# CHAPTER 1

# Definitions

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The introduction of new technologies into the built environment and its professions are fraught with the challenges of hype, limited adoption, and, in some cases, indifference. In some cases, there is a trend that new technologies are showing signs of adoption but need guidance, education, and sound strategies in order to become valuable to the built environment industries and professions. A first step in the education and communication process is to define the numerous elements that are affecting our built environment. The following definitions are a snapshot from this moment, a foundation to build upon and are meant to be revisited and challenged as we learn, fail, succeed, and adapt to our ever-changing world of the intersection of the physical and digital worlds.

The following definitions are not meant to be comprehensive, but rather to be used as a referenced foundation for your journey of moving through the rest of this book.

## Metaverse

William Gibson's quasi-prophetic vision of cyberspace as a "consensual hallucination" manifests itself in the emerging definition of the metaverse. Our company describes metaverse as an analogy to Outer Space. There is no there, there. It is a digital immersive environment that has the equivalent of galaxies, solar systems, and planets (virtual worlds) that provide a sense of place. The term "metaverse" originated in the 1992 science fiction novel *Snow Crash* as a portmanteau of "meta" and "universe." Metaverse development is often linked to advancing virtual reality technology due to the increasing demands for immersion. Recent interest in metaverse development is influenced by Web3, a concept for a decentralized iteration of the internet. Web3 and metaverse have been used as buzzwords to exaggerate the development progress of various related technologies and projects for public relations purposes. Information privacy, user addiction, and user safety are concerns within the metaverse, stemming from challenges facing the social media and video game industries as a whole. What we are learning as a company about metaverse is that through iterative design and delivery of 3D immersive experiences, is that new measures of usage and value need to be developed and implemented. We use terms such as Level of Experience and Level of Engagement (LOE) to describe how a user of the metaverse is immersed in a 3D digital environment.

At its current core, the metaverse is a spatial computing platform that provides digital experiences as an alternative to or a replica of the real world, along with its key civilizational aspects like social interactions, currency, trade, economy, and property ownership, all experienced on a bedrock of blockchain technology. Metaverse is an interaction, and, in certain cases, an integration of 3D worlds accessed through a browser, a mobile app, or a headset. It allows people to have real-time interactions and experiences across large distances, either by themselves, one-on-one and/or with many people. A vast ecosystem of online applications is emerging to build these human and non-human interactions, communications, and relationships (Figure 1-1).

The metaverse is an environment where the physical and digital worlds can coexist and significantly impact fundamental areas of daily life. It is a universe of limitless, interconnected virtual communities where people can socialize, collaborate, and have fun. It may include additional aspects of online life, such as social media and shopping. As application scenarios mature, the metaverse will develop into an exceptionally large-scale, extremely open, and dynamically optimized system. To create a system that can support various virtual reality application scenarios, creators from different fields will need to work together to fulfill the promise of the metaverse.

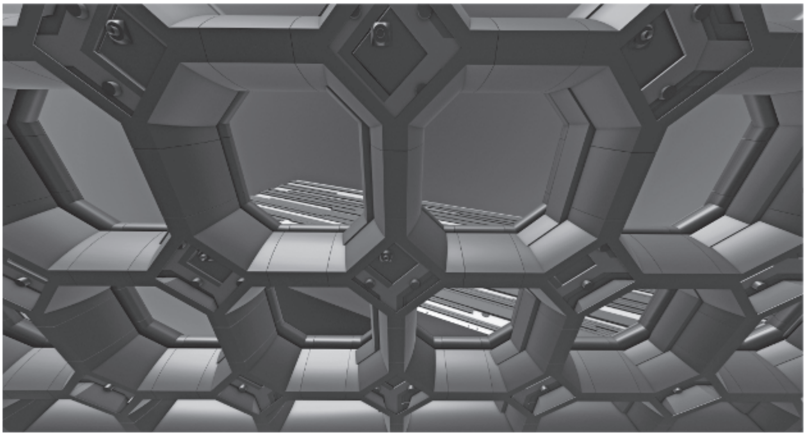

**Fig. 1-1:** Expo2020 Metaverse in Dubai.
Courtesy: Paul Doherty.

Our company is partnering and strategizing with a broad range of creators to deliver our virtual worlds in the metaverse around the theory that Web3 will be the next generation of the Internet as a 3D immersive environment that links virtual worlds in the metaverse together similar to how hyperlinks work in the current Web2 Internet environment of 2D web sites. Immersive worlds with next-generation hyperlinks are an amazing world to explore.

In the context of the built environment, the metaverse can be used to visualize and manage various aspects of a physical facility, such as building layouts, maintenance schedules, and resource allocation. For example, a facility manager could use a virtual reality (VR) headset to explore and interact with a 3D model of a building, viewing detailed information about various systems and equipment, such as HVAC, plumbing, and electrical. They could also use the metaverse to track and schedule maintenance tasks, assign work orders to technicians, and track the progress of ongoing projects.

Another example is through the use of augmented reality (AR) technology. A facility manager could use an AR app on their smartphone or tablet to view information about a specific location or piece of equipment with a digital overlay on their physical surroundings. This could be useful for accessing technical manuals, viewing repair histories, or identifying potential issues. The use of the metaverse in facility management can help improve efficiency, reduce costs, and improve the overall management of physical facilities (Figure 1-2).

**Fig. 1-2:** Qingdao, China Virtual Reality Theme Park Metaverse.
Courtesy: Paul Doherty.

## Digital Twin

A digital twin is a digital representation of a physical object or system. It is typically created using data from sensors, simulations, and other sources, and it is used to analyze, optimize, and predict the behavior and performance of the corresponding physical object or system. Digital twins are often created using software tools such as computer-aided design (CAD) and Building Information Model (BIM) programs, and they can be updated in real time as new data becomes available. They can also be integrated with other systems, such as manufacturing equipment or transportation networks, to enable real-time monitoring and control.

Digital twins can be used to optimize the built environment by providing a virtual model of the facility that can be used to simulate and analyze different scenarios, such as predicting maintenance needs or optimizing energy use. Here are some examples of how digital twins can be used in facility management:

- Predictive maintenance: By continuously monitoring the performance of physical assets and comparing it to the digital twin model, facility managers can predict when maintenance is needed and schedule it in advance, reducing downtime and improving efficiency.
- Energy optimization: Digital twins can be used to simulate different energy consumption scenarios and optimize energy use in a facility. For example, a digital twin of an office building

could be used to determine the most energy-efficient lighting and temperature settings.

- Space optimization: Digital twins can help facility managers optimize the use of space in a facility. For example, a digital twin of a warehouse could be used to simulate different layouts and determine the most efficient use of space.
- Emergency management: Digital twins can be used to simulate different emergency scenarios and develop emergency response plans. For example, a digital twin of a hospital could be used to simulate a fire and determine the best evacuation routes and resources needed to respond.
- Virtual commissioning: Digital twins can be used to test and commission new facilities or equipment before they are built or installed, reducing the need for physical testing, and improving efficiency.

When used in construction, digital twins can refer to digital replicas of physical assets and systems used to simulate, monitor and optimize their performance. Some examples of digital twins in construction:

- Building Information Modeling (BIM): BIM is a digital twin of a building, which provides a 3D model of the building's physical and functional characteristics. It can be used to simulate and optimize the building's performance, energy efficiency, and safety.
- Construction site simulation: Digital twins can be used to simulate construction sites to optimize the construction process and improve safety. For example, a digital twin of a construction site can be used to simulate the movement of materials and workers, identify potential safety hazards, and optimize the layout of the site.
- Smart infrastructure: Digital twins can be used to monitor and optimize the performance of infrastructure assets such as bridges, roads, and tunnels. For example, a digital twin of a bridge can be used to monitor its structural health, predict maintenance needs, and optimize traffic flow.
- Asset management: Digital twins can be used to manage and optimize the lifecycle of construction assets such as cranes, excavators, and trucks. For example, a digital twin of a crane can be used to monitor its performance, predict maintenance needs, and optimize its usage.

## Virtual Worlds

Virtual worlds are 3D digital environments or spaces that exist online and can be accessed and interacted with through the internet. They can be used for a variety of purposes, such as socializing, entertainment, education, and business. Virtual worlds can be accessed through a variety of devices, including computers, smartphones, and virtual reality headsets. They can take the form of social media platforms, online multiplayer games, virtual reality environments, or virtual-reality-based social spaces. In a virtual world, users can create and customize their own digital avatars, or online identities, which they use to interact with other users and the environment. Users can also participate in activities and events, communicate with other users through text or voice chat, and explore different areas and features within the virtual world.

Virtual worlds can be designed to mimic real-world environments or can be entirely fictional and imaginative. They can be used for a wide range of purposes, including socializing with friends, playing games, attending virtual events and concerts, participating in educational or training programs, and even conducting business meetings and transactions (Figure 1-3).

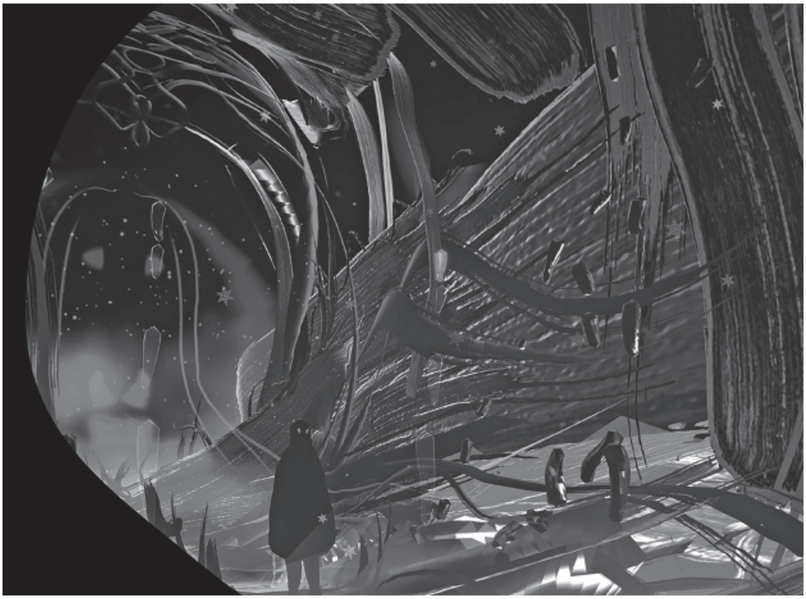

**Fig. 1-3:** A virtual world in the Metaverse.
Courtesy: Paul Doherty.

Virtual Worlds are the provenance of the Industrial Metaverse that can build upon a vertical business sector and focus its data from this vertical viewpoint. This approach promises to provide value to a specific industry faster than waiting for the digital “big bang” to occur on a global, multi-sector scale.

## Blockchain

A blockchain is a decentralized, distributed ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the consensus of the network. Each block in the chain contains a record of multiple transactions, and once a block is added to the chain it cannot be altered. The decentralized nature of a blockchain makes it resistant to fraud and tampering, as there is no single point of control.

Blockchains are often associated with cryptocurrencies, such as Bitcoin and Ether, but they can be used to record and verify any type of data or information. They have the potential to revolutionize our industry by providing a secure, transparent, and immutable record of transactions and other data. Some examples of how blockchain technology is being used in the real estate industry:

- Property ownership and transfer: Blockchain can be used to record and verify ownership of real estate assets, making it easier to track the ownership of a property and facilitate the transfer of ownership when the property is sold.
- Mortgage and loan origination: Blockchain can be used to securely store and verify mortgage and loan documents, streamlining the loan origination process and reducing the risk of fraud.
- Lease management: Blockchain can be used to track and verify rental agreements, making it easier for landlords and tenants to manage their leases and ensure that all parties are following the terms of the agreement.
- Facility management: Blockchain can be used to track and verify facility and property maintenance and repair records, making it easier for property managers to manage the upkeep of their properties.
- Land registry: Blockchain can be used to maintain a secure and transparent record of land ownership, making it easier for governments and other organizations to track and verify land ownership and reduce the risk of fraud.

## Fungible Token (FT)

A fungible token is a type of digital asset that is interchangeable and identical in value to another asset. This means that any unit of the token can be exchanged for another unit of the same token without any loss of value. Fungible tokens are often used as a medium of exchange, similar to how traditional fiat currencies are used in the real world.

In the context of facility management, fungible tokens could potentially be used to track and manage the usage of resources within a facility, such as electricity or water. For example, a building owner could issue tokens that represent a certain amount of electricity and sell them to tenants. The tenants could then use these tokens to pay for their electricity usage. This could allow for more flexible and efficient billing and payment processes, as well as provide a way for tenants to track their energy usage and potentially incentivize them to use resources more efficiently.

Another potential application of fungible tokens in facility management is in the tracking and management of maintenance and repair work. For example, a building owner could issue tokens that represent a certain amount of maintenance or repair work and sell them to tenants or contractors. The tokens could be used to track the progress of the work and ensure that it is completed in a timely and satisfactory manner.

The use of fungible tokens in the built environment can provide a more transparent and efficient way to track and manage the use of resources and services within our buildings around the world.

## Non-fungible Token (NFT)

An NFT, or non-fungible token, is a type of digital asset that represents ownership of a unique digital item or piece of digital content. NFTs are stored on a blockchain and are unique in that they cannot be exchanged for other items of equal value. This is in contrast to fungible assets, which are interchangeable and can be exchanged for other items of equal value, like a security.

NFTs have gained popularity in recent years as a way to authenticate and monetize digital art, music, videos, and other forms of digital media. They can also be used to represent ownership of physical items, such as collectible items, artwork, or even elements (systems) of buildings.

One key feature of NFTs is that they are immutable, meaning that they cannot be modified or altered once they have been created. This ensures that the ownership and authenticity of the asset can be verified and traced. NFTs also allow for the creation of unique digital marketplaces and communities around specific types of content.

We are exploring the use of NFTs in construction documents and facility management documents to identify building systems like electrical, plumbing, and mechanical. By minting these systems as NFTs, we create immutable data that can be authenticated and trusted. With trusted data, the geolocation of building systems can augment as built/record documents to also be trusted, saving time and money. This same data can be used to provide measurement and analytics on the performance of building systems and their materials and equipment.

## Smart Contracts

A smart contract is a self-executing contract with the terms of an agreement between buyer and seller being directly written into lines of code. The code and the agreements contained in them are stored and replicated on a blockchain network. Smart contracts allow for the automation of electronic contracts and can be used to facilitate, verify, and enforce the negotiation or performance of a contract. So cool.

Smart contracts can be used in a variety of contexts, such as financial transactions, supply chain management, and real estate. They can help to streamline processes, reduce the risk of fraud, and increase transparency and accountability. Because they are stored on a decentralized, immutable ledger (blockchain), they can also provide a permanent record of the contract and its terms. Overall, smart contracts offer the potential to increase efficiency, reduce the need for intermediaries, and enhance trust in contractual relationships. Smart contracts can be used in facility management to automate various tasks and processes. Here are some examples of how smart contracts could be used in facility management:

- Lease agreements: Smart contracts can be used to automate the process of signing and executing lease agreements for rental properties. The contract can include terms and conditions for the rental, as well as automatic payment and renewal provisions.

- Maintenance and repair: Smart contracts can be used to schedule and track maintenance and repair tasks for a facility. The contract can specify the frequency and scope of the maintenance, as well as the terms for payment to contractors.
- Utility management: Smart contracts can be used to automate the process of managing utilities for a facility, such as electricity, water, and gas. The contract can track usage and automatically bill tenants or occupants for their consumption.
- Security and access control: Smart contracts can be used to manage access to a facility, such as by issuing digital keys or badges to authorized individuals. The contract can also specify the terms under which access is granted or revoked.
- Environmental monitoring: Smart contracts can be used to monitor and track environmental conditions within a facility, such as temperature, humidity, and air quality. The contract can trigger alerts or actions when certain thresholds are exceeded.

When used in construction, smart contracts can be used for:

- Payment Management: Smart contracts can automate the payment process between parties involved in a construction project. The contract can be set up to release payments automatically when certain milestones are reached or specific tasks are completed. This eliminates the need for manual invoicing and reduces the risk of payment disputes.
- Supply Chain Management: Smart contracts can also be used to manage the supply chain in construction projects. The contract can be set up to automatically order materials when inventory reaches a certain level, track shipments, and verify delivery of materials.
- Quality Control: Smart contracts can be used to ensure quality control in construction projects. The contract can be set up to verify that certain standards are met, such as building codes and safety regulations.
- Project Management: Smart contracts can also be used to manage the entire construction project. The contract can be set up to track progress, schedule tasks, and monitor budgets. This can help ensure that the project is completed on time and within budget.

## Tokenomics

Tokenomics is a term that refers to the study of the economics of tokens, which are digital assets that can be used to represent ownership, access, or rights within a particular ecosystem or platform. Tokenomics involves the design and analysis of the economic rules and incentives that govern the creation, distribution, and circulation of tokens within a particular system. This can include the issuance and distribution of tokens, the use of tokens as a means of exchange or payment, and the management of the overall supply and demand for tokens. Tokenomics is a complex and multifaceted field that involves economics, psychology, game theory, and computer science, and it is often used to design and analyze decentralized systems and platforms, such as cryptocurrency networks and blockchain-based applications. I find it easy to think of tokens in the context of needing a token to play an arcade game. Once you insert the token, you can play the game.

## GPT

GPT (Generative Pre-training Transformer) language model was specifically designed for chatbots and conversation systems. It can be used to build a wide range of conversation-based applications, including facilities management systems. Here are a few examples of how GPT could be used in facility management:

- Building maintenance: GPT can be used to build a chatbot that helps facility managers track and schedule maintenance tasks for various parts of a building, such as elevators, HVAC systems, and electrical systems. The chatbot could allow users to report issues and request maintenance, and then generate responses based on the user's input and the status of the maintenance tasks.
- Meeting room booking: GPT could be used to build a chatbot that helps users book meeting rooms and conference facilities. The chatbot could allow users to search for available rooms based on their location, size, and availability, and then make a booking by providing their name and the dates and times they want to reserve the room.
- Visitor management: GPT could be used to build a chatbot that helps facility managers manage the flow of visitors in a building. The chatbot could allow users to check in and out of the

building, request access to certain areas, and track their movements within the building.

- Energy management: GPT could be used to build a chatbot that helps facility managers monitor and optimize energy usage in a building. The chatbot could allow users to view real-time energy consumption data and suggest ways to reduce energy usage, such as by turning off lights or adjusting thermostats.
- Emergency response: GPT could be used to build a chatbot that helps facility managers handle emergencies in a building. The chatbot could allow users to report emergencies, such as fires or medical emergencies, and provide guidance on what to do in case of an emergency (Figure 1-4).

GPT has the potential to revolutionize the construction industry by automating various tasks and improving efficiency and accuracy. Some examples include:

- Automated documentation: GPT can be used to generate reports and other documents automatically. For example, it can generate reports based on construction progress, project status, and other project-related data.

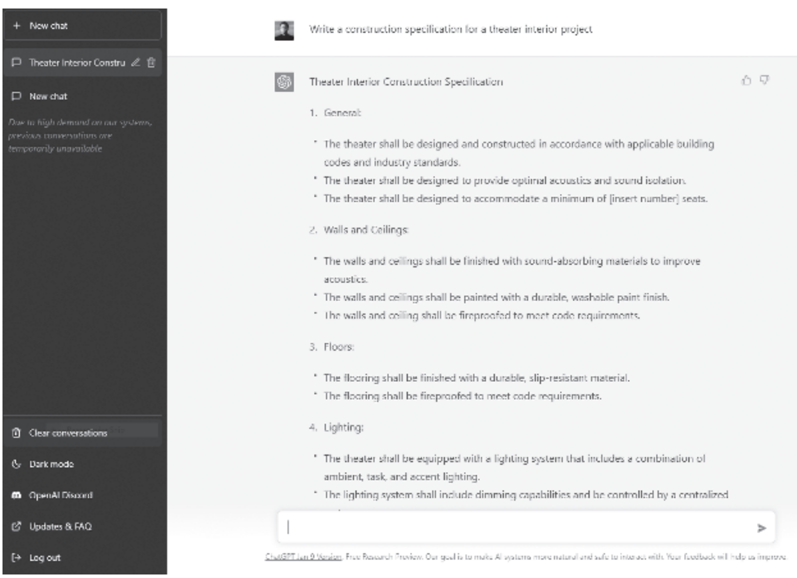


**Fig. 1-4:** Artificial Intelligence (AI) ChatGPT construction specification example. Courtesy: Paul Doherty.

- Quality control: GPT can be used to analyze and identify errors in construction plans and designs. It can also be used to monitor construction progress and detect potential quality issues.
- Safety monitoring: GPT can be used to monitor construction sites and detect potential safety hazards. It can analyze sensor data such as temperature, humidity, and vibration to identify potential issues.
- Predictive maintenance: GPT can be used to predict maintenance requirements for construction equipment and machinery. It can analyze data such as equipment usage, performance, and environmental conditions to identify potential maintenance needs.
- Cost estimation: GPT can be used to generate cost estimates for construction projects. It can analyze project specifications, materials, and labor requirements to provide accurate cost estimates.

There will be a continuous stream of new terms, phrases, and acronyms for us to learn as we enter and evolve into this decentralized digital world of the metaverse. These definitions are just a starting point for us to begin our journey into the metaverse and will continuously be challenged, changed, and used as our maturation into the metaverse evolves.