIM models, which went to the city as soon as they were started, allowing cities to weigh in on potential code issues ahead of time. This optimization led to more of a collective dialogue between firms, designers, clients, and cities; it's been especially helpful when cities needed to build their own projects, as the models can factor in when construction teams might have downtime due to the permits submitted. Looking to ensure residents' satisfaction, cities have also implemented digital town halls where the digital twins of the potential projects are displayed and voted on by residents. Then, residents feel they are part of the process, and will weigh in on the public infrastructure needed. City inspections now include deconstruction plans, changing demolition permits, which are actually the permits that are hardest to obtain.

SMART CITY IMPLEMENTATIONS

1ST YEAR ON THE LIST

SMART BUILDINGS

WHAT IT IS

The buildings we occupy are becoming further automated as smart technology is incorporated. Smart buildings, integrating advanced technologies and automation for enhanced efficiency and user experience, are emerging as a transformative trend in the built environment sector.

HOW IT WORKS

Building automation continues to give operators greater control over smart building systems. Companies like ABB are selling systems that offer control over HVAC and building energy management; they've brought a range of scalable automation and energy control to the United Arab Emirates, with a plan to continue to deploy its offerings in other places over the next three years. Facilio also expanded into the Australian market, deploying its AI SaaS platform to help with monitoring energy efficiency and fault detection and diagnosis.

Platforms like nClarity offer 24/7 real-time monitoring, using cloud-based analytics to look for anomalies and performance degradation, as well as finding ways to mitigate issues. Typically these systems have been cost affordable only for large-scale buildings, but Siemens debuted a new hub that would allow for its IoT-based system to work with small buildings and even office campuses. ProSentry and Senet's new partnership will offer smart building monitoring for everything from gas leaks to mouse traps.

These smart building management systems are also looking to manage space. Tenantcube helps landlords manage their properties by helping them automate listing and renting. Platforms like the one offered by ApartX also increase automation by using biometrics to automate operations and Smart Residence's app that allows residents to control and reserve amenities in the building. A continued focus on bringing workers back to the office has spurred an increase in technology use for visual and auditory privacy and lighting—including bulbs that help circadian rhythms and other technologies that can automatically detect Covid's presence by smell.

WHY IT MATTERS

Building and space automation continues to focus on efficient systems. As new regulations are handed down, the presence of these systems could separate legacy buildings from newer ones—if more efficient buildings are prioritized, urban decay could fester should those buildings not occupy space in downtown areas. Emerging economies and regional cities could capitalize on this to bypass their neighbors if they have the needed infrastructure in place. For economic stimulation, the development and retrofitting of smart buildings drive growth by creating jobs and stimulating demand for new technologies and services.

In addition, smart buildings generate valuable data that can be used to enhance building management, user experience, and inform future development. Landlords and developers should continue to prioritize these types of buildings, as this type of automation will allow them to tightly manage space occupation, which is a growing concern. It could be useful for future lease and tenant negotiations as well, as they can predict the performance of their future spaces. This could also help tenants, by giving them the very granular data they expect, including the performance of their space when compared to other units in the building and their area.

1ST YEAR ON THE LIST

SMART HOME AUTOMATION AND MONITORING

WHAT IT IS

Homes are continuing to become more helpful and personalized through smart technology.

HOW IT WORKS

Recently, smart homes and apartments have seen an influx of newly connected and automated integrations. The open source interoperability standard Matter became a major focus toward the end of 2023 and continued in 2024. It would allow for in-home devices to control multiple connected components. Other smart home technologies include auto-arming alarms, ovens that allow for livestreamed cooking, sensors that can have fans track your face, heaters that learn to optimize energy consumption, and Kohler's Stillness bath, which uses light and fog to create a soothing environment. Kohler also launched its voice-controlled bidet that has a self-cleaning mode. Lighting controls continue to improve with Phillips' Hue E14 bulb—which includes over a million shades of programmable white light to choose from—and Nanoleaf's Sense+ Controls, which learn when to turn off lights based on a person's daily activity. This dovetails into a continuing trend in smart homes: monitoring for safety. Elsi's Smart Floor can track if a person has fallen, and MIT created a monitor that can track how Parkinson's disease has progressed based on the afflicted person's gait.

In many homes and apartments, noise is a top complaint; it may soon be addressed by a new plasma-based silencing technology. Another chief challenge is space: in response, Ori, a provider of multifunctional, robotic-power spaces, has launched a pocket office that can expand and collapse to turn one space into two. And to increase security, researchers have filed a new patent to use doorbell cameras and other CCTV cameras to track and predict criminal activity in an area. This includes Lockly's Visage, a smart lock that can store 100 face profiles to allow entry to a home.

WHY IT MATTERS

Most people spend a lot of their time at home, and in-home smart technology continues to change the way people interact with their environment. As the world's population gets older, integrating aging-in-place technology into the home will become more important—whether in apartments, shared living spaces, or traditional single-family homes. New monitoring devices, which may be covered by insurance in the future, could offer more connected care. Concerns for energy stability could lead to a greater need for renewable energy sources for these homes, which could shift infrastructure and planning needs. This would also affect zoning and need to be welcomed by the residents. For multifamily apartment buildings and complexes, automated systems and AI in smart buildings streamline maintenance and operations, reducing costs and improving performance. These smart homes can also offer curated personalization in new forms: through smart windows and new connected devices, they can bring community cohesion and bridge the gap for families that live in different places. This can also be utilized in co-living complexes and neighborhoods where residents want to share experiences.

1ST YEAR ON THE LIST

SMART PARKING AND ROADWAYS PREDICTABILITY

WHAT IT IS

Traffic congestion is one of the top concerns many municipalities hope to address with smart technology. They are also implementing new technology that can help generate less carbon dioxide with more efficient traffic patterns.

HOW IT WORKS

The structures and roadways in smart cities continue to provide opportunities for both data collection and improved resident experiences. Eventually, traffic lights could be used to monitor congestion and report when accidents occur, according to a recent patent. The proposed patent is also examining how traffic lights can connect to emergency services should an accident occur. Cities are exploring solutions for intersection congestion: for instance, Seoul is implementing a combination of AI, lidar, and CCTV at an intersection to enhance traffic signaling for improved safety. Parking spaces—whether in garages or on the street—are also data points that allow for potential visibility into available spaces within smart cities. Southwest of Denver, Colorado is testing interlocking Smart Pavement slabs that use Wi-Fi and detect when a crash occurs, which will then alert emergency services. In a recent study in the International Journal of Grid and High Performance Computing, researchers proposed an IoT-AIPS system that can predict parking spot availability to help reduce wait times for finding parking. HaydenAI took this a step further and, in collaboration with New York City, used the technology to detect illegal parking in bus lanes.

WHY IT MATTERS

Finding a place to park has always been a challenge in major cities, but new technology can alleviate this concern. It can also increase a sense of safety in more remote locations, with the implementation of these new traffic signals. Countries with a more mobile populace should prioritize these types of technologies to enable better experiences on the roads and create higher safety standards. This trend could also impact traffic patterns, where local jurisdictions might need to create plans, and then communicate any changes through connected devices and autonomous vehicles. The connected monitoring devices and traffic lights could ultimately take away emergency vehicle drivers' worry about crossing through intersections, at least when autonomous vehicles scale. In the meantime emergency personnel can gain a view into the current condition of their destination site they are going along with how to get there.

1ST YEAR ON THE LIST

UBIQUITOUS SENSOR DISTRIBUTION

WHAT IT IS

Sensors are being further integrated into the built environment to collect data that can be used in predictive models and enable intensive and ongoing monitoring.

HOW IT WORKS

Sensors have become ubiquitous. In smart cities, IoT sensors and devices are embedded to collect data for operational use and predictive models. To fuel this connectivity, there have been several new network deployments, like Amazon Sidewalk, which aims to create a low-power, long-range network from IoT devices. In Scotland, the Aberdeenshire Council is trying out North's IoT Accelerator Pack program, which will reveal insights on building health, social housing, water monitoring, waste management, air quality, and road surface temperature.

As connected data collection in smart cities has increased, so has resident engagement. In Israel, Nexar and MuniAI are operationalizing IoT sensors and citizen feedback to alert city workers to maintenance issues. In the UK, Visual Solutions launched a crowdsourced measurement service that uses mobile Wi-Fi signals to sense and count crowds. Sensors and AI are being integrated into safety vests for construction workers to reveal their location and excessive body heat, or integrate wearable detection methods to prevent people from being hit by cars.

Other companies are continuing to use sensors to predict air quality and pollen distribution, like Norwegian startup Airmine. Companies are also embedding sensors into IoT predictive HVAC systems to increase building performance and tenant experiences. Water quality technology also increasingly uses sensors for monitoring water and detecting lead and other toxins. In interior spaces, furniture and even walls are becoming embedded with sensors for data collection. A patent for a new office chair uses sensors in combination with more reactive fabrics and materials to tell when the occupant is stressed and needs to take a break.

WHY IT MATTERS

IoT connection is increasing the amount of data available to smart cities, and the industry is currently prioritizing water, traffic, and resident experience and safety. As sensors in the built environment begin to share more data between themselves, this will create greater opportunities for managing increasingly granular needs within the city. This also presents greater data security needs, and the necessity for residents to opt in to data collection. Without residents' consent and understanding, a pervasive sense of fear will arise over how their data will be used. Cities implementing these sensors should create robust campaigns to dispel concerns, and create plans to deal with potential sensor system hacks. New talent may be necessary for integrating the design of these sensors into projects; they also require an increased amount of IT investment in the office and on-site. Ultimately, sensors will provide a more continuous awareness of project status, which would solve a persistent client need.

1ST YEAR ON THE LIST

DIGITAL TWIN PREDICTIVE PLANNING AND PREVENTION MONITORING

WHAT IT IS

Digital models are not new to the built environment industry. However, as they evolve, they are becoming more integral for upfront planning by enabling the constant flow of data about the long-term visibility of a structure, building, or product's life and use.

HOW IT WORKS

Urban transportation has been a major user of digital twins, with companies like ShapesAI using the technology to predict collisions. Cities and countries are also leveraging these models to predict when roads will need repair, and when traffic could occur. Estonia is rewriting its road maintenance manual using digital twins, and a new patent explores embedding sensors so that digital twins can predict settling and cracks in the road. In the US, startup Citydata utilizes AI to collect census data to look for patterns in transportation and population movements.

Urban planning has also been affected. Los Angeles is creating a digital twin of a neighborhood to test out decarbonization strategies, and new research from the University of Twente in the Netherlands found that digital twins can help improve the efficiency of planning and coordination in cities. This technology can be a boon to cities looking for new residents, which is what Miami is using its digital twin to do—helping them find schools and other amenities when they are looking to move. Jacobs in the UK is using digital twins to model potential floods to help communities know where to place key infrastructure. For interior spaces, Matterport recently launched Genesis, a generative AI that creates a digital twin of interior spaces to help property management teams make design and utilization decisions about physical spaces. The Korte Co., a US construction company, uses its data and digital twins in preconstruction to model what changes to parameters will do to costs and construction schedules.

WHY IT MATTERS

Digital twins and models are becoming an expectation within the built environment. However, the players who will most benefit from the technology are finding new ways to collect data that these models can use to generate meaningful insights. They'll be able to identify potential issues and make informed decisions even before issues arise or construction begins. The technology also enhances the design process and improves communication among project teams as they can model the repercussions of their decisions. Many working in BIM models will need to elevate their current level of modeling to achieve a true digital twin; when the digital twins link to become a digital mesh, it will signify the next evolution of this trend. When digital meshes become a reality for the built environment, that is when smart cities will truly become responsive and enabled. But this trend isn't just for new or smart buildings: Local firms can leverage their on-the-ground locations to start modeling older buildings, allowing them to have their own digital twins.

1ST YEAR ON THE LIST

ENABLED DEVICES FOR URBAN MANAGEMENT

WHAT IT IS

New technologies such as edge drones, connected cameras, and novel communication systems are being used to enhance urban management processes.

HOW IT WORKS

Smart cities are leveraging multiple types of devices to monitor and detect events. One example is a new camera from Vivotek that uses a vision-processing chip and platform called BrainChip to utilize edge computing. It also uses AI to identify gender and age from video footage, even when people are wearing masks. Hailo Technologies in Tel Aviv is also exploring smart cameras that use edge AI processors for smart cities, security, retail, and other applications for analytics at the edge.

Drones are now also bringing smart city capabilities to rural areas, and a patent is exploring the potential for drone air and water monitoring. Light poles, like Voltpost, are transforming lamp posts into charging stations for drones and security monitoring stations; their cameras can also analyze images to determine if a pedestrian is in distress. Other Smart Poles from Vitrulux are also incorporating voice assistants, which could help pedestrians with navigation.

In Boston, Soofa digital kiosks provide air quality updates throughout the city and can even suggest what activities are safe to do outside. Bettair in Spain uses a network of sensors to map and identify pollution hotspots. In Houston, the city is using smart meters to track water usage and monitor its water distribution system.

Trash and waste management systems in smart cities also continue to improve. In the UK, the Sunderland City Council is testing out the use of solar-powered smart compactor bins. A recently filed patent is exploring using sensors and AI to help plan more efficient routes for garbage collection in cities, and for the detection of waste bins in the street.

WHY IT MATTERS

Improving the quality of life is a fundamental part of the built environment industry, and new technology makes that goal even easier for professionals. Real-time monitoring can detect and respond to security threats or emergencies, ensuring the safety of citizens. Monitoring of utilities like water and electricity can also allow for more efficient resource use and can help in early detection of issues like leaks or outages. What will be key here is the interoperability of these devices, so that they can communicate and share information. If multiple competitors begin to take hold in one region, future sharing of data could be problematic. Governments will need to carefully consider new regulations as the trend scales, and any new guidelines should be coordinated among local, national, and international entities so that new devices can be compliant in multiple regions. This will ultimately allow for more global interoperability and sharing of information, which could become crucial during times of global crisis. Well-monitored cities will also attract more businesses due to a better enabled environment and happier, healthier residents.

SCENARIOS

SCENARIO YEAR 2038

The New Way to Walk

On any given day in London, it is now quite common to see mobs of people gathering and walking down the street. However, this isn't your usual tourist crowd or flash mob. Instead, it's due to Zwift's route automation, which directs residents to take certain routes throughout the city to optimize their route in real time. Such a capability was attempted in 2023, with Transport for London's initiatives aiming to fix traffic congestion and address air pollution and climate issues, but it met heavy resistance after charges and fines were levied.

Most residents feel Zwift has taken this initiative to the next level in 2038, as it has allowed them to sync their calendars, and it can also help them to gain access to public transportation and other amenities; the app then tells them which route would be the most efficient for their time, cost, and carbon neutral goals based on their day. The app also suggests the walking path that might best suit their health needs and that they might find most pleasant. Users rely on its air quality alerts for the areas to avoid.

With more people walking, sidewalks have leveled up. They now incorporate new built-in resting pads; when you need a break, the pads sense your fatigue and can fold up to create a place for you to sit and recharge your wearables. A favorite sitting activity involves experiencing the rewilding forest through AR, learning about local history and indigenous wildlife. This experience can be had on London's autonomous public transportation, too, which has become its own tourist attraction.

CONSTRUCTION PRACTICES

1ST YEAR ON THE LIST

MASS TIMBER CONSTRUCTION

WHAT IT IS

As one of the newer developments for more sustainable construction, mass timber construction is gaining attention as many studies and projects consider using its components in lieu of concrete and steel.

HOW IT WORKS

Mass timber construction is scaling, and a wide swath of new research indicates it can perform in extreme conditions and have sustainability benefits that were not previously known. In 2022, there were 139 mass timber buildings in the world eight stories or higher either complete, under construction, or proposed, according to the Council on Tall Buildings and Urban Habitat.

There are potentially several environmental and financial benefits. Recent research shows mass timber panels' inherent thermal properties could possibly simplify or replace a building's traditional HVAC system. Another study found wood can match concrete's performance in thermal mass design. And when cross-laminated timber is used to create a structural floor system, it could lower costs and possibly reduce the need for load-bearing walls and columns, per research from Clemson University.

In practice, mass timber is moving into new sectors, like hospitality. DLRGroup collaborated with designers, architects, and other experts to showcase a mass timber hotel prototype for the Marriott group—the hotel meets its stringent sound insulation standards, has a lower carbon footprint than concrete, ensures structural integrity, and aligns with the 2021 updated International Building Code for safety. And as the technology progresses, mass timber is reaching new heights. At 284 feet, The Ascent in Milwaukee is the world's tallest mass-timber building and is fully compliant with Milwaukee's building codes, including fire safety.

WHY IT MATTERS

Mass timber construction will allow buildings to last longer and perform better. With new exploration, the material can replace steel, act as a means to reduce material use and waste, increase carbon capturing, and provide new design flexibility. While most governments worldwide have yet to adopt wood-first laws, major economies are modernizing building codes, funding research, and promoting sustainable forestry to advance mass timber construction. As it increases, this form of construction will continue to grow as well. New regions looking to use this construction practice will have to study supply chain stability, and it's likely there will be greater stability and faster adoption in mature industry regions like Europe. For emerging markets, more mass timber construction could mean new jobs in both the construction industry and manufacturing.

Mass timber construction can also benefit users. Wood provides aesthetic beauty and mental health and wellness benefits. Utilizing mass timber can also position a business as a leader in innovative, sustainable construction methods, enhancing its reputation and market appeal. The ability for new structural spans also lends itself to enabling new design challenges and innovative solutions to explore.

1ST YEAR ON THE LIST

NET-ZERO CONSTRUCTION

WHAT IT IS

Net-zero construction is about balancing carbon emissions during construction and over the life of a project. This can be done through monitoring energy consumption, as well as through what materials are used, how the materials are produced, and other carbon offset strategies.

HOW IT WORKS

The 2022 Global Status Report for Buildings and Construction report found that the building and construction sector's energy consumption and carbon dioxide emissions reached unprecedented heights post-Covid, accounting for over 34% of global energy demand in 2021. Net-zero construction and techniques could help reduce this industry's energy use, and there are already promising examples like the Lola Mora Cultural Center in Argentina. The center is described as being net-zero with advanced energy-efficient systems, such as wind turbines, solar panels, rainwater harvesting, and natural ventilation, which will allow it to generate 20% more energy than it consumes.

Net-zero practices are moving into material development for the built environment industry as well. Sweden's SSAB has introduced its SSAB Zero recycled steel: rather than burning coal in the process, this approach uses fossil-free electricity and hydrogen, targeting near-zero emissions. There's also a lot of potential in the concrete industry, including CarbonCure, which strengthens concrete by adding CO2.

On the construction front, the electrification of construction machinery is advancing rapidly due to improvements in battery technology. Japanese-based Komatsu will soon roll out an electric excavator and a fully electric compact wheel loader; this machinery offers significant benefits such as enhanced air quality and noise reduction, making it suitable for both indoor settings and urban areas.

Direct air capture (DAC) has emerged as another solution for buildings seeking net-zero. While the US Department of Energy is advocating for DAC, the technology remains costly and energy-consuming, which could pressure cities to invest further in the necessary infrastructure. But the original form of DAC—sequestering carbon in plants—is still an option. In one interesting case, Barcelona-based TAKK Architecture completed a mobile garden designed to be relocated to areas with the highest carbon emissions in the city.

WHY IT MATTERS

Net-zero construction plays a pivotal role in modern building practices due to its significant impact on climate change mitigation, energy efficiency, and sustainability. By aiming for a balance where the total amount of energy used by a building is roughly equal to the amount of renewable energy created on-site, these buildings drastically reduce greenhouse gas emissions. Additionally, net-zero construction often incorporates elements that enhance indoor air quality and comfort, contributing positively to occupant health and well-being.

Projects that are carbon neutral or even carbon negative are growing in number. As more projects utilize net-zero construction practices, they will need access to more renewable resources. Future energy storage solutions that enable shorter durations for recharging batteries, vehicles, spaces, and equipment from renewable sources promise a transformative future for urban construction. Currently, approximately 253 global cities have net-zero targets, with half formulating plans. Many communities are also looking to become net-zero. They will have a growing need for sustainable infrastructure and collaboration as they seek out established goals.

1ST YEAR ON THE LIST

ADDITIVE CONSTRUCTION

WHAT IT IS

The 3D and 4D printing of structures, materials, and buildings is becoming more of a norm.

HOW IT WORKS

The option to use 3D printing technology is revolutionizing the construction industry with notable examples around the world. Glasgow's "active transport" bridge, the largest printed concrete construction in the UK, showcases the potential for creating intricate and unique infrastructural components in bridge construction. Dubai's 3D printed office in the Emirates Towers highlights how this technology can save both time and money, and aligns with the city's goal of having a quarter of all buildings 3D printed by 2030. Telangana, India, is looking to blend cultural reverence with innovation, by building the world's first 3D printed Hindu temple. Meanwhile, in Texas, ICON is partnering with Lennar and Bjarke Ingels Group to develop the largest 3D printed community offering, which includes 100 homes.

But the technology is still evolving. Tech company RENCA has pioneered the use of geopolymers for 3D printing entire houses, and the EU-funded WOOL2LOOP project repurposed mineral wool, typically considered waste with low-recyclability, into geopolymer concrete for construction. Meanwhile, a research initiative at the Missouri University of Science and Technology aims to develop an AI program that determines the best locally sourced materials for 3D printed concrete. By testing a variety of fibers, including unconventional plant-based and recycled fibers, the program seeks to enhance local sustainability, reduce construction costs, and improve the efficiency and safety of military construction efforts.

Scientists have developed a new 3D printing technique that allows them to control the cell structure and influence the final product shape; though early in development, this sustainable, reusable wood retains its original properties including strength and scent. Researchers from Bath and Imperial College London introduced Aerial Additive Manufacturing drones capable of 3D printing buildings.

WHY IT MATTERS

With a global demand for new homes and a need to convert aging infrastructure into revitalized assets, additive manufacturing offers solutions. For overpopulated cities or suburbs looking to expand, the technology could provide avenues to develop sustainable neighborhoods quickly. This could lead to new ways for businesses to use additive manufacturing for repair, product manufacturing, and increasing construction speed. The compounds and materials that go in and come out of this construction type will become increasingly important for the built environment. The fact that waste is becoming a targeted material, could form new circular business offerings as well.

As additive manufacturing begins to generate more aesthetically pleasing materials, it will help acceptance. But as the technology scales, it will disrupt many traditional forms of design and construction, as it will offer new ways of creating and building. Such changes can bring customizable diversity to regions and for new homeowners, where they can choose from a menu of offerings made just for them. And by localizing production for product manufacturers, construction site selection could become more of a focus.

1ST YEAR ON THE LIST

INTERACTIVE PROJECT MANAGEMENT

WHAT IT IS

Project management tools that allow for real-time monitoring and data transmission are creating efficiencies in construction. This includes the platforms themselves, as well as wearables that project visual data for workers as they build.

HOW IT WORKS

Studies have found that most general contractors use minimal automation for their subcontractor management processes. This leads to data silos, and contractors lose out on potential improved productivity, cost performance, and profitability. Autodesk Construction Cloud's (ACC) 2020 acquisition of Pype introduced AI-powered submittal logs, and now the company's launch of AutoSpecs in ACC can help streamline the construction processes for those just starting down this road.

On the front end of projects, management platforms for various tasks, like CoConstruct's integrated suite of construction estimating tools and STACK estimating software, are hitting the market. Join offers a platform that streamlines construction decision-making by importing data from tools like Excel and letting users evaluate the cost implications of preconstruction choices in real time.

For the building itself, management systems are not new. However, management systems that track efficiency are gaining ground. Learnd, a UK startup, is offering a unified building management system platform that integrates with existing systems to enhance energy efficiency and decrease carbon emissions.

New tools and platforms are also creating overlays that enhance project management. Argyle is an AR application for job sites that offers BIM visualization to prevent errors and ensure smooth project progression without the need for Wi-Fi. GAMMA AR uses augmented reality to overlay 3D BIM models on job sites. VSight is an AR-powered platform used by industrial workers for remote collaboration and knowledge access, streamlining operations in over 100 countries. OnSiteXR is a mixed reality app for HoloLens 2 that aids in attaching prefab building elements and records work using speech-to-text and image capture.

WHY IT MATTERS

Project management during the construction process is time-consuming and laborious. Addressing the challenge of workforce depletion, new platforms replace time-losing work processes so workers can focus on other needed workflows. More wearables that allow for the monitoring and managing of workers can also increase worker safety, and subsequently impact the bottom line of a company with reduced on-site injury claims. These wearables could become more standardized and interoperable, which would allow for more health management of the worker as well. Devices like these can not only prioritize on-site safety but also bridge communication gaps, enabling real-time access to data and fostering remote collaboration, leading to better project management. With more immersive technologies, the jobsite can now become interconnected with the model back in the office, which could allow for real-time drafting and designing coordination, replacing RFIs and even submittals.

SCENARIOS

SCENARIO YEAR 2031

Road Today, School Tomorrow

As with many developing countries, Kenya once struggled to balance building infrastructure over schools. The country needed schools to educate workers, but getting schools built and roads to get there also needed workers. This challenge persisted until the MIGA expanded its guarantees to help develop real-time monitoring for additive roadways. Through a partnership between investors, COBOD International, and several universities, they were able to create an offering that used real-time monitoring to know where roads would be most helpful, but could also be additively-made to be weather resistant. Once trade routes were established, the roads themselves could be converted into materials to build new schools. Once the schools have been established for several years, and repairs of the new roads become no longer feasible, the roads are recycled and ready for reuse for water management or other necessary infrastructure. This has helped Kenya to continue to develop while also managing some of the issues the country faces due to climate change.

SCENARIOS

SCENARIO YEAR 2040

Tag You Later!

“Day of Drafting,” or Tag Day as it was first called because it emerged in Germany, has become a phrase many firms discuss when they talk about the history of construction documents. The combination of AI project management tools, AR drafting, and additive manufacturing combined in an unforeseen way to change the industry in the early 2030s. New wearables for drafting allowed connected professionals the ability to draft in an AR space; the design was then immediately run through an AI code check in the ConPro management platform, and, if it passed, printed on-site immediately. Gone are the days of waiting for permits and the right site conditions, thanks to the connected sensors on site. The sensors told the crew what was ripe for building on that day, and then the component was drawn and printed immediately. The drone workers helped by then taking scans of what was printed, comparing it to the model through the platform, and then asking the architect, engineer, and designer to sign off on it. Because of this new form of building, at the end of the day, most construction workers now sign off with, “Tag you later!”

1ST YEAR ON THE LIST

MODULAR CONSTRUCTION

WHAT IT IS

Modularity has struggled to scale within construction, but has still continued to grow with its technical precision to include whole hospital suites that can be shipped and plugged into a new hospital building.

HOW IT WORKS

Health systems increasingly prefer modular and prefabricated construction methods due to their speed and efficiency. That's why M Health Fairview St. John's Hospital in Maplewood, Minnesota, used modular expansion to swiftly add 16 extra beds in nine months; traditionally, that project would have taken 15 months. As a project director at the University of Pittsburgh Medical Center, Michael Schesler is overseeing the construction of a 17-story inpatient tower that will use various prefabrication methods, with components like walls and bathroom pods being made in a nearby warehouse. A notable feature is the preassembly of horizontal MEP distribution systems, which are prepared in the warehouse, transported, and installed on-site. And even outside of hospitals, the ANNA Collection is taking modular living to a new level as its prefabricated cabins can be shipped anywhere.

The "polyroom" concept, developed by the French firm Cutwork, aims to tackle the looming global housing shortage with modular construction. The company builds small modular units with green spaces that can be swiftly assembled and reconfigured to adapt to daily needs, making it ideal for rapid urban development. For furniture, Ori specializes in robotic-powered space-saving solutions that transform single-use areas into multifunctional spaces.

Modular "jigsaw" roads, designed for rapid disassembly and reassembly, offer urban areas an adaptive solution to fluctuating traffic, construction demands, and emergency situations. CirculinQ, a Netherlands-based company, utilizes recycled plastic blocks for roads and pavements, efficiently managing water and showcasing impressive durability. Carlo Ratti Associati has furthered this concept with a modular street prototype, featuring hexagonal blocks that can be quickly rearranged, transforming a busy road into a community space like a basketball court.

WHY IT MATTERS

At scale, modular construction would address much of the renovation many cities will need to help prevent urban decay. As residents move from downtown areas, they are looking to modular homes in suburban areas. Modular construction can offer complete customization and be shipped anywhere in the world, which, with a growing mobile population would be very attractive. Communities may become more ephemeral, and prefabricated neighborhood setups may need to be ready. While upfront costs can be higher, the rapid construction timeline offers quicker delivery. With a growing unhoused population, modular units could be used to add on to existing structures in a cost effective manner that would not hurt the building's existing function or a multifamily residence's performa. It can also help minimize disruption when spaces need to remain open—like emergency rooms.

1ST YEAR ON THE LIST

AUGMENTED CONSTRUCTION

WHAT IT IS

The use of robots and other automated processes is changing construction practices and reporting, reducing project timelines, as well as reducing worker risk.

HOW IT WORKS

Cobots, the robotic coworkers, are becoming an established presence on many job sites—and they come in all sizes and for multiple functions. San Francisco-based startup Canvas leverages robotics, AI and machine learning to enhance drywall finishing and painting. This compact robot, roughly the size of a kitchen stove, is outfitted with laser scanners and operates on a vertical platform to navigate unfinished structures. Ken Robotech's Tomo-robo is a handheld tool designed to automate the repetitive task of rebar tying in construction, enhancing efficiency and alleviating the physical burden on workers.

Boston Dynamics has unveiled a substantial update to its Spot robot dog, by introducing advanced inspection workflows, enhanced interactions with humans, autonomous door manipulation, and a new vocal capability powered by ChatGPT and other AI models, which can boost its efficiency and user-friendliness. The Ddog project from MIT Media Lab combines Spot with a Brain-Computer Interface system, utilizing AttentivU's wireless glasses to measure brain activity and eye movements for nonverbal communication. While not in use on the construction site, yet, if successful it could aid in tasks all controlled through brain signals—and potentially be a game-changer for those with physical challenges.

Ballast Nedam, in partnership with ROPAX, launched a masonry robot in late 2021 to boost the efficiency of residential housing construction. It can measure a facade in 15 minutes and ensure level masonry even on unstable scaffolds, saving a day's work per facade. The Hadrian X, developed by Australian-based FBR Limited, is a swift and efficient mobile robotic blocklaying system capable of constructing house walls within a day using 3D CAD models. Beginning in 2025, HD Hyundai plans to broaden its Xite technology, which will enable greater site connectivity in the construction, demolition, and mining industries.

WHY IT MATTERS

As labor continues to be a challenge, integrating robotic and augmented processes can reduce the need for staff on-site. This can be helpful in developing regions where workers are scarce, but they may need to consider partnering with companies to bring the tools and technology to the region. Augmented construction by way of cobots could allow for continuous repair of aging infrastructure. While manufacturing already uses robotics in the production of many of its products, the built environment products may soon need to contend with figuring out how to teach cobots how to install their sometimes delicate products. Construction tolerances will need to be updated as more cobots perform the tasks, either negating the tolerance altogether or increasing them depending on the task the cobot is performing. Lastly, while safety may increase in some areas, in others it may decrease with the use of the cobots, which could mean a change to insurance premiums.

SCENARIOS

SCENARIO YEAR 2032

Nostalgia-Made Spaces

As many homeowners struggled to find homes in the early 2020s, they would often complain that the homes they could find were nothing like the ones they grew up in—and they cost twice as much as they could afford. Enter Nostalgia Homes, a developer that started out working with new parents who wanted to re-create the home they grew up in, so their kids could share the same memories they experienced decades ago.

Nostalgia Homes started in Austin, Texas, and soon became a global developer after completing its first 3D printed neighborhood. The company impressed clients with its details and accuracy. Through AI simulations, couples were even able to blend the best parts about each other's childhood homes and share that blended experience with their family. Not to leave urban clients out, Nostalgia Homes soon spun out Nostalgia Apartments and even Nostalgia Venues for repeating travel memories. The company could go into a modular blank apartment and retrofit the empty space using additive drone swarms to look like any place the tenant had previously lived. Nostalgia Venues offers the ability to re-create destination locations where couples were married or where a family had vacationed together. Some of the venues are going even further, using AI simulation to help find ways to build portions of international landmarks in other countries to help those who cannot afford to travel.

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ABOUT FUTURE TODAY INSTITUTE

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METHODOLOGY

Future Today Institute conducts in-depth qualitative and quantitative research throughout the year to identify emerging trends. We review patent and trademark filings, pre-print and published scientific papers, investment rounds, online search trends, macroeconomic data, publications from governments worldwide, news mentions, influencer posts and other sources, and we use a proprietary system to identify patterns, which are then grouped into nodes and evaluated using a set of standardized indicators. Qualified trends are further scored for their trajectory, momentum and timing. Additionally, we harness the deep subject matter expertise of our Future Today Institute network, leading to valuable insights about the topics we cover.

In continuous publication since 2007, Future Today Institute's annual report includes maturing and emerging trends grouped into two categories: industry and technology. Industry trends reflect the ways in which technology is shaping the future of an entire industry. Technology trends are specific developments within one arena, such as artificial intelligence. Covering a wide range of technologies across industry sectors creates a holistic view of change and provides leaders with a clear understanding of their potential impact. Trends are published as individual Industry and Technology reports, as well as in one combined report with all of our research.

Monitored regularly, trends help executives recognize emerging threats and opportunities in the near-term and enable them to develop perspectives, strategies and plans for the future.

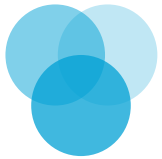
Future Today Institute's Strategic Foresight Methodology

SIGNALS & LONG-TERM TRENDS

What is INFLUENCING the future?

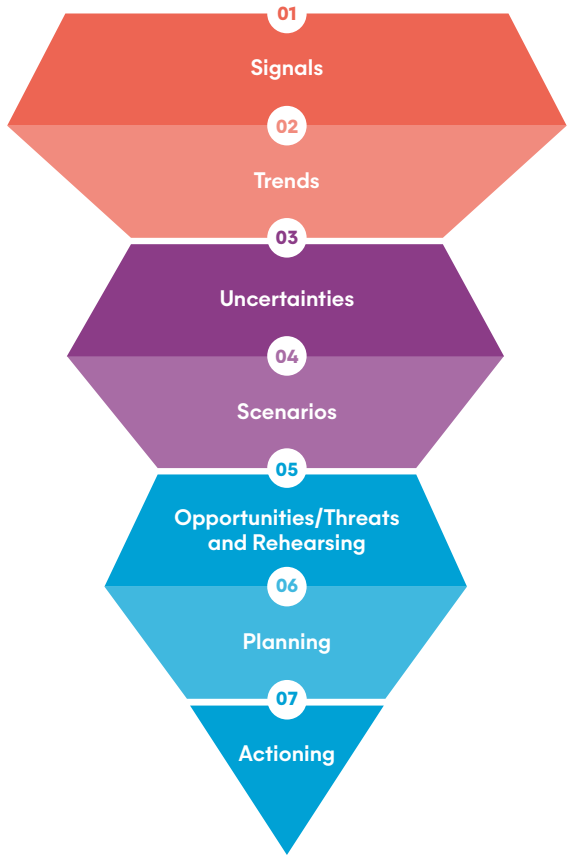
GLOBAL MACRO SCENARIOS

What is THE future?



STRATEGIC

What is YOUR ORG'S future?



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Future Today Institute's 2024 Tech Trends Report relies on data, analysis, and modeling from a number of sources, which includes sources within public and private companies, securities filings, patents, academic research, government agencies, market research firms, conference presentations and papers, and news media stories. Additionally, this report draws from Future Today Institute's previous EMT Trends Reports, FTI Trend Reports, and newsletters. FTI's reports are occasionally updated on the FTI website.

FTI advises hundreds of companies and organizations, some of which are referenced in this report. FTI does not own any equity position in any of the entities listed in this presentation.

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