BuildingPoint™

# Digitization and Connected Construction

**Volume One:** The Constructible Process

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## Volume One: The Constructible Process

## Introduction

The goal of the **constructible process** is to connect the right people to the right data at the right time using a cloud-based collaboration platform designed for the needs of the construction industry.

### Definition

The constructible process is a connected environment in which everyone collaborates seamlessly throughout the construction lifecycle, including the design, build, and operate phases.

**Purpose**

The constructible process saves time and money throughout the project lifecycle through improved:

- Planning
- Communication
- Knowledge sharing
- Productivity
- Efficiency and
- Quality

**Lifecycle Stages**

The construction lifecycle includes the following stages:

- Plan
- Concept
- Design and Engineering
- Bid and Award
- Fabricate and Construct
- Oversee and Manage
- Utilize and Optimize

The constructible process calls for capturing all information created throughout the construction lifecycle in a shared digital system. This process facilitates collaboration to ensure the efficient design, fabrication, construction, and operation of structures.

### Phases – Design, Build, Operate

Trimble constructible workflows group the above stages into three broader phases:

| Design | Build | Operate |
|---|---|---|
| Plan | Fabricate | Oversee and Manage |
| Concept | Construct | Utilize and Optimize |
| Design and Engineering | | |
| Bid and Award | | |

Let's take a deeper dive.

## Building Information Modeling (BIM) and Trimble Connect

Managing the constructible process calls for integrating a range of digital tools.

These can include:

- 3D BIM constructible models
- Laser scanning
- Augmented or mixed reality (AR/MR) tools
- Robotic layout
- Productivity analysis
- As-built quality analytics
- Final BIM deliverables


Trimble Connect provides a common data environment (CDE) to enable this integration. It's an open collaboration platform connecting the right people to the right data at the right time.

Our productive combination of client tools and applications provides a continuous experience for optimal collaboration and productivity. Trimble Connect shares information from BIM models and data collected from field equipment using familiar user interfaces.

These interfaces can include the web browser for project creation and administration as well as 2D and 3D model viewing. Our Windows application can provide the required graphics performance for larger models and AR integration with Trimble XR10 with HoloLens 2.

Field users can improve productivity using the mobile application, which is optimized for compact touch screens. AR/MR applications enable visualization using IOS or Android mobile devices, or Trimble XR10 with Hololens2.

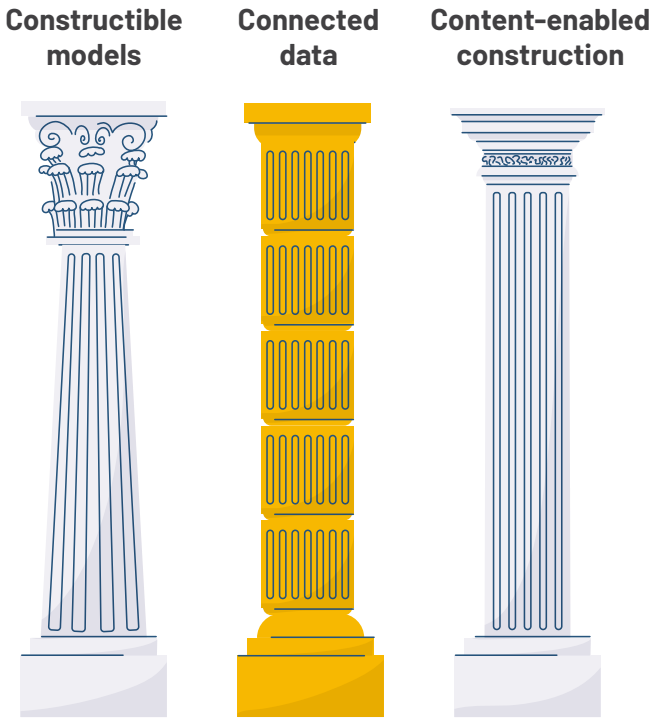
Trimble Connect's Visualizer creates basic renderings of Tekla Structures 3D models, including snapshots and animations. Trimble Connect Sync keeps files from multiple projects synchronized on Trimble Connect, transferring large data volumes to and from the cloud.

# Constructible, Connected, Content-Enabled

## Principles

The constructible process is built on three pillars:

- Constructible models
- Connected data
- Content-enabled construction




Contractors, trades, and sub-trades refer to models prepared with precise geometry to direct their construction processes. Applications share content, liberating data, and breaking down information silos. Construction crews work with the most up-to-date design, engineering, and project management content, improving accuracy, efficiency, and quality.

These three pillars support an approach where content goes beyond the structural design. It also drives the engineering, planning, procurement, construction, and delivery tasks. Teams throughout the project lifecycle now use the same precise, constructible data to design, build and operate structures of any scale.

## Purpose-Built Hardware and Software

The constructible process also supports the newest digital technologies in collaboration, AR/MR and robotics. Current equipment and workflows accommodate existing BIM processes and execution, while bringing structure to less systematic contractor, trade, and subtrade work processes.

## Single Source of Truth

Project teams organized around the constructible process can store, organize, and share data using one cloud-based BIM collaboration tool. This "single source of truth" ensures that everyone involved in the project tracks design changes in real time based on up-to-date information.

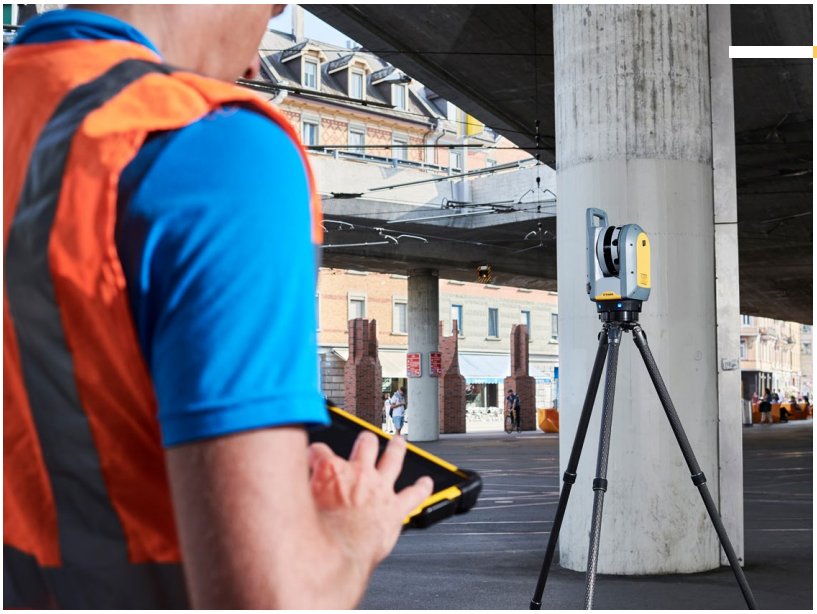
## Keep Teams Connected

Traditional project coordination methods depend on labour intensive tasks and time-consuming progress meetings that can throw the project behind schedule. The constructible process eliminates these delays by enabling everyone on the project to access, share, review, comment on, and assign tasks in the same model.

### Automate Workflows

The constructible process integrates a wide range of online systems with application programmer interfaces (APIs). This can include enterprise resource planning (ERP) systems, document management software, and many others. Teams apply this integration to set up automatic tasks and streamline their work processes.

Trimble continually introduces new technologies that support workflow automation. For example, SketchUp now includes embedded AR, enabling note decoration and clash detection.



The Trimble X7 is an architecture, engineering, and construction (AEC) innovation that streamlines progress monitoring. Using laser scanning, the Trimble X7 enables high-quality in-field registration, in-field FF/FL calculation, and self-calibration.

**Trimble Construction One** is a brand-new product that integrates applications throughout the plan, build and operate phases of the project lifecycle. It will align tools including SketchUp, Tekla, Accubid Anywhere, Viewpoint, Trimble Connect, ProjectSight and more.

## The Connected Process

The constructible process is a connected process. Project teams can link constructible, historical data and content to project delivery tasks, enabling optimized, predictable project plans.

At the same time, the connected process integrates data and content between project delivery and supply chain systems. This connection improves project control and progress monitoring. Teams produce improved project deliverables throughout the project lifecycle.

### Building Construction Field Systems

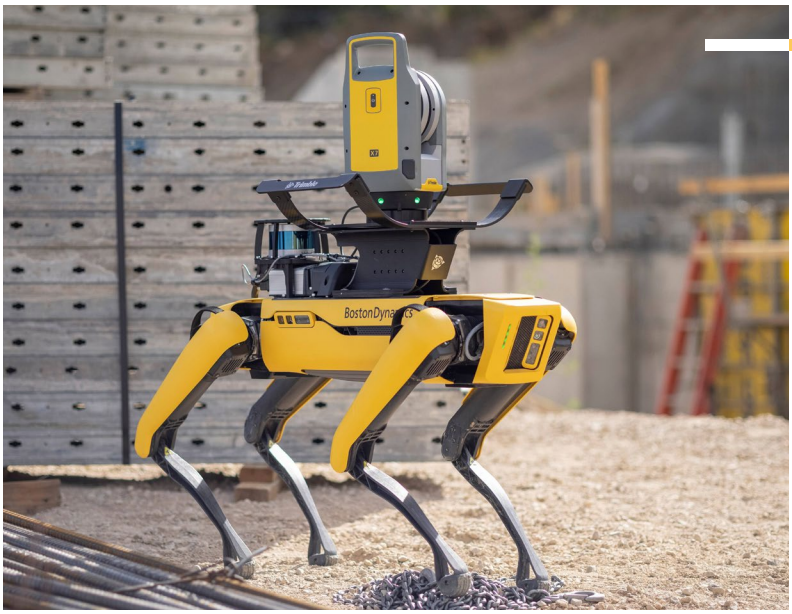
The connected process also includes the tools project managers need to connect people in the field with people in the office. Project stakeholders share drawings and progress reports using a common data platform, maintaining that one source of truth.

Integrated devices can include field layout tools providing 2D or 3D plans to field survey crews via robotic total stations or GPS. This helps onsite workers quickly locate points shown in the plans at jobsites, such as embeds, sleeves or stub-ups more efficiently.

Other field systems support **3D reality capture** at the site. For example, the Trimble X7 is a terrestrial-based scanner that crews can mount on a tripod. Using the X7, field staff can generate digital twins of site plans or quickly capture extremely precise site measurements.

Field crews can control both the field layout and 3D capture tools from one tablet. This makes it easier for supervisors to train and transfer field workers.

Trimble's **Mixed Reality** technology helps field crews visualize design models at jobsites. It drives MR products like the XR10 headset for HoloLens2. It also supports AR applications on tablets or smartphones.



Trimble has entered a partnership with Boston Dynamics to co-develop robotics solutions for the AEC industry. So, for example, field crews can mount devices like the X7 as payloads on Spot, Trimble's autonomous construction robotics solution. Construction robotics can automate moving tasks and can also take on work in confined or hazardous spaces.

## Trimble Connect

### Trimble Connect

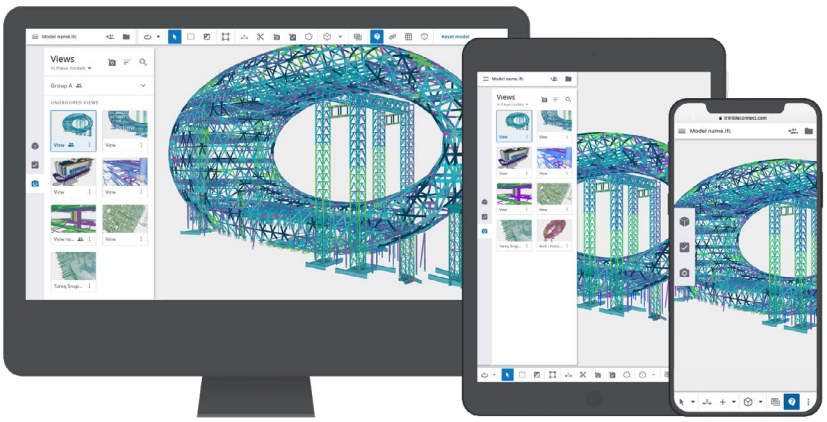
Trimble Connect provides the common data platform that keeps these field systems working together.

The constructible process bridges the gap between the abstract design model and the real-world structure. Having a common data platform facilitates the design review process.

Data sharing also enables project stakeholders to communicate change orders quickly. Too often, project teams work in separate platforms, designing in 3D models while communicating with 2D plans to erect 3D structures.

Trimble Connect enables everyone connected with the project to collaborate by sharing 3D models throughout the plan, build and operate lifecycle phases. Anyone onsite can visualize both plans and structures with timely access to accurate data.

The constructible process is also cloud-based to provide data in design context. Teams can share project data using Trimble Connect and view it wherever they happen to be using a desktop, laptop, tablet, smartphone, HoloLens, or AR glasses. This accessibility enables better decision making.



## Extended Reality Software

Using Trimble's Connect AR, field crews can take digital 3D or 2D models and superimpose them over the real-world construction site to view models in context.

Mixed reality is a similar technology that, in this context, uses HoloLens optical tools instead of tablets or smartphones. Although it requires more specialized hardware, it provides a more immersive experience, helping viewers to visualize the model more accurately.

### Trimble Connect AR Application

Trimble Connect AR provides a 1:1 scale augmented reality view of digital models. The product was specifically designed to support AEC workflows.

This includes pre-construction coordination, construction checking, post-construction tasks, and quality assurance. Working with Trimble Connect AR takes field crews to the next level, replacing conventional paper plans or mobile device viewing.

Connect AR improves design review processes. It can also facilitate prefab concrete projects by enabling crews to verify the quantity and placement of rebar offsets and embeds in precast products.

Onsite staff can also superimpose PDF files using Connect AR. This enables them to view notes and annotations superimposed on the PDF image.

Connect AR supports a portfolio of robotic total stations to meet customer needs, including Trimble's RTS series and the Trimble Ri. Crews can also work with Trimble's ProPoint positioning engine to access the Global Navigation Satellite System (GNSS).

GNSS goes beyond traditional GPS by including corrections from satellite providers outside the United States. The added corrections provide even more accurate positioning for tasks like underground work.

Trimble's SPS instruments provide built-in tilt compensation for prism poles, providing the correct point even when workers need to angle the pole for tasks like underground conduit plumbing, for example.

### FieldLink MR

Onsite staff can use Trimble's new FieldLink MR to perform layout tasks using the 3D design model and HoloLens. Trimble's robotic total stations enhance HoloLens accuracy, enabling crews to visualize design points without using a field tablet or any other mobile device.

The FieldLink Robotics Module is a new approach to autonomous field capture. FieldLink software can manage laser scanners, GNSS smart antennas, and Spot from one application.

This provides crews with a robotic total station that can move autonomously to multiple locations, capturing a complete worksite without human intervention. FieldLink also offers remote operator functionality, enabling users to drive Spot around the site, view it via its pan-tilt-zoom camera or capture the site with an attached scanner from anywhere in the world.

Past

Present

### History Snapshot

The Trimble X7 3D scanning system simplifies onsite data capture by automating registration and georeferencing. Field crews can link scans directly to the digital 3D model. The X7 also has built-in autocalibration to reduce maintenance requirements. It can operate in temperatures ranging from -20˚ C to +50˚ C.

Using the X7, onsite staff can document a construction site, capturing high-resolution 3D images that can be visualized in greyscale.

In the past, capturing dark or reflective surfaces with EDM systems could produce inconsistent results. Today's EDM technology has the sensitivity to capture these surfaces onsite using 3D laser equipment.

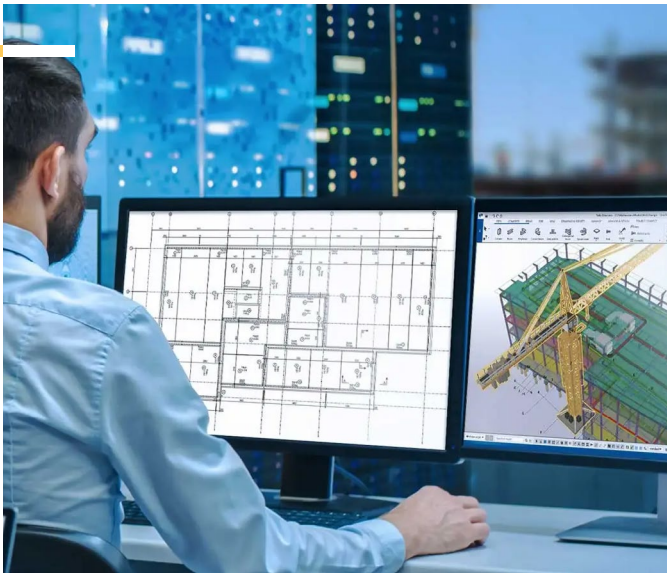
## Content-Enabled Process

We can also view the constructible process as content-enabled. It expands on 3D modeling by linking every phase, person and procedure required throughout the project lifecycle. Team members use integrated tools that work together seamlessly, ensuring effective communication and collaboration.

The constructible process also includes giving software applications access to data-rich libraries that assist construction professionals. The constructible vision includes a complete set of integrated tools from an architect's concept all the way through to a facility manager's daily maintenance schedule.

### The Problem is Paper-Based Processes

The traditional approach to construction, which many teams still follow, is to work from 2D paper drawings. They also refer to printed spreadsheets, schedules, and reports for team communication, causing information to be filtered and lost.



This filtering prevents stakeholders from visualizing their specialized tasks in the context of the complete structure. Working with a 3D Tekla Structures model, each team member's data is shared collaboratively in a common repository, enhancing the team's collective understanding of project progress.

Project managers have told us that fifteen minutes with a 3D model provides a more thorough understanding of a structure than poring over 2D drawing sheets for weeks.

### Design, Constructible Models, Fabrication, and Construction

In summary, the constructible process involves:

1. Creating and acquiring design information
2. Coordinating and transforming it into accurate, constructible information for downstream use
3. Delivering constructible information to the shop or the construction site in a timely fashion under pressure

The result is a complete, up-to-date information resource supporting all project phases. It remains relevant throughout the project lifecycle and identifies potential issues proactively.

This improves project delivery in terms of time, cost, quality, and ultimately profitability. Not only is this constructible process already possible, but today's tools from Trimble also make it completely practical to implement.

## Concrete Construction Workflow

Here's an example of how the constructible process can improve productivity at a concrete construction worksite.

### Quantity Take-Off

Tekla software can extract the data contractors need for quantity take-offs and project tenders directly from the 3D model. It also supports budgeting, tracks quantities for ordering and monitors onsite progress.

It can calculate either concrete or steel volumes or both. For concrete structures, Tekla can produce take-offs for formwork, embeds, rebar, and more.

### Scheduling and Logistics

Scheduling directly from one model is an essential principle of the constructible process. Tekla offers detailed daily or weekly schedule reports. It can also calculate pouring schedules based on the detailed quantities derived from the model.

### Pour Planning and Documentation

Tekla simplifies site planning. Project managers can import equipment data from the Tekla warehouse and place equipment based on the quantities required. It can also model virtual onsite cranes.

The system also enables steel erection planning. Project managers can establish pourers using Tekla's pour management solution. The application can also display and manage pour breaks within pour objects.

Tekla supports project management using pour information, enabling users to share pour data with anyone on the project team. The system can generate pour drawings and quantities directly from the model.

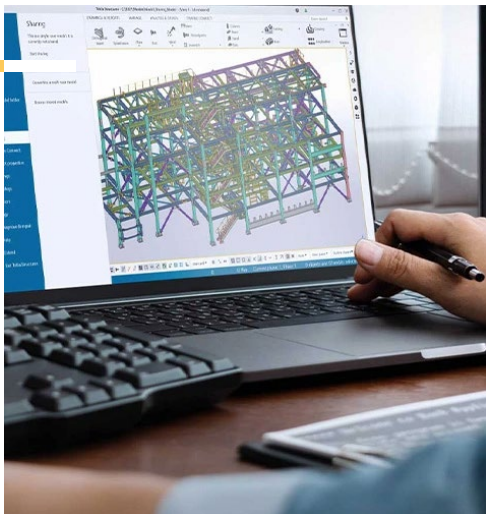
### Formwork Planning and Detailing

Tekla Structures includes built-in tools to automatically generate automated formwork quantity takeoffs. This can include planning detailing formwork.

### Reinforcement Coordination and Detailing

Construction managers can quantify reinforcement needs using formworks. The system can base this on volume and take rebar splices into account, for example.

Teams can use the model to coordinate rebar placement with mechanical, electrical, and plumbing (MEP) trades or other stakeholders. Tekla Structures is the leader in rebar placement applications.



### Anchor Bolt, Embed and Trade Coordination

Within Tekla Structures, managers can import embeds and anchor bolts from other project team members such as steel fabricators. If the steel fabricator uses Tekla, the teams can share the data directly. Alternatively, Tekla can import and exchange models from other applications to identify anchor bolts and embeds.

### Construction Layout and 3D Scanning

Tekla software provides tools for detailers to enter layout points. Onsite teams can then export them into scanning total stations, simplifying site survey tasks.

To create as-built plans, teams can import points from the worksite by scanning the interior structure and verifying locations based on visible objects. Those 3D laser scans can then produce a 3D as-built model.

### Project Status Management

Tekla includes a complete toolset for communicating project status to all project stakeholders using one digital 3D model as the source of truth for the entire project.

### The Trimble Difference

The fundamental advantage of Trimble's constructible process lies in the distinction between conceptual versus constructible BIM applications. Conceptual building models lack the level of detail needed to enable the complete design, build, and operate phases of the construction lifecycle.

Constructible models contain features like accurate geometries and pours created with the patented Tekla pour technology. For concrete structures, for example, these models display reinforcement, formwork, and layout points.

Regardless of the construction type, Trimble is committed to a building information modeling process that all stakeholders can use at any phase of the design, build, and operate lifecycle of any structure.

Contact BuildingPoint Canada today to discuss how the constructible process can help your business deliver construction projects more efficiently, profitably, and accurately.

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