# Building Information Collection

## Autonomous Building Information Collection

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**Part I – Planning**

In developing a Digital Twin, it’s key that we develop a method to lower the barriers to entry for our customers. Speeding up the process but maintaining accuracies.

**What is BIM?**

An acronym for Building Information Modeling/Management. In brief, it's a digital model that multiple tenants utilize to collaborate on the successful delivery of a building, or construction project. Other industries are utilizing these BIM's to correctly anticipate the delivery of assemblies and other sub-systems.

**What are the current methods used in BIM collection?**

It's currently industry method to utilize tools like Laser scanners, photogrammetry, manual documentation, electrical panel schematics, and any other form of diagram previously developed by Architects, construction teams and manufacturers for these orchestrations.

**Data Sources**

* Schematics
* System Manuals
* Issues/Tasks associated with an area/component.
* Measurements
* System Meta Data (electrical values, nut types, etc..)
* Blueprints
* CAD (2d/3D)
* Excel sheets of asset metadata
* Hand drawn layouts
* Software as a Service platforms (NetBox for rack management and documentation)
* Experience/Human memory

**Data Types**

* Wiring
  + Type (Electrical, Data (copper, fiber, air), Conduit)
  + Gauges
  + Age
  + Path
  + Circuit Types
  + Material
  + Sheathing
  + Watts/Volts (current + max)
  + Length
  + Girth (outer)
  + life cycle (install date, end of life, warranty)
* Plumbing
  + Type (potable water, milk, chemical)
  + PSI (current + max)
  + Material (copper, cast iron, plex, pvc)
  + Length
  + Girth (inner, outer)
  + life cycle (install date, end of life, warranty)
* Flooring
  + Type (concrete, carpet, tile, wood)
  + Finish
  + Barriers
  + Fillers
  + Capacity
  + Scratch resistant ratings
  + Primary use
  + life cycle (install date, end of life, warranty)
* Walls
  + ...
* Lights
  + ...
* HVAC
  + ...
* Windows
  + ...
* Fire Suppression
  + ...
* Compliance
  + ADA
    - Signage
      * Type (...)
  + Fire Marshal
    - Signage
      * Type (...)
  + Health
    - Signage
      * Type (...)
* IT
  + Type (Intercom, Wireless, Network, Surveillance, Door Access)

**Purpose of Data**

The time to collect and the Data itself can be completely wasted if there is not a use case. The scope of this paper is to identify data types correlated to a facility’s structure that has a direct impact in the initial ingestion cycle of a new site to develop the ground plans of a digital twin. With that information, we can attempt to create automated pipelines to take the ingested *data sources* and convert it into *data types* autonomously. Ultimately lowering the barrier to entry for a digital twin and digital thread product while maintaining standards for accuracies.

**Minimal Data Needed for a Digital Twin**

* Walls
* Ceilings
* HVAC
* Plumbing
* Electrical
* Data Systems (IT systems (door access, wireless, infrastructure), IoT devices)
* Flooring
* Thresholds (door openings, windows, garages)
* Storage areas
* Structural Asset Locations

**Best Method to Collect the Baseline Data**

Laser Scanning with 360 photo captures, supplemented with high resolution photos and 360 videos. *This method, however, must be challenged and the workflows proven.*

**Challenges & Constraints**

* Obtaining a high quality and highly accurate mesh model with photogrammetry
  + And if you do get it, was it done with government approved software and hardware?
  + Photo to Mesh quality for collection to model is not up to par without human interaction. There are some great platforms, but workflow is not documented; along with there being a lack of automated workflow. (upload thousands of photos and let the computer take over)
* NeRF technology recently released with no true workflow practiced. Generative AI uses photos to "fill the gaps" for photogrammetry - accuracy is the winner with this one.
* AI for object segmentation has been around, but no good workflow developed. Object segmentation is useful for providing modelers with a singular object out of the gate to work with rather than attempting to segment billions of points for each little object they may need.
* AI for text identification and correlation has no workflow, but the technology is prominent. This will be helpful for capturing asset tags, qr codes, hand-written text, etc...
* Lack of a data catalog for CAD/Modeling to easily find all of the necessary data they need when modeling. All photos, scans, videos should be searchable by meta data and image detection (ai). Something along the lines of Google image search where you can upload a reference image and it'll populate where that source is from, and high confidence matches.
* Collection times require extensive planning, expensive hardware/software, and long processing times with manual experienced human interaction.

**Goals**

* Automate Building Information Collection allowing the human to verify and assign.
  + This may mean automating the scan to mesh process so the computer can calculate and process by area/room rather than attempting to generate the entire building at once with no form of path reference.
* Visualize BIM data quicker with fewer human hours involved.
* Lower the cost of entry for the initial ingestion cycle when onboarding a new client site.
* Optimized for low touch collection, reducing the needs for clearances, training, tethering, and so much more that goes into being authorized to enter a space.
* Integrate with information management platforms.
  + A good example of this would be with NetBox. If a survey crew captures a site with B12 patch port in a room, NetBox api should tell our system that B12 feeds back to the main distribution frame in building B on rack #1, U3-U5 with switch Meraki 225-48P last managed by Technician #1.
    - It should also be able to highlight a path going back to that location in a digital twin, following the visible conduit and "generating" a path through the non-visible conduit.
    - This provided information should also calculate the anticipated length of the runs, if not calculated in the switch or cable management platform (netbox).
* Auto calculate identified objects by groups. # of exit signs, # of visible fire extinguishers, # of fire strobes, # of suppressions etc... for building compliance and planning. These items should be visible, therefore, automatically collected using traditional photo/video.

**Part II - Approvals**

**Workflows**

**Raw documentation**

What can the client provide? Do they have a record of sub-systems, installation dates, and types of materials as-built?

**Systems as a Service**

What systems are they currently utilizing to manage materials, installations, and any sub-system activity? Is there an API? Does it provide granular use of metadata and tracking?

**Physical Collection**

What collection methods are approved? Will these collection methods work to maximize exposure but reduce exposure time?

**Laser Scanning**

Distance requirements, length of time to capture.

**Photogrammetry**

**360 Photogrammetry**

Distance requirements, how far is too far?

**Drone Photogrammetry**

Distance requirements, how close can we get? Is there enough clearance? Do we need a certified drone operator?

**Still Image Photogrammetry**

Can we get enough angles? When would NeRF kick in? What's "enough"?

**Part III - Framing**

**Artificial Intelligence, Deep Learning, Machine Learning**

How do we build the data catalog? How do we get the information to CAD when they want it? How do we notify them of an identified object that wasn't previously identified?

**Part IV - Do it again**

How do we verify year over year? How do we Frame, Erect, and Reference faster? How do we scale horizontally without extending time? How do we handle live content streams?

**Resources:**

<https://constructible.trimble.com/construction-industry/what-is-bim-building-information-modeling>