Pain Points in the Use of Big Data Analytics for Transportation Project Delivery

Transportation Research Board Webinar

Sub-Committee on Information Systems in Construction Management

Amlan Mukherjee, Ph.D., P.E.

Associate Professor, Civil & Environmental Engineering

Michigan Tech University

Panelists

Ron Perkins,
President, Jobsite Tech Group
Kelley Severns,
Bridge Engineering Research Lead,
WSP | Parsons Brinckerhoff is now WSP
Ches Maier,
Principal Consultant, Fair Cape Consulting
Pei Tang and Umesh Jois
Project Controls Manager, JCMS Inc.

Background & Objectives

- Significant progress in the area of transportation digital project delivery
- How can we critically analyze current methods to:
  - Identify unresolved pain points
  - Significantly add value to future projects.
- The speakers will analyze project experiences through the lens of big data analytics,
  - Identify opportunities presented by better organizing and analyzing digital project delivery data,
  - Developing intelligence that can improve decision-support for complex projects

TRB
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

INNOVATIONS FOR CONSTRUCTION

SUPPORTING INFORMATION MOBILITY | IoT | BIM

RON PERKINS

PRESIDENT | JOBSITE TECH GROUP

SPONSORED BY:

REGULATED INDUSTRY

SYNNEX GOVSolv REGULATED INDUSTRIES

JOBSITE TECH GROUP

The National Academies of SCIENCES ENGINEERING MEDICINE

BIO

Ron Perkins

President | Jobsite Tech Group

BUSINESS

- JOBSITE TECH GROUP, LLC
- CONSTRUCTION MARKET DATA (CMD)
- ARCHITECTS FIRST SOURCE
- AUTODESK | BUZZSAW
- NRI (NOW BLUEDGE)
- CONSULTANT FOR:
  - HP
  - SYNNEX
  - DROPBOX
  - SMARTVID.IO
  - SAMSUNG
  - SHARP

SPEAKER

- AUTODESK UNIVERSITY
- ENR CONSTRUCTION FUTURETECH
- AGC IT FORUM
- AGC BIM FORUM
- TRB
- USMCA
- SYNNEX RED, WHITE & YOU
- AIA
- ABC
- TEXO
- ORACLE
- MERIDIAN

EDITORIAL | RESEARCH

- DESIGN INTELLIGENCE
- BUILDING DESIGN AND CONSTRUCTION
- ENR
- CONSTRUCTION EXECUTIVE
- COMMERCIAL CONSTRUCTION RENOVATION
- AEC CAFÉ’
- DIXIE CONTRACTOR
- CALIFORNIA BUILDER & ENGINEER
- NEW ENGLAND CONSTRUCTION
- CONSTRUCTIONEER
- TEXAS CONTRACTOR
- CONSTRUCTION NEWS

JOBSITE TECH GROUP

CONSTRUCTION

Innovation is Anything But Business as Usual

JOBSITE TECH GROUP

UAVs

Cameras

BIM Box

Print/Scan

Asset Tracking

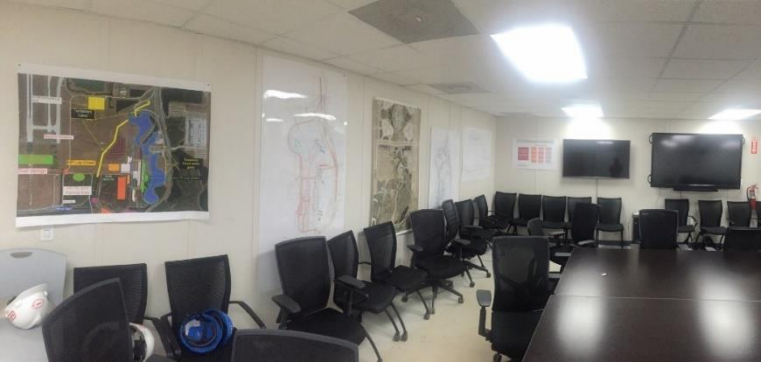
Electronic Plan Table / Whiteboard

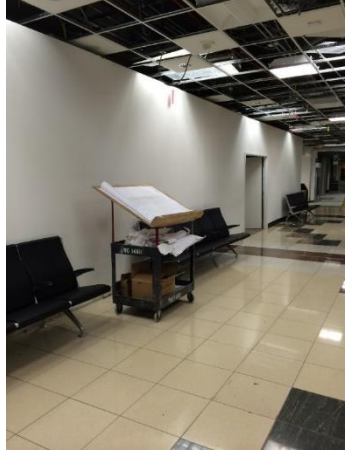
Ruggedized Portable Devices

Wearables

3D Scanner

AR/VR





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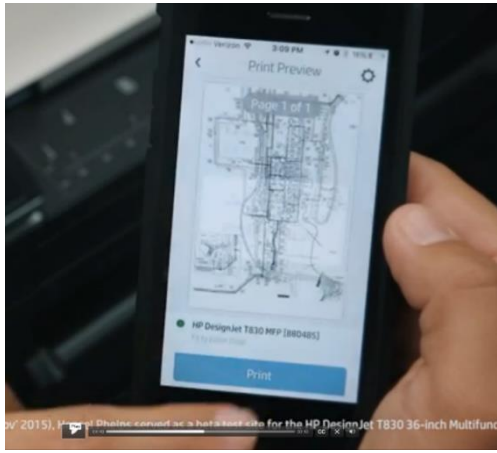

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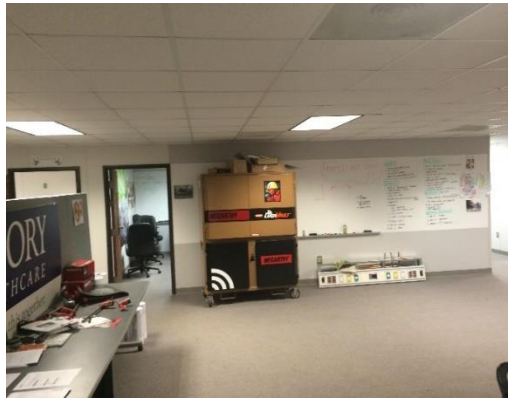
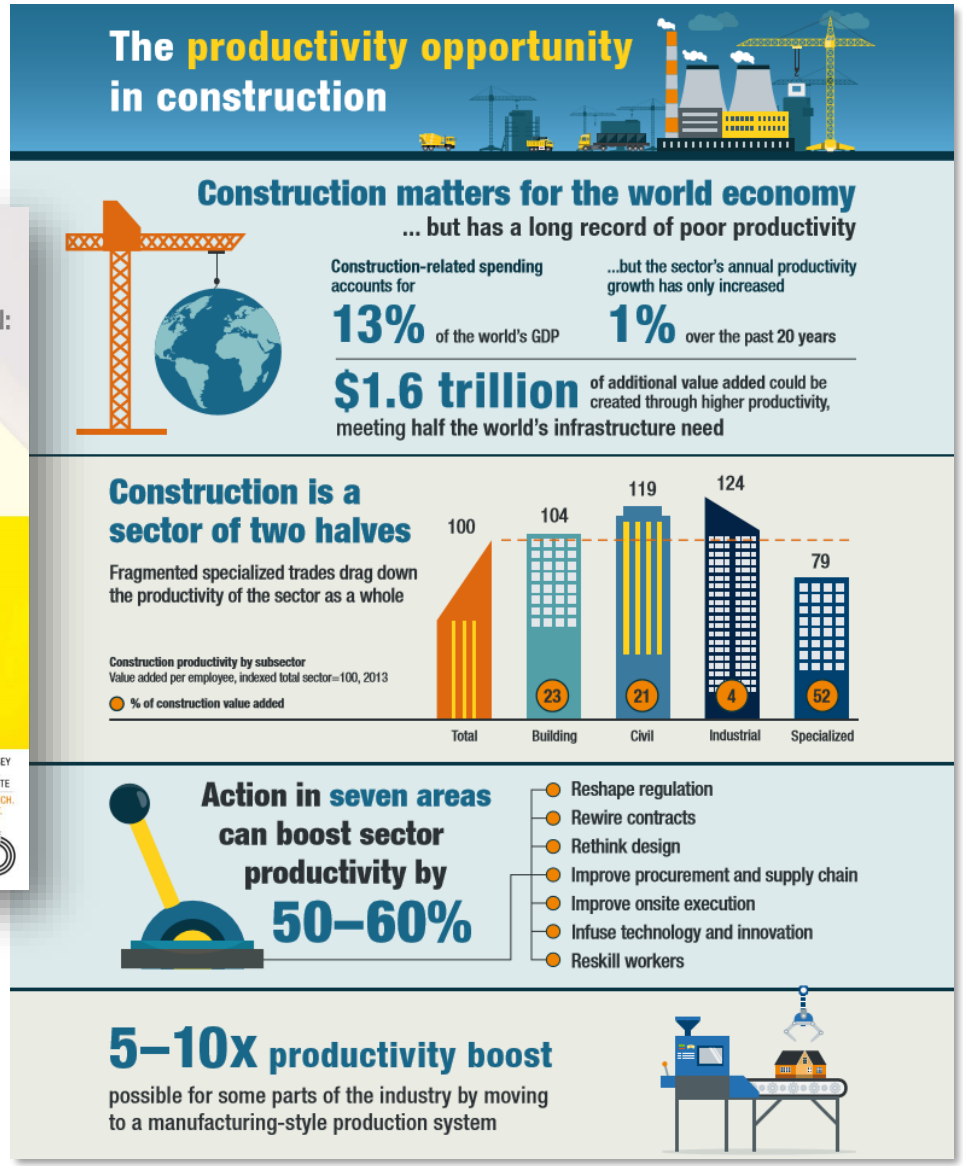


JOBSITE TECH GROUP

McKinsey&Company



DESIGNS ARE **CHANGING**

PRE-FAB IS **AFFECTING SUPPLY**

TECHNOLOGY IS **BEING DEPLOYED**

BIM & VDC IS **BECOMING A STANDARD**

JOBSITE TECH GROUP

McKinsey&Company

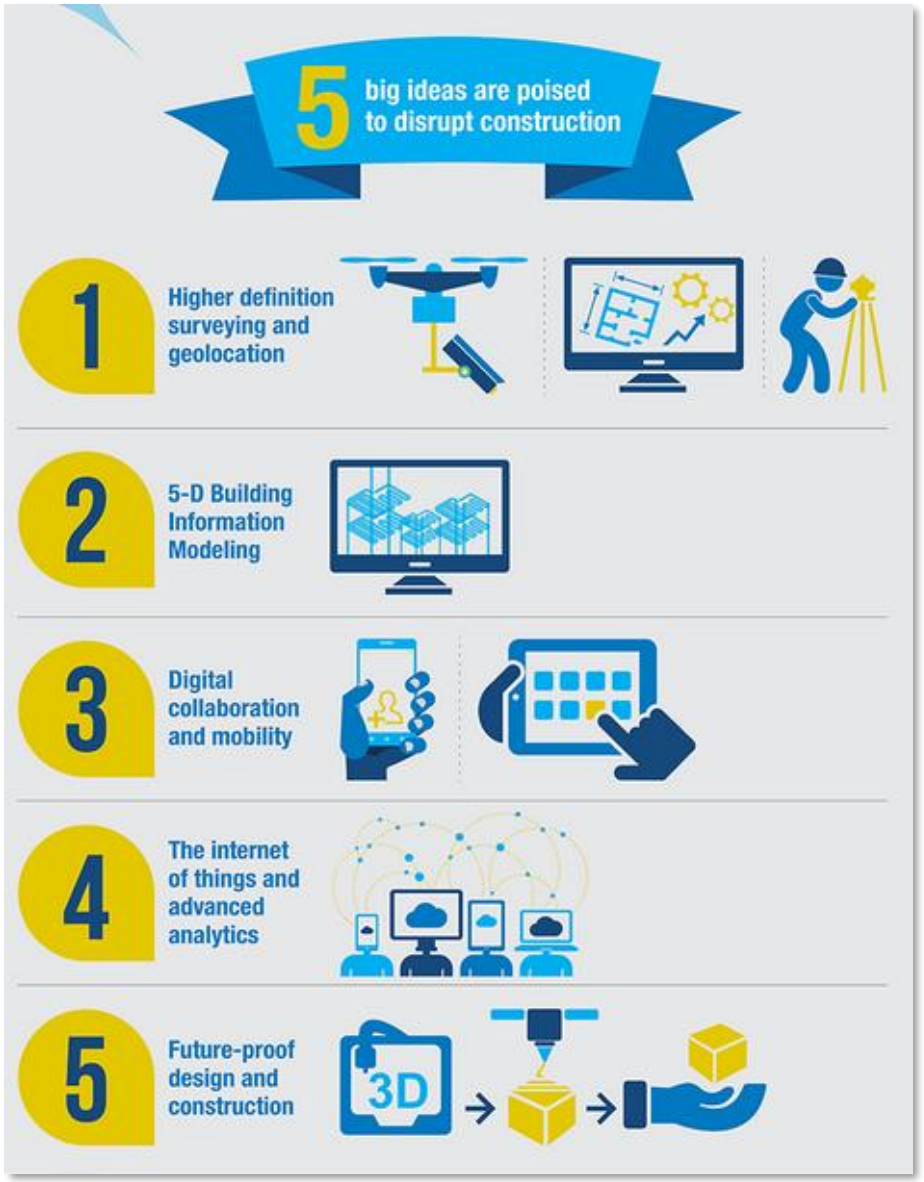
DRIVERS OF CHANGE

PROJECTS TAKING **20% LONGER TO COMPLETE**

BUDGETS ARE **EXCEEDED 80%** OF THE TIME

R&D SPENDING LAGS **BEHIND < 1%**

TECHNOLOGY IS THE **TOOL**



JOBSITE TECH GROUP

Q4 2018

COMMERCIAL CONSTRUCTION INDEX

U.S. CHAMBER OF COMMERCE

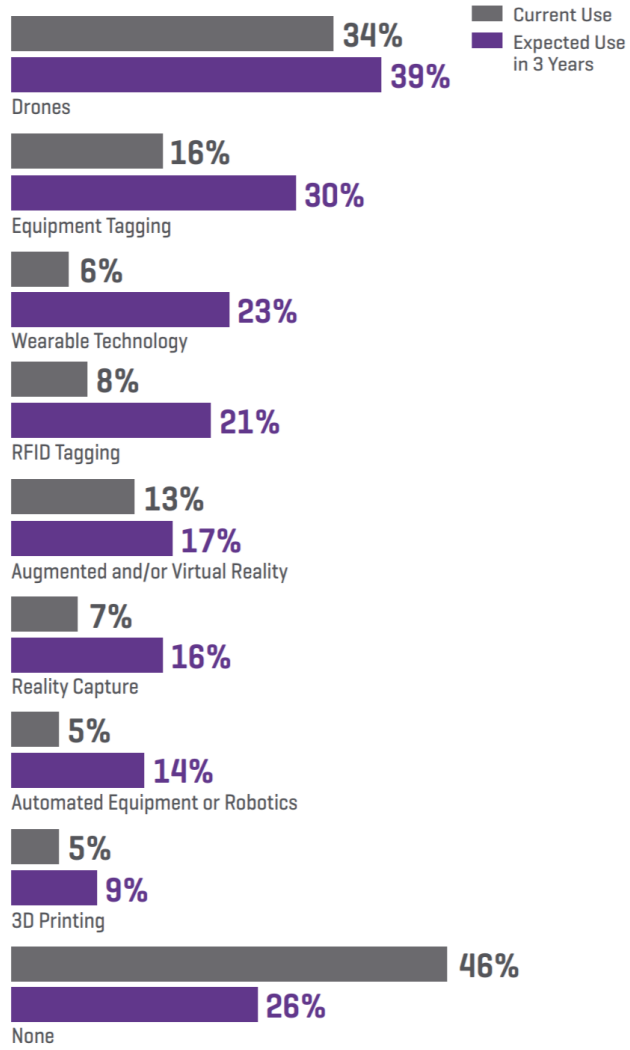
DODGE DATA & ANALYTICS

CURRENT USE OF ADVANCED TECHNOLOGIES BY CONTRACTORS

This quarter, contractors were asked about the use of advanced technologies in their construction projects. Over half (54%) of contractors report that they have used at least one of these technologies on their jobsites, with drones selected as the most widely used technology in this survey. Nearly three-quarters (74%) of contractors expect to adopt one or more of these technologies in the next three years.

Contractors indicated which technologies their companies were most likely to adopt in the next three years. Notably, all of the technologies included in the survey are expected to grow in use. Respondents expect drones, equipment tagging, wearable technologies and RFID tagging to be most widely adopted, with the use of wearables expected to increase by the greatest amount. These findings suggest that the commercial construction industry is beginning to embrace many of the emerging technologies available in the marketplace.

Current and Expected Future Use of Advanced Technologies Onsite by Contractors



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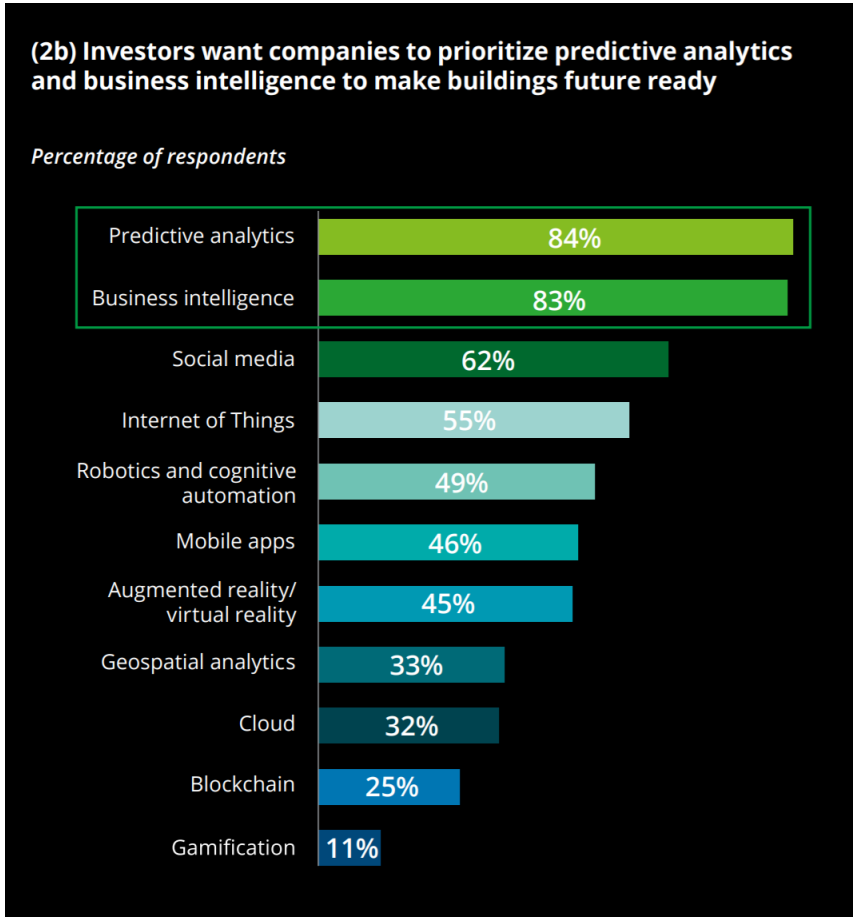
Deloitte.

2019 Commercial Real Estate Outlook

Agility is key to winning in the digital era



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A COUPLE YEARS AGO…

Goldman Sachs

…VR market will generate $110 billion dollars compared to TVs $99 billion in 10 years.

Source: Goldman Sachs Global Investment Research, IDC

BUILTWORLDS

VR and AR promise to transform AEC, but for many firms it's still out of reach

ARCHITECT

THE JOURNAL OF THE AMERICAN INSTITUTE OF ARCHITECTS

…virtual reality, human-to-machine collaboration, and wearable technologies will integrate into the building industry.

Source: Autodesk University 2015 Bets on the Augmented Age

National Institute of BUILDING SCIENCES
An Authoritative Source of Innovative Solutions for the Built Environment

Technology, including BIM, virtual and augmented reality, gaming, and 3D printing provide a wide range of opportunities to improve productivity throughout the project lifecycle, as well as attract new talent to the industry.
http://facilityexecutive.com/wp-content/uploads/2016/01/TacklingProductivity.jpg

RedVector
Online Education for Design and Construction

Virtual Design and Construction (VDC) processes deliver…

- **50% time-savings in the design document phase**
- **80% reduction in time to complete cost-estimate**
- **60% fewer Requests-for-Information (RFIs)**
- **7% schedule savings**
- **600 total days direct schedule reductions**
- **Productivity increases of 25% or more**
- **2.95% average direct cost reductions**

Source: Top 5 Emerging Technologies for 2016 in Engineering & Construction by Red Vector

CONSTRUCTION BUSINESS OWNER
THE LEADING BUSINESS MAGAZINE FOR CONTRACTORS

As an industry of professionals specializing in the design and construction and operations of a physical, spatial environment, we are uniquely suited to master this new virtual, spatial environment. **If you haven't begun to embrace these tools and embed them in your operations, what are you waiting for**?

CONSTRUCTION EXECUTIVE

TECH TRENDS

"momentum will continue to mount around cloud-based enterprise applications in 2016, according to a new survey of CIOs and other tech leaders."

engineering.com

The Internet of Things, blockchain, robotics, 5G Internet, quantum computing—these are all advancing individually, and increasingly overlap with one another.

DesignNews

Drones are leveraging artificial intelligence and machine learning to find a stronger foothold in construction and other enterprise markets.

CNBC

Drone use is skyrocketing in construction work, at a rate even higher than agriculture and manufacturing, data shows. **Construction drone usage has skyrocketed by 239 percent year over year**

Redshift by AUTODESK

In the future, not only will IoT devices be used on the construction site, but they'll be used throughout the building operations to give us continued insights on how that building is performing. There's so much opportunity for IoT to support construction safety, quality, efficiency, productivity, and sustainability.

BUILDING DESIGN + CONSTRUCTION

"The vision of the AR cloud will come to fruition in the next five to seven years," says Adamek. **"A virtual copy of everything on earth, including buildings, will be scanned and converted into 3D.** All of this 3D will make up an entire, new virtual world that will be available for billions of users to step into via their persistent mobile connections."

constructconnect®
Powering connections. Improving results.

While there may be some attrition in the future, the most likely scenario is that **robots will be used alongside human workers to augment their work**, keep them safer and boost productivity. The current capabilities of existing robot combined with a growing labor shortage will probably lead to robots handling some of the more menial repetitive tasks, leaving the human worker to focus on other aspects of their job.

CAT

DRONES IN CONSTRUCTION:
NOT JUST THE LATEST TECHNOLOGY, BUT A BUSINESS TOOL

JOBSITE
TECH GROUP
SOURCE: Dodge DATA & Analytics - ICA

JOBSITE
TECH GROUP
SOURCE: Dodge DATA & Analytics - ICA

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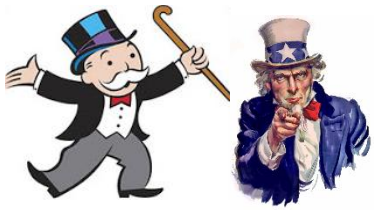
COMMUNICATION

COLLABORATION

COORDINATION

INTEROPERABILITY

PROJECT TEAM



Owner

Manufacturer

Architect

Distributor

Engineers

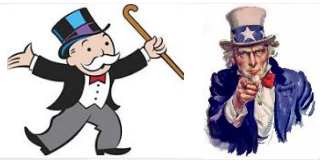
Supplier | Reseller

Subcontractors

General Contractor

JOBSITE TECH GROUP

PROJECT TEAM



Owner

- On time
- On/under budget
- Efficient
- Sustainable
- Low maintenance
- Comprehensive As-Builts

Architect

- Capture client vision
- Design details
- Specify products
- Meet codes
- Collaboration
- Flexibly enforce standards

Engineers

- Building integrity
- Code compliance
- Coordinated systems
- Energy efficient
- NEW technologies (IoT)

General Contractor

- Achieve Scope of Project
- Control Budget & Schedule
- Manage Subs & Safety
- Minimize Change Orders
- Deliver project on time
- Comprehensive project handover

Subcontractors

- Stay on schedule & budget
- Order building products
- Coordinate with GC and others
- Adopt BIM practices if needed
- Use NEW tech-tools & services
- Install NEW technologies

Supplier | Reseller

- Support sales process
- Handle - PO, Invoice & Delivery
- Provide install or training on specialized products
- Stay current on AEC tech – BIM, IPD, Pre-Fab, UAV, Scanning

Distributor

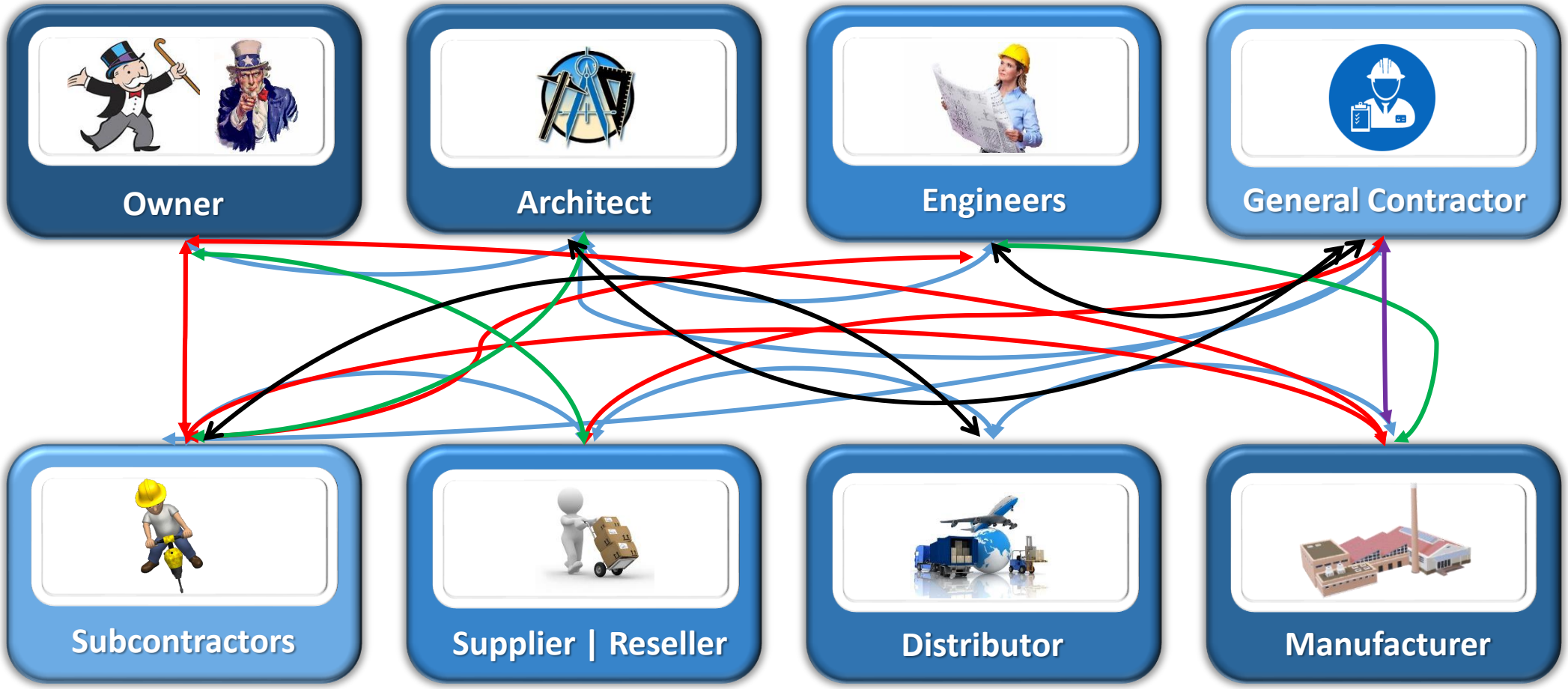
- Pricing and Promotions
- Support VAR channel
- Training on new products and services
- Provide sales tools
- Logistics

Manufacturer

- Innovative products
- Sustainable designs
- Proper Go-To-Market
- Support BIM and other tech
- Educate Owners / Developers
- Pre-Fab R & D

JOBSITE TECH GROUP

PROJECT TEAM



COMMUNICATION | COLLABORATION | COORDINATION | INTEROPERABILITY

INNOVATION

JOBSITE TECH GROUP

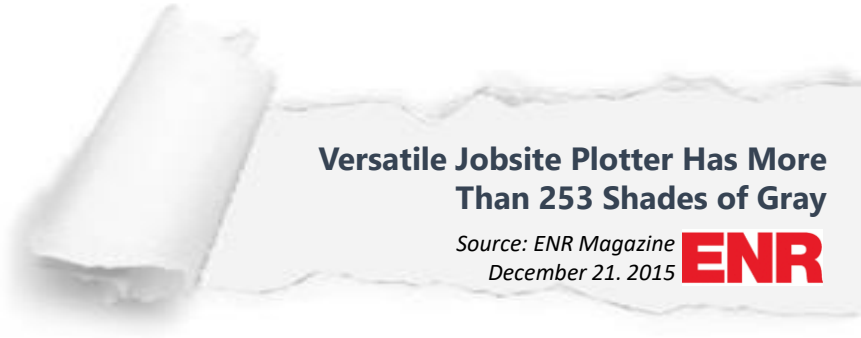
PRINT | SCAN | COPY | SHARE

HP DesignJet MFP solutions solve some of the toughest challenges in the construction industry. Stay up-to-date and focused on building with the complete portfolio of products from HP. Designed to fit your unique requirements, printing, scanning solutions and accessories, like the HP DesignJet Rugged Case make it easy to transport and protect your MFP from onsite damage.

"The HP DesignJet T830 printer enables us to scan and print virtually anywhere we choose, which frees up a lot of resources and helps us work more efficiently. It is currently sitting in a dusty trailer but that less than ideal environment hasn't affected its performance. Compared to some of the plotting devices we have used in the past, which needed serious effort to move, it's night and day. This machine is truly portable."

Maurice Clarke
Virtual Design and Construction Manager

Hensel Phelps Construction Co.



Versatile Jobsite Plotter Has More Than 253 Shades of Gray

Source: ENR Magazine
December 21. 2015
ENR

JOBSITE TECH GROUP

PRINT | SCAN | COPY | SHARE

"A lot of our markups that we will do in Bluebeam for example it is very helpful to have that in color….comments from the architect in green, you've got comments from the contractor in red, you got comments in blue from the engineer…**to be able to print in color is very helpful… Its very important to have that ability to print be able right there onsite**, it really helps minimize the time it takes to get an updated submittal…"

O'NEAL THE BUSINESS OF PROJECT DELIVERY

Jason Jones, Technology Director
O'Neal, Inc.

"There was a definite benefit of being able to get one sheet, one pertinent bit of information, whether it was a plan or a detail or a section whatever the case may be. **Being able to print that on the spot** the most up to data from our Bluebeam PDF session. That was a very good benefit to have and it was received very well…"

HENSEL PHELPS Plan. Build. Manage.

Maurice Clarke, Virtual Design and Construction Manager
Hensel Phelps Construction Co.

"The majority of the subs still build off of their shop drawings at the end of the day which is produced from the model but its paper drawings that they are producing from the model that they're building off of."

BATSON-COOK CONSTRUCTION

Jason Waddell, Director of Construction Technology Development
Batson-Cook

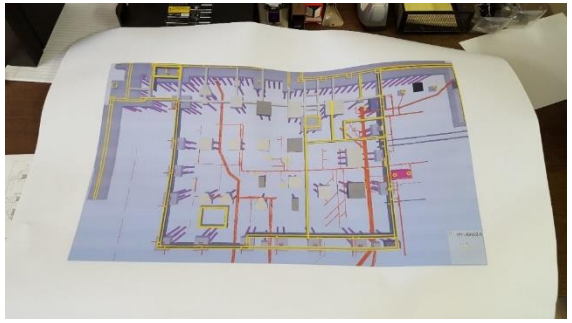
"There are times where there are particularly tough areas where its easier just to print out that view or a couple of views there and get around the group and they can easily mark it up."

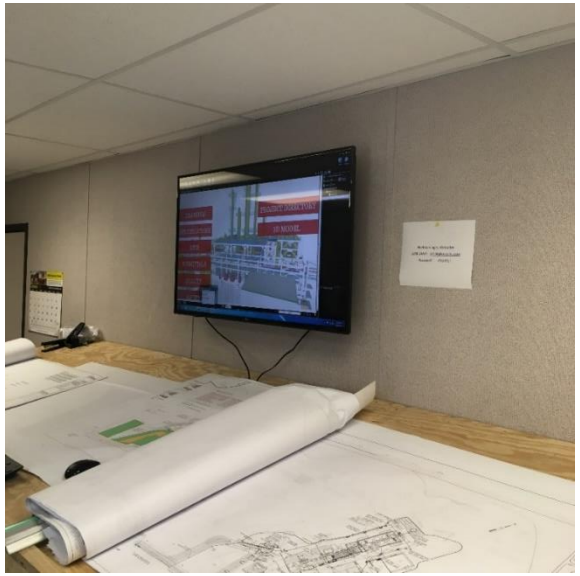
YATES CONSTRUCTION

Benjamin Crosby, Director of BIM / VDC
W.G.Yates & Sons Construction

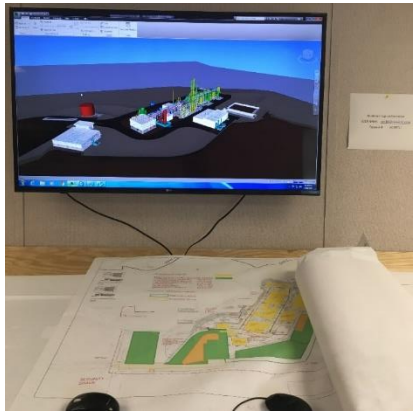
JOBSITE TECH GROUP

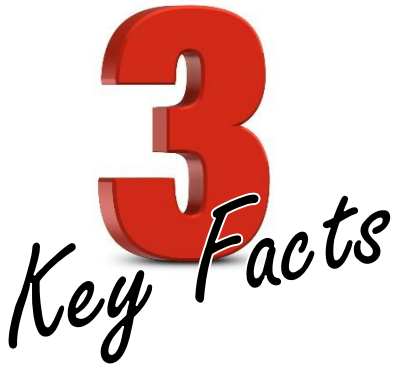
PRINT | SCAN | COPY | SHARE





- Printing BIM models for better collaboration
- Scanning marked up models to send to BIM Manager for Revit® modifications
- Printing in color supports LEAN and reduces latency on the jobsite!
- **INSTANT PRINT AND THE TARGETED PRINTING SUPPORTS THE BIM PROCESS AND KEEPS US INTO IT**





1. Print on demand is the new normal
2. HP and others are embracing the digital workflow in product design
3. Print/Scan incorporated into digital workflow shortens RFI roundtrip

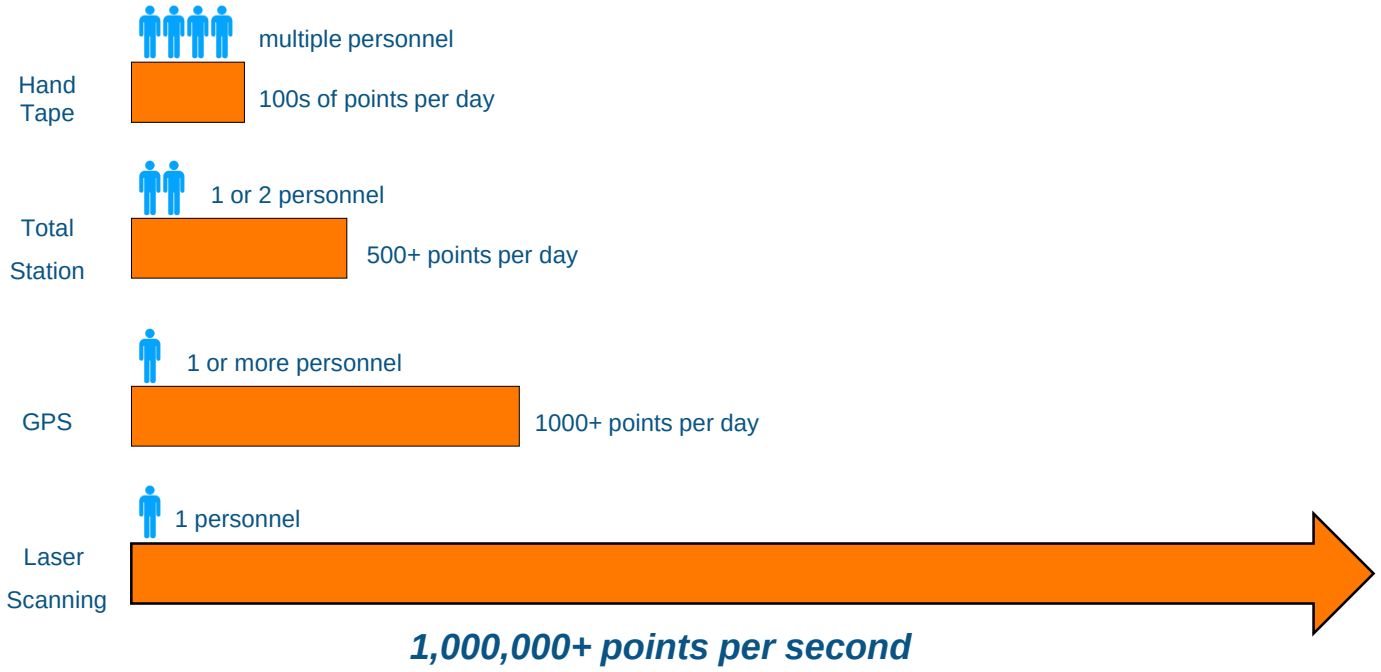
JOBSITE TECH GROUP

SCANNING | AS-BUILT | VERIFICATION | ARCHIVE

"A lot of this wouldn't happen at all without scanning and 3D models. True, it's exactly what surveyors have been doing for a long time, gathering 3D coordinates, *but what we have now is a system and method that can collect all these 3D data points incredibly quickly*. We're solving the same problems—defining shapes and surfaces—but we're doing it a heck of a lot quicker, and in a way that is perceived as exciting."

Simon Barnes, RICS,
CEO of Plowman Craven

3D Scanning Technology permits **precision measurement**, imaging and comparison for production and **quality assurance** in the design, building and restoration industries. **Inspections**, planning or **documenting structures in 3D**, laser measurement technology allows companies to maximize efficiencies and improve processes.


multiple personnel
Hand
Tape
100s of points per day
1 or 2 personnel
Total
Station
500+ points per day
1 or more personnel
GPS
1000+ points per day
1 personnel
Laser
Scanning
1,000,000+ points per second

JOBSITE TECH GROUP

SCANNING | AS-BUILT | VERIFICATION | ARCHIVE

VERSATILE

PORTABLE

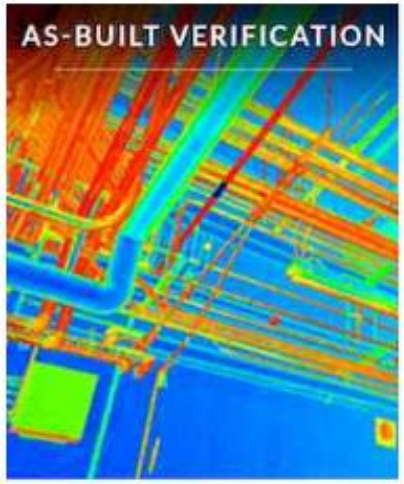
ACCURATE

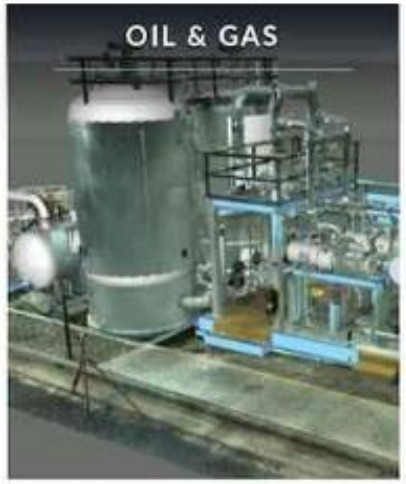
USER-FRIENDLY

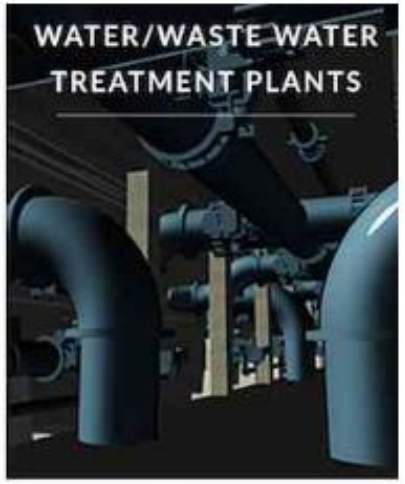
- **Rapid**, **simple** and **complete** recording of the current status of buildings and building sites.
- **Millimeter-accurate measurement** of large environments and objects in only a few minutes
- **Immediate processing** of the data in all commonly used CAD programs.
- Simple **variance comparison** in the construction process and in the case of final building inspections.
- Greater **transparency**, greater legal certainty in claim management.
- **Data is available for the entire building lifecycle.**

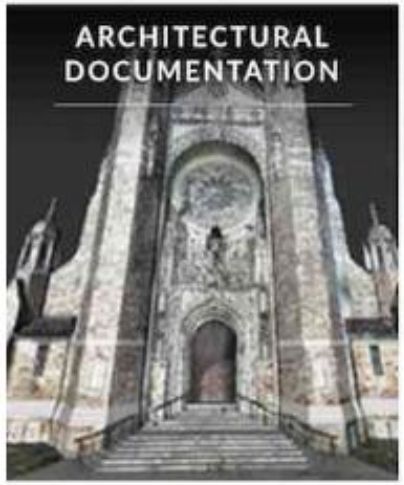
JOBSITE TECH GROUP

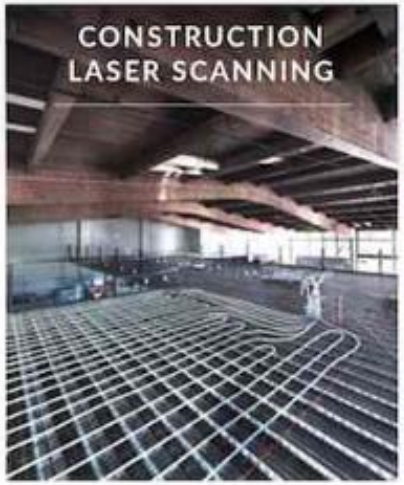
SCANNING | AS-BUILT | VERIFICATION | ARCHIVE

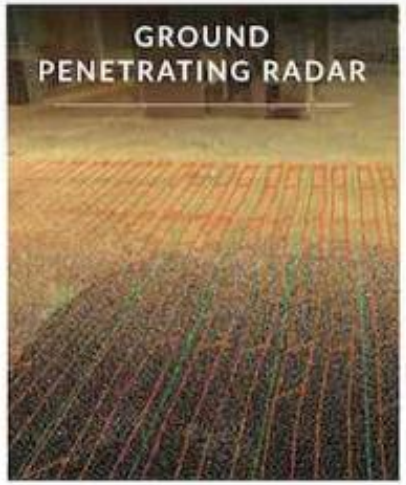


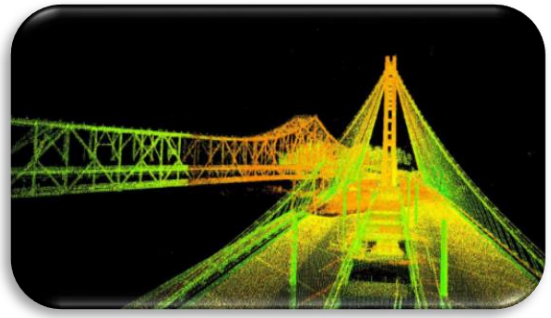


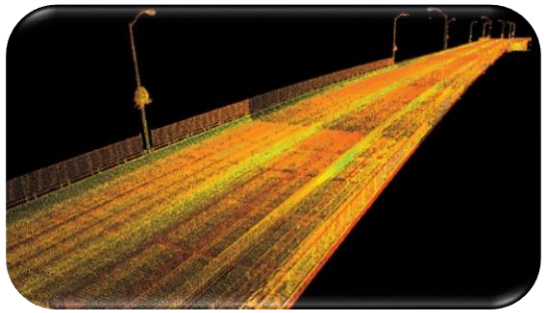


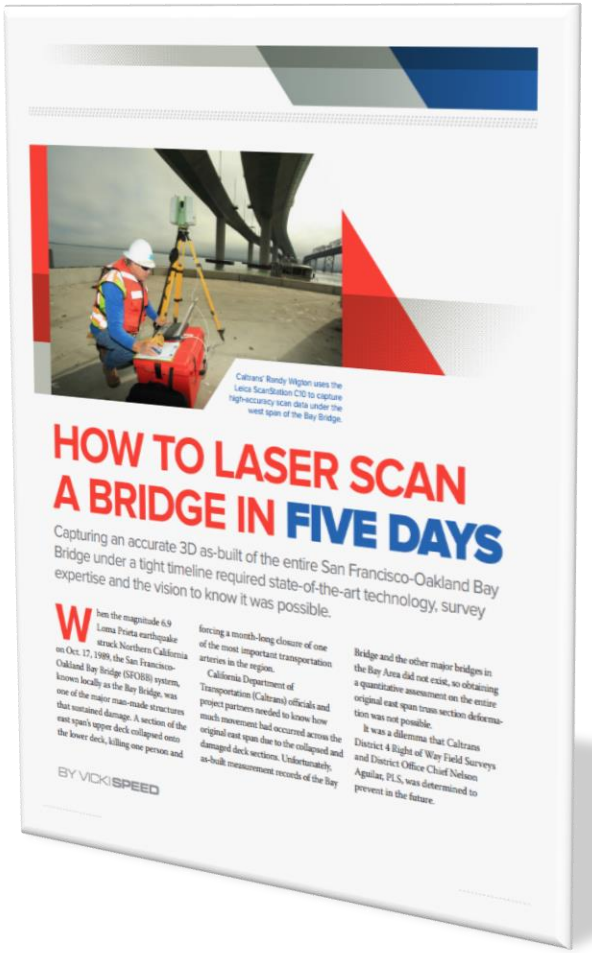












Intel Flies Drones for Bridge Inspection

According to Intel, the aerial survey made the survey far quicker and less expensive. The Stone Arch inspection saw a **cost savings of approximately 40 percent**, and across both projects, the drone inspection **reduced overall workhours by 28 percent**. (Read More)

Trimble®

Leica Geosystems

TOPCON

FARO®

Surphaser

JOBSITE TECH GROUP

SCANNING | DISRUPTION

Leica Geosystems

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)

VR has captured the imagination of architects seeking the ultimate experience for design and creation. Likewise, AR has captivated contractors, seeking the "ultimate stud-finder" to assist in layout and inspections.

Unlike VR, which fully immerses participants in an artificial environment, AR enhances the experience of the real world by incorporating contextual information when and where it is needed. **AR will be more integrated into our everyday lives than VR, and a much larger market opportunity in construction and facilities maintenance.** The sweet spot for AR lies at the intersection and overlay of domains of information.

CONSTRUCTION BUSINESS OWNER
THE LEADING BUSINESS MAGAZINE FOR CONTRACTORS

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)

PHYSICAL MOCK-UP
12 WEEKS

VIRTUAL MOCK-UP
2 WEEKS

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)

"Manipulating large and complex Revit® files to convey critical information pertaining to a high profile, mega project can be a daunting task. Utilizing visualization tools such as Samsung Gear VR, VIMaec™, and Unity enabled our project team to communicate more effectively, collaborate in a virtual environment, and minimize project delays - therefore minimizing cost impacts."

Alexa Malusky
Virtual Design and Construction Engineer.

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)

"We use VR to communicate with our project staff and the owner on how we are building the job, The value of augmented reality is being able to take the model in the field," "You can see the work that is real and virtual overlaid on top of each other. **We can identify scheduling, coordination and production impacts**."

Brian Krause
Director of Virtual Design and Construction
Clark Construction

"It's powerful and adds another dimension to the way in which we can de-risk the project," "**Pixels are cheaper than bricks**."

Chris Mayer
Chief Innovation Officer
Suffolk

"Some benefits accrue to the client, because they have a better sense of the structure they will have when it's done, but other benefits accrue to the contractors and engineers,"

Jim Dray
Chief Information Officer
Thornton Tomasetti

"Our biggest clients are requesting to have VR on their future projects – proof enough that it's been a great success. It not only benefits our clients but also benefits our own project teams and estimators."

Wade Martin
Virtual Design and Construction Coordinator
Brasfield & Gorrie

constructor
THE MAGAZINE OF THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AR enables Pepper Construction to understand scale, check placement of mechanical, electric and plumbing or other equipment as a way of assuring quality control and will inspect a site before a concrete pour to check sleeves and imbeds are in place and in the right spot.

Jennifer Suerth
Vice President of Technical Services
Pepper Construction Co.

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)

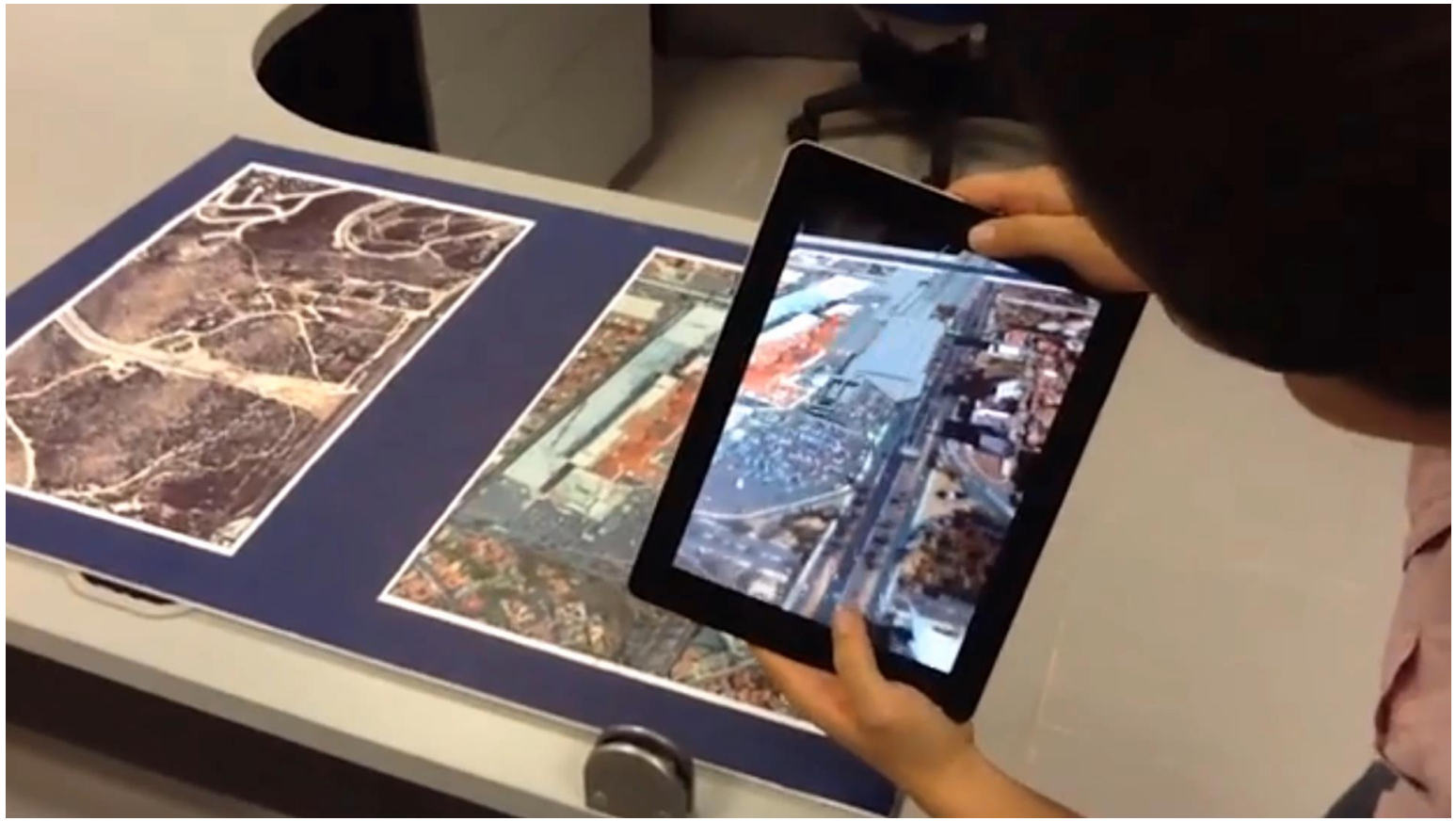
BENEFITS

- Immersive experience
- Realistic presentations
- Free roam walk-throughs
- Easy to Use
- Improves collaboration
- Retains all BIM data
- No need for Revit® to view
- Cloud based
- No file size limits

JOBSITE TECH GROUP

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)

VIRTUAL REALITY (VR) | AUGMENTED REALITY (AR)



BIM in the FIELD

VERSATILE

PORTABLE

ACCURATE

USER-FRIENDLY

BIM is used both for the design of a structure and is very much driving the innovation in the **field of construction**. The “I” in BIM stands for Information. This information is used downstream throughout the project’s lifecycle for planning, designing, analysis, fabrication, construction and ownership.

GCs and CMs have known this for years: the value of a BIM model to them is if they can positively impact downstream processes like coordination, scheduling, estimating, and **field layout**.

What good is a model if it can’t tell the story of project cost, time, and quality?

JOBSITE TECH GROUP

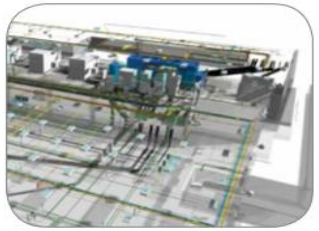
Turner

BIM in the FIELD

The Smart Jobsite: BIM in the Field at Turner Construction Company

Before the Field

Turner Construction Company uses Building Information Modeling (BIM) throughout the life of a project. Starting early in the design phase, Turner works with designers, trade subcontractors, and owners to identify the risk areas on the job and leverage the use of BIM to control that risk. This includes applications such as 3D virtual trade coordination, estimating, scheduling, constructability reviews, and logistics planning. Early planning is integral to the implementation of BIM throughout the rest of the project process.

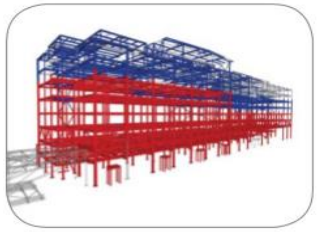


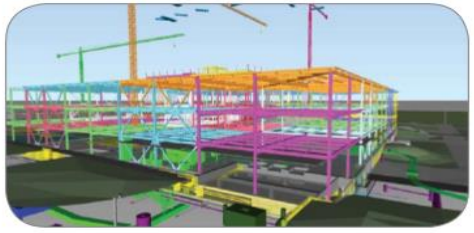
Eliminating Surprises: Laser Scanning to Capture Existing Conditions

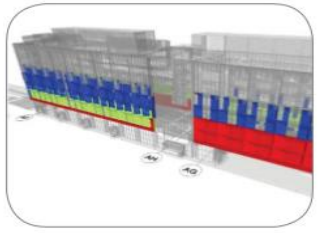
Turner uses laser scanning to capture detailed geometric information about existing conditions and has used the scanning process on 8.5% of all BIM projects to rapidly and accurately produce a model-based representation of existing conditions for the project team. The process often uncovers information about existing conditions, identifying variances from as-built documentation and deficiencies in surfaces not being level or plumb due to settlement or improper placement. This information can be critical for alterations or additions.

Scientific Management of Work: Visual Production Control™

Turner captures jobsite material information in several ways, using tools such as Radio Frequency Identification (RFID) tags and barcodes, and can represent that information visually in digital models for user-friendly, rapid project status updates. Reviewing the steel and curtainwall tracking images below, it is easy for the project team and the owner to quickly understand which materials are on site, in place, or not yet installed. This accurate and up to date record keeping can be used to identify issues with supply lines or rapidly adjust the project schedule.







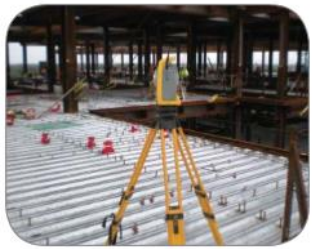
BIM BEFORE THE FIELD

BIM IN THE FIELD

Turner

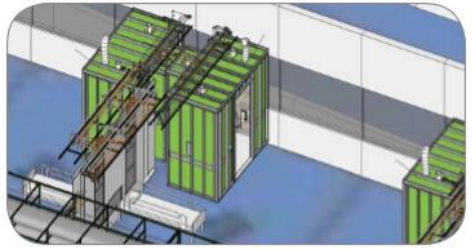
Building in Quality: Model-Based Layout with Robotic Total Stations

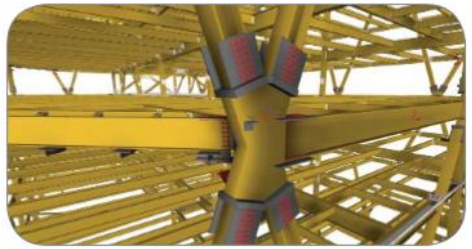
With model-based layout, Turner takes traditional survey methods further and adds precise location coordinates from the model. This helps Turner leverage detailed models built for trade coordination or other purposes and accurately lay out building systems in the field exactly as planned during the 3D model-based coordination process. Model-based layout not only increases the level of layout precision, but also takes less manpower than traditional layout methods. This confidence and trust level is based on a reliance of the accuracy of the BIM model.



Offsite Construction Prefabrication of Systems and Assemblies

The use of BIM enables Turner's subcontractors to prefabricate a wider variety of building systems than was possible in the past. Prefabrication from a coordinated model assures project team members that building elements will be fabricated and installed just as modeled. Prefabrication has other advantages as well; prefabrication work that is completed offsite under controlled conditions improves safely and quality. Building systems that have been pre-assembled can be rapidly installed, requiring less rework than traditional methods.





BIM IN THE FIELD

Turner

KNAACK DataVault™

DataVault™

DataVault™ Mobile

KNAACK DataVault™

PRODUCTIVITY

- Bringing information closer to the work area
- Save time - View Forms, RFI's, Drawings with no travel
- Extend the Trailer – hold coordination meetings and safety briefings at the "BIM" Box

"Placing a DataVault in the work area will guarantee two hours of time savings per day. For each floor you move up you can add an additional 30 minutes of productivity"

Jason Jones | VDC Director | O'NEAL

BIM in the FIELD

Miron’s Ci Hubs are essentially modified gang boxes equipped with a TV monitor, computer, printer, and file-synchronizing software. A complete synchronized system provides the construction team with the building information model and the digital drawing set right where they need it, just in time, and always current. **Crews are trained to use the unit and provide everyone on site (including subcontractors) with increased efficiency due to the ability to not only view plans, sections, and details, but print them!**

BIM in the FIELD

CONNECTIVITY

PRODUCTIVITY

MOBILE

SECURE

- Faster access to the data
- Increased confidence in the build and reduced mistakes
- Improved Building Information Modeling Integration
- Reduced wait times
- Improved durability, security and mobility
- Connectivity
- Productivity - Building Information Modeling (BIM) access directly at the jobsite
- Mobile Work Environment - Reach nearly every job on the construction site during any stage of construction.
- Securing Assets - KNAACK® quality steel box is built to protect against theft and resist jobsite conditions.

For builders, the case for return on investment is straightforward. Drones are cheaper to fly than manned aircraft and faster than human surveyors, and they collect data far more frequently than either, letting construction workers track a site's progress with a degree of accuracy previously unknown in the industry. With the right computing tools, builders can turn sensor data into 3D structural models, topographical maps, and volumetric measurements (useful for monitoring stockpiles of costly resources like sand and gravel). **Collectively, that intelligence allows construction companies to more efficiently deploy resources around a job site, minimize potential issues, trim costs, and limit delays.**

FORTUNE

According to a March 2016 report from Goldman Sachs, **construction will be the largest use case for commercial drones in the immediate future, generating $11.2 billion of the projected $100 billion in global spending over the next five years.**

Goldman Sachs

Preconstruction survey, topographical measurements, project progress, and even as-Designed/as Built become concise and efficient using unmanned aviation solutions. The Yuneec H520 is designed to fly repeatable, perfect-placement flight over construction sites, providing not only measurable and demonstrable project data, but also helping to identify shrink points, at-risk areas, or security breach points.

"We've mapped 1,400 acres of Brasfield & Gorrie job sites. Over the next five years, we hope to use drones on most, if not all, of our 200-plus job sites. People often think of drones and reality capture as a future concept, pie-in-the-sky dream, but at Brasfield & Gorrie we're seeing real value using UAS today."

BRASFIELD & GORRIE GENERAL CONTRACTORS

Hunter Cole
Virtual Design & Construction

YUNEEC

JOBSITE
TECH GROUP

JOBSITE TECH GROUP

THE TECHNOLOGY CONTINUUM IN DESIGN AND CONSTRUCTION

THE OFFICE

THE TRAILER

THE JOBSITE

THE FIELD

FACILITIES MANAGEMENT

THE INTERNET OF THINGS

BAIN & COMPANY

Bain predicts that by **2020 annual revenues could exceed $470B for the IoT vendors** selling the hardware, software and comprehensive solutions.

McKinsey&Company

McKinsey estimates the Internet of Things (IoT) has a potential economic impact of $**2.7-6.2 trillion USD until 2025**

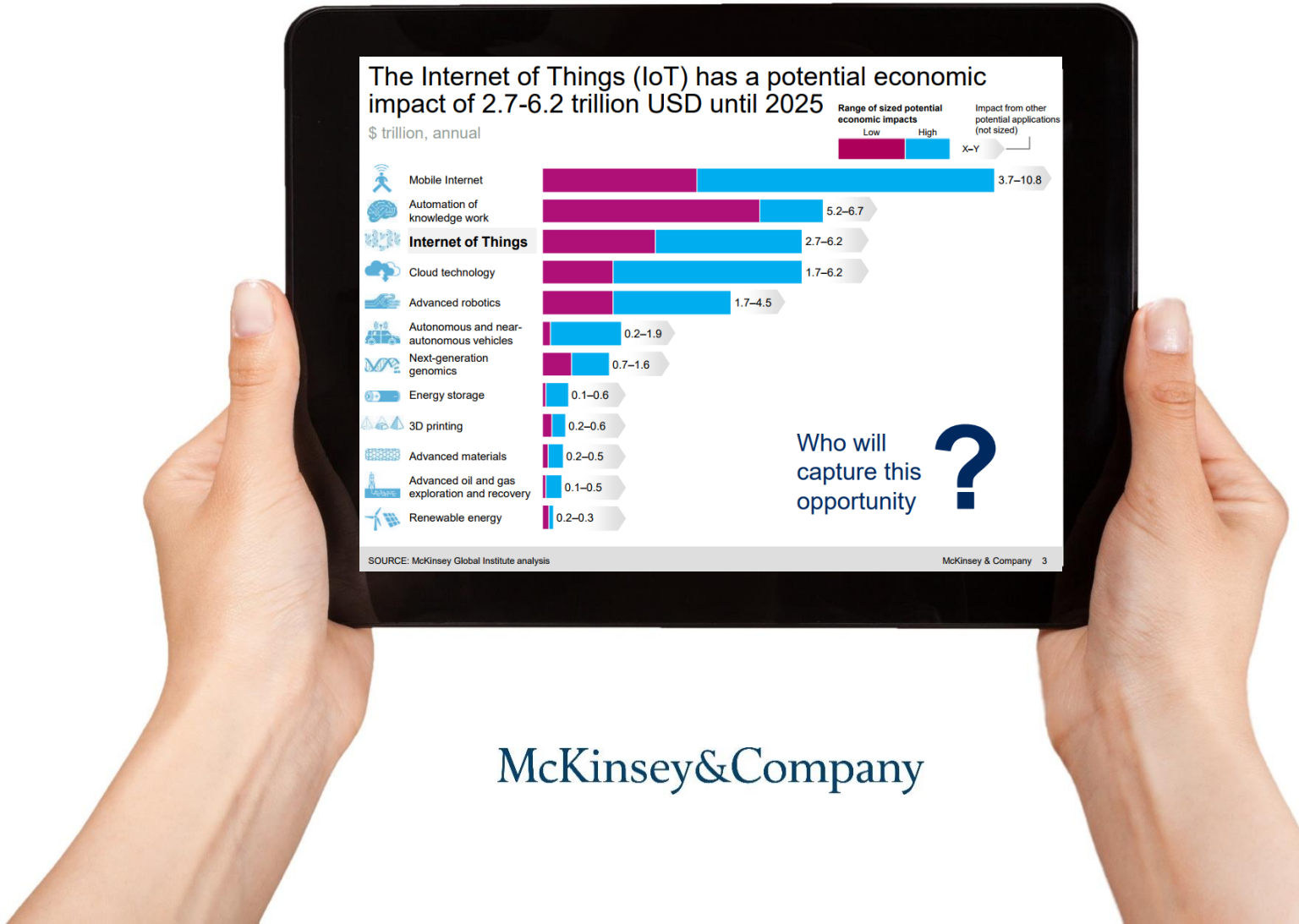
General Electric predicts investment in the Industrial Internet of Things (IoT) is expected to top **$60 trillion during the next 15 years**.

IHS Markit

IHS forecasts that the IoT market will grow from an installed base of 15.4 billion devices in 2015 to **30.7 billion devices in 2020** and **75.4 billion in 2025**

JOBSITE TECH GROUP

THE INTERNET OF THINGS



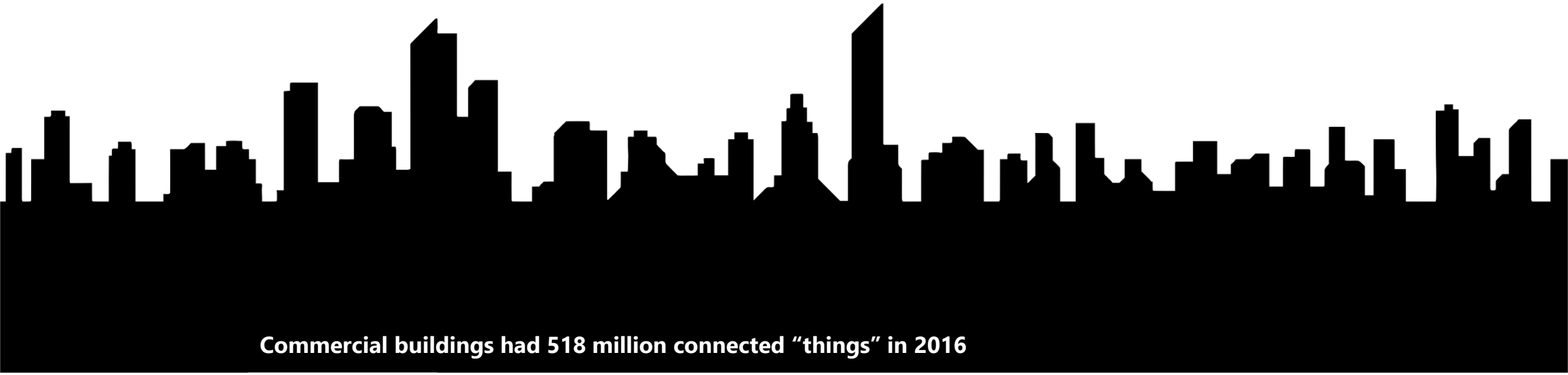
McKinsey&Company

THE LEADERS ALL HAVE IoT STRATEGIES

INNOVATION EXPLOSION

McKinsey&Company

THE INTERNET OF THINGS

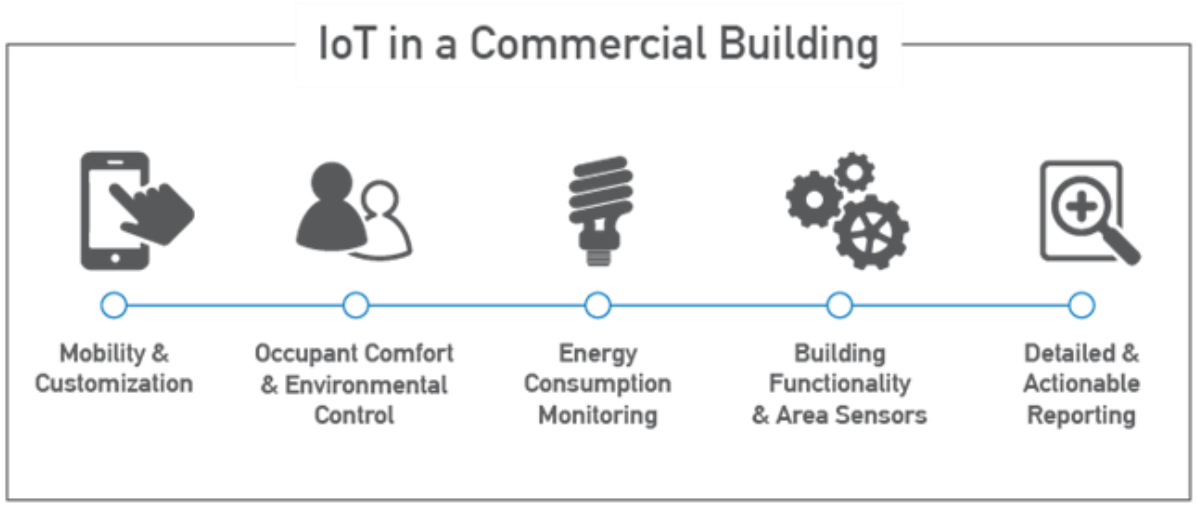


Commercial buildings had 518 million connected “things” in 2016

Gartner

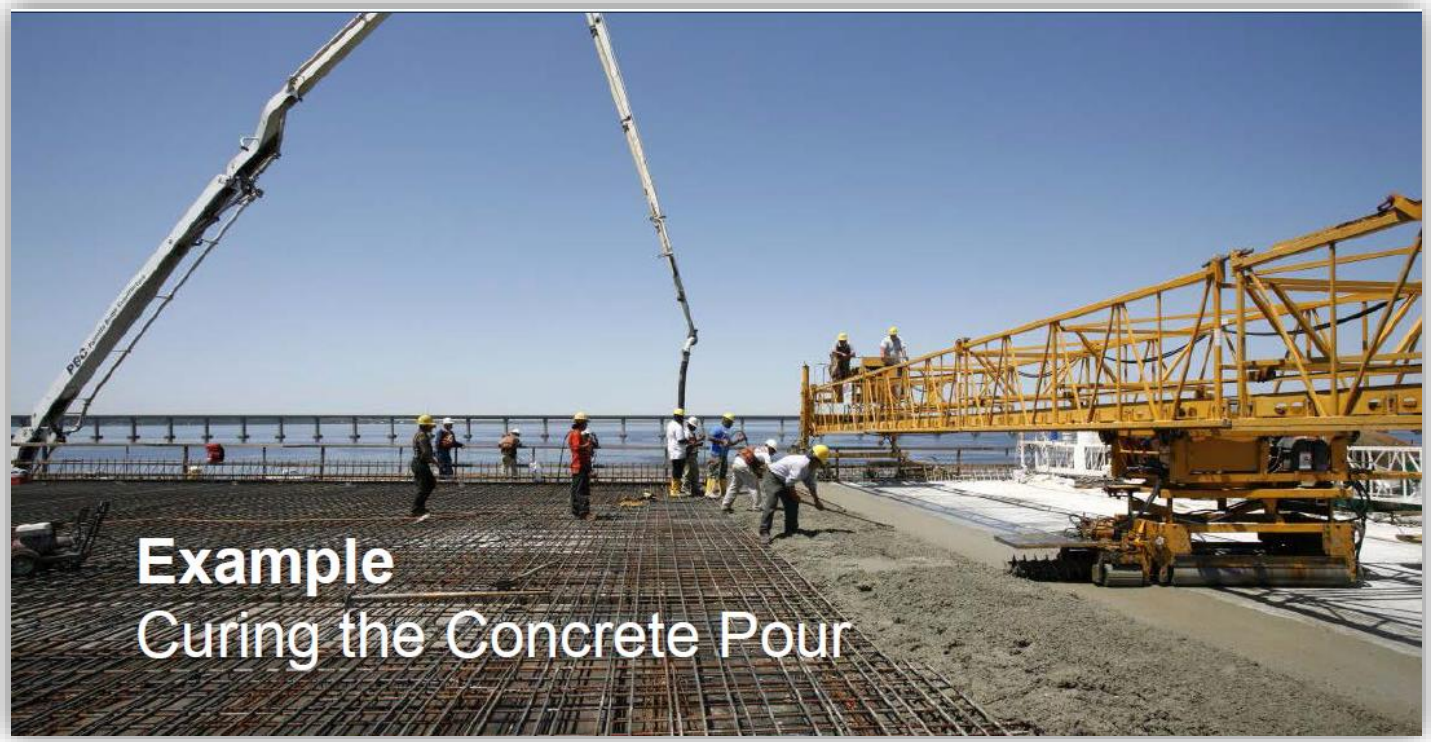
- A building is constructed with HVAC, lighting, security & access, safety, and water management systems that contain sensors for management and tracking
- Facilities managers and owners have access to tools, applications and services that enable monitoring of devices
- Applications and tools create detailed and actionable reports
- Integrates information with company's financial, security and accounting systems
- Facilities managers and owners can pinpoint areas of service, areas for energy improvement and benchmark facility
- Building occupants' experience, more secure systems and more satisfaction with building environment

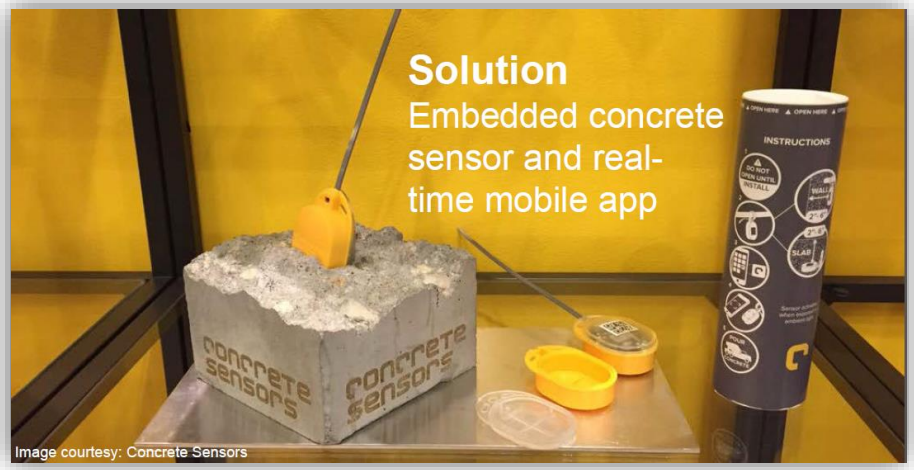
Internet of Things in Construction

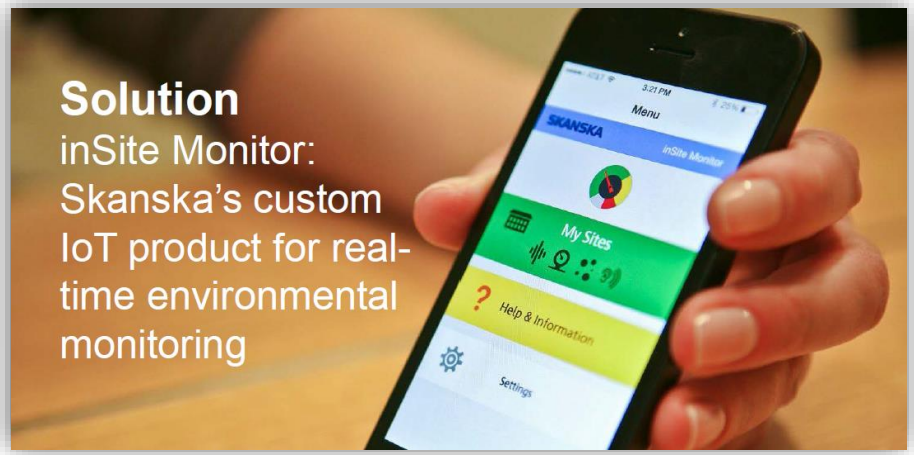

IoT in a Commercial Building
Mobility & Customization
Occupant Comfort & Environmental Control
Energy Consumption Monitoring
Building Functionality & Area Sensors
Detailed & Actionable Reporting

JOBSITE TECH GROUP

THE INTERNET OF THINGS







SOURCE: SKANSKA

The **Smart City sees an even larger adoption with the use of 1.6 billion connected things**.

Gartner

DEVICES | DISPLAYS

INTERACTIVE | PORTABLE

INTERACTIVE TOUCH
MOTORIZED STAND

INTERACTIVE TOUCH

COMMAND | CONTROL ROOM

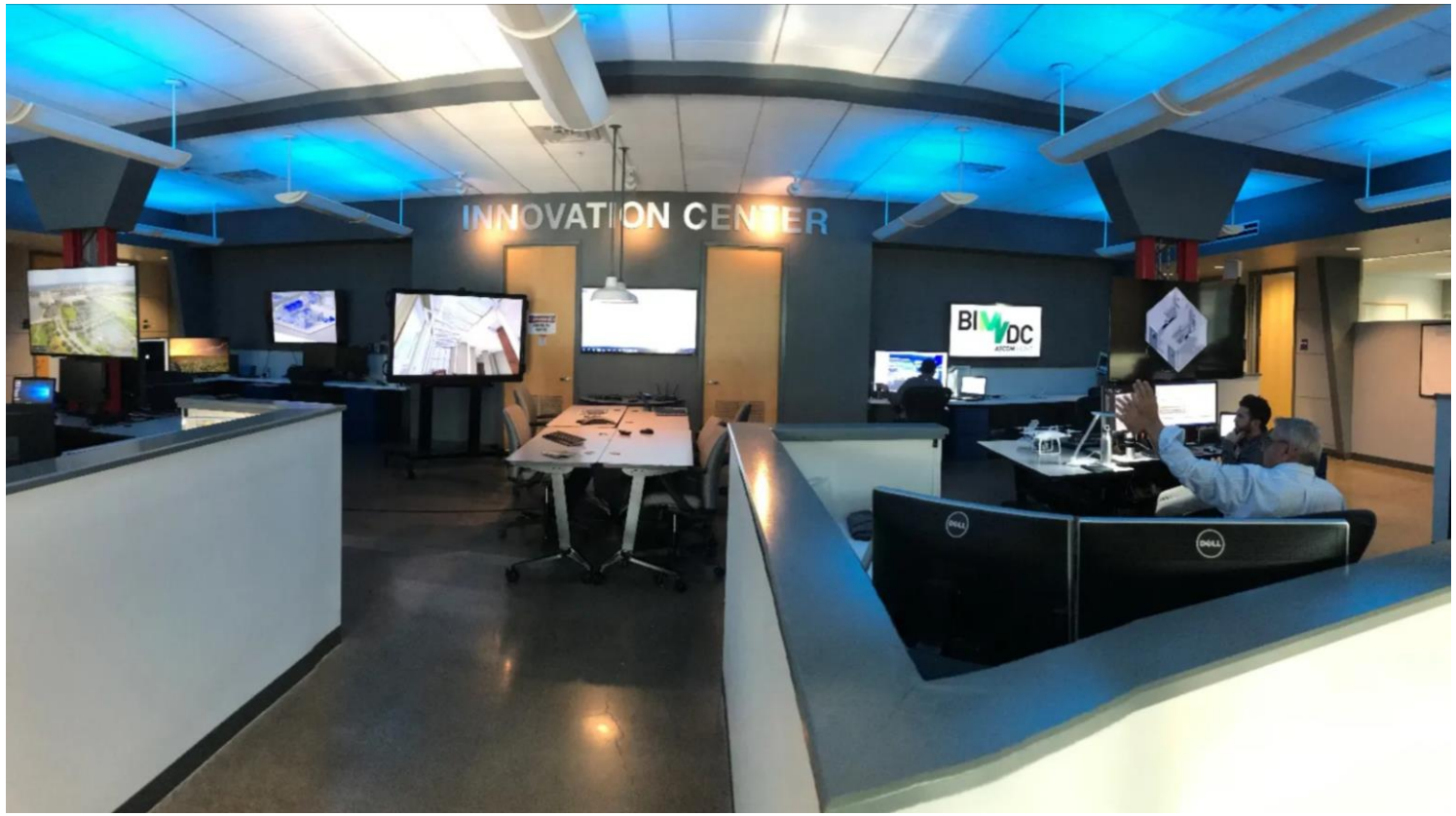
JOBSITE TECH GROUP

JOBSITE TECH GROUP

WSP | PARSONS BRINCKERHOFF

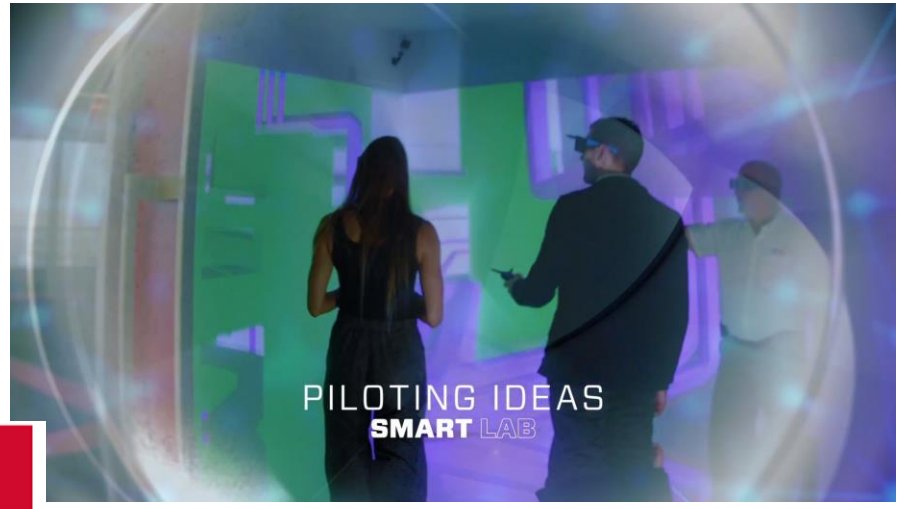
JOBSITE TECH GROUP

AECOM HUNT



AECOM Hunt's Innovation Center in Indianapolis supports several Midwest U.S. projects in implementing BIM.

JOBSITE TECH GROUP



SUFFOLK

"Suffolk is ahead of the curve, using machine learning to analyze data, predict risk, and deliver better buildings."

Jit Kee Chin
Executive Vice President and Chief Data Officer

YouTube

JOBSITE TECH GROUP

SKANSKA

Innovation

Our innovation services continue to evolve alongside technology's exponential growth. As pioneers in construction and project development we are not bystanders to the future of our industry – we are its builders. We are actively pushing our people, our projects and our industry forward with today's most exciting emerging technologies to deliver on the needs of our clients.

*"BIM is evolving very rapidly as new software and processes are developed. Some of the things Skanska is pioneering include the use of **drones**, **virtual reality**, **laser scanning** and leveraging **gaming technology** to easily navigate models."*

*"We are also using **cloud-based** systems for quantifying and estimating, and for project collaboration."*

Mark King
VIRTUAL DESIGN & CONSTRUCTION MANAGER
SKANSKA USA

Reality Capture

With advanced reality capture tools, including laser scanning and 360-cameras we can reveal inconsistencies between real-life and a plan.

Connected Jobsite

Access the most current information in the field, with technologies, including sensors, real time location tracking systems and IoT.

Immersive Experiences

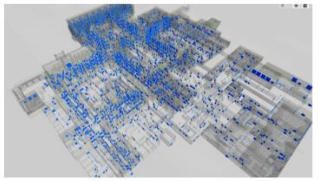
Enhance the client experience and accelerate decision making with virtual reality, augmented reality and mixed reality.

Unmanned Aerial Systems (UAS)

UAS/drones help reduce costs of surveying and project monitoring, and safely verify and validate work-in-place of hard to reach locations.

Advanced Visualization with BIM

Advanced visualization reduces rework through improved communication and collaboration, and optimizes project timelines with construction simulations.



BIM Analytics

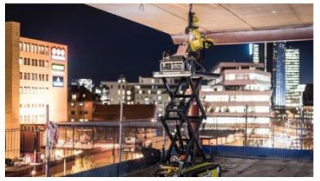
Merging BIM data and visualization tools creates context for project costs and schedules, leading to smarter decisions during project planning.

VDC / BIM

VDC / BIM enhances quality, minimizes cost, improves safety, reduces schedules, and strengthens collaboration across the project life cycle.

Prefabrication / Industrialization

A manufacturing approach to construction can help reduce construction waste, shorten the project schedule, and improve worker safety.



Global R&D

Our Skanska Global Research & Innovation network is the hub for technical expertise and knowledge transfer between the various Skanska units across the world.

JOBSITE TECH GROUP

THE INTERNET OF THINGS

JOBSITE TECH GROUP

THE INTERNET OF THINGS

BUILDING SYSTEMS

SCAN DATA

TABLETS DEVICES

DRONE DATA

AR / VR

SECURITY & PROGRESS

PRINT | SCAN

INTERACTIVE DATA ACCESS

ASSET TRACKING EQUIPMENT

WEARABLES

RFID TAGS

ASSET TRACKING VEHICLES

ASSET TRACKING TOOLS

ASSET TRACKING PERSONEL

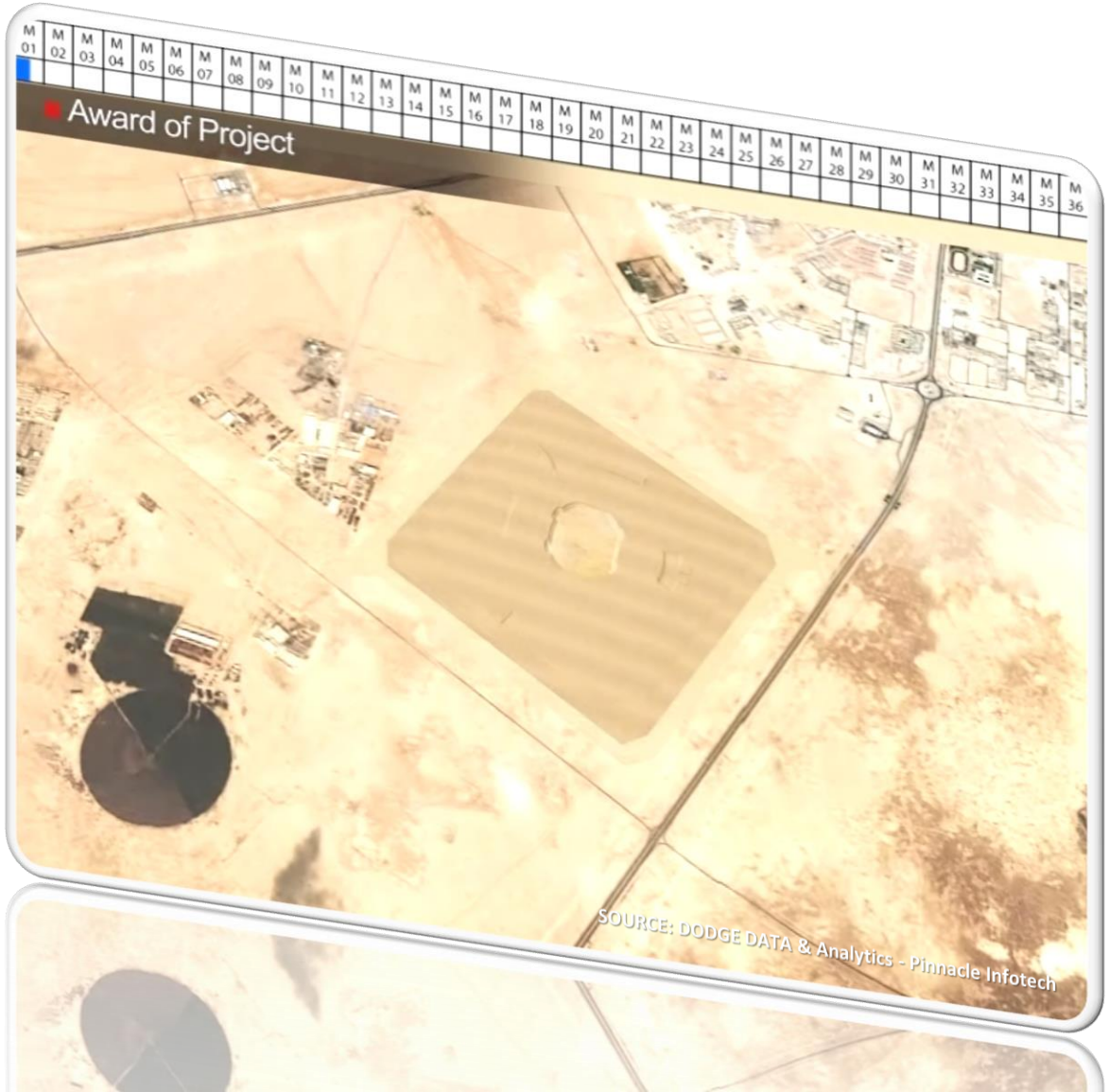
INTERACTIVE DATA ACCESS

EQUIPMENT | MATERIAL DELIVERY

MATERIAL SENSORS

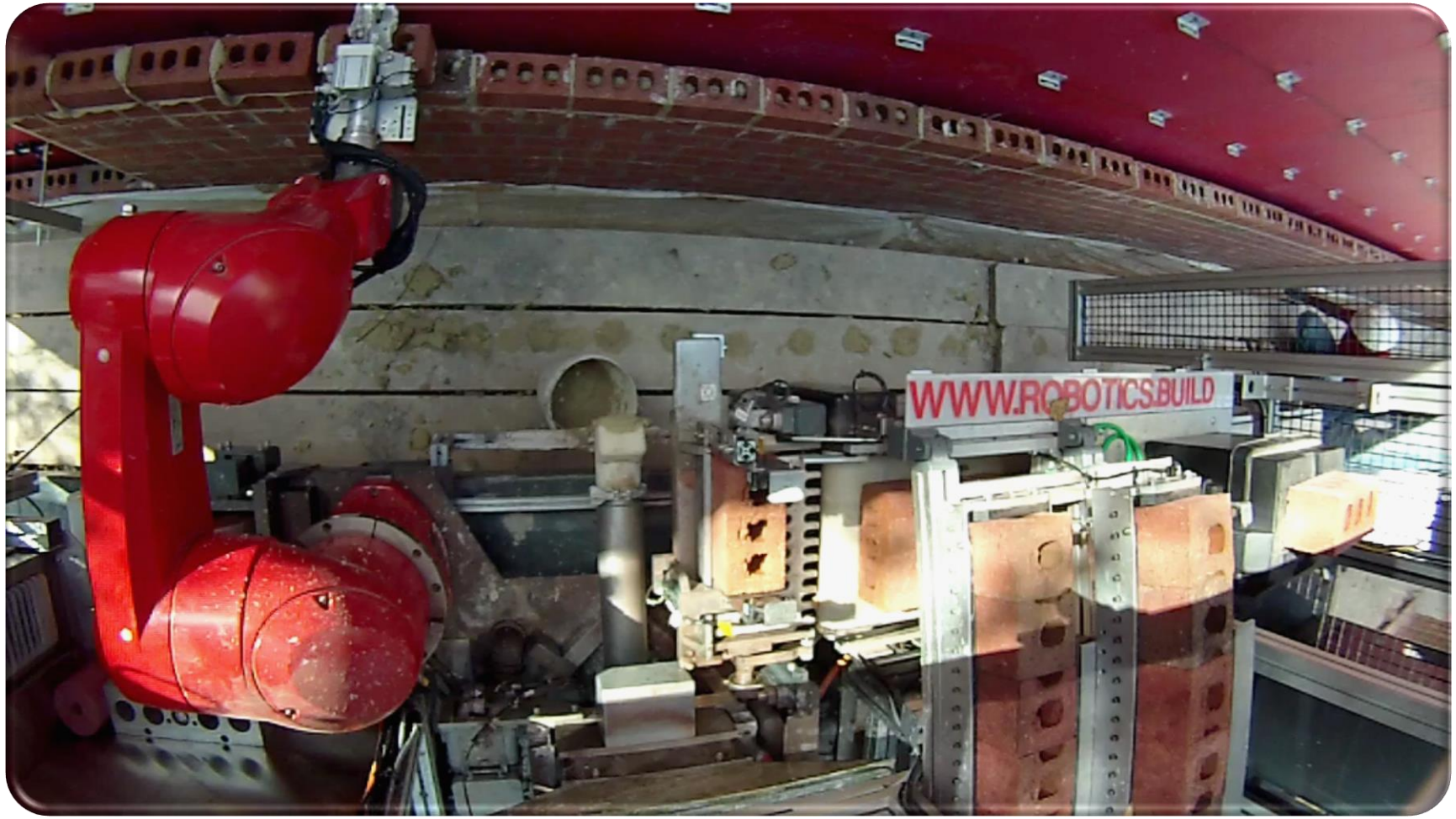
JOBSITE TECH GROUP

VIRTUALIZED SITE



JOBSITE TECH GROUP

NEW WORKFORCE?



JOBSITE TECH GROUP

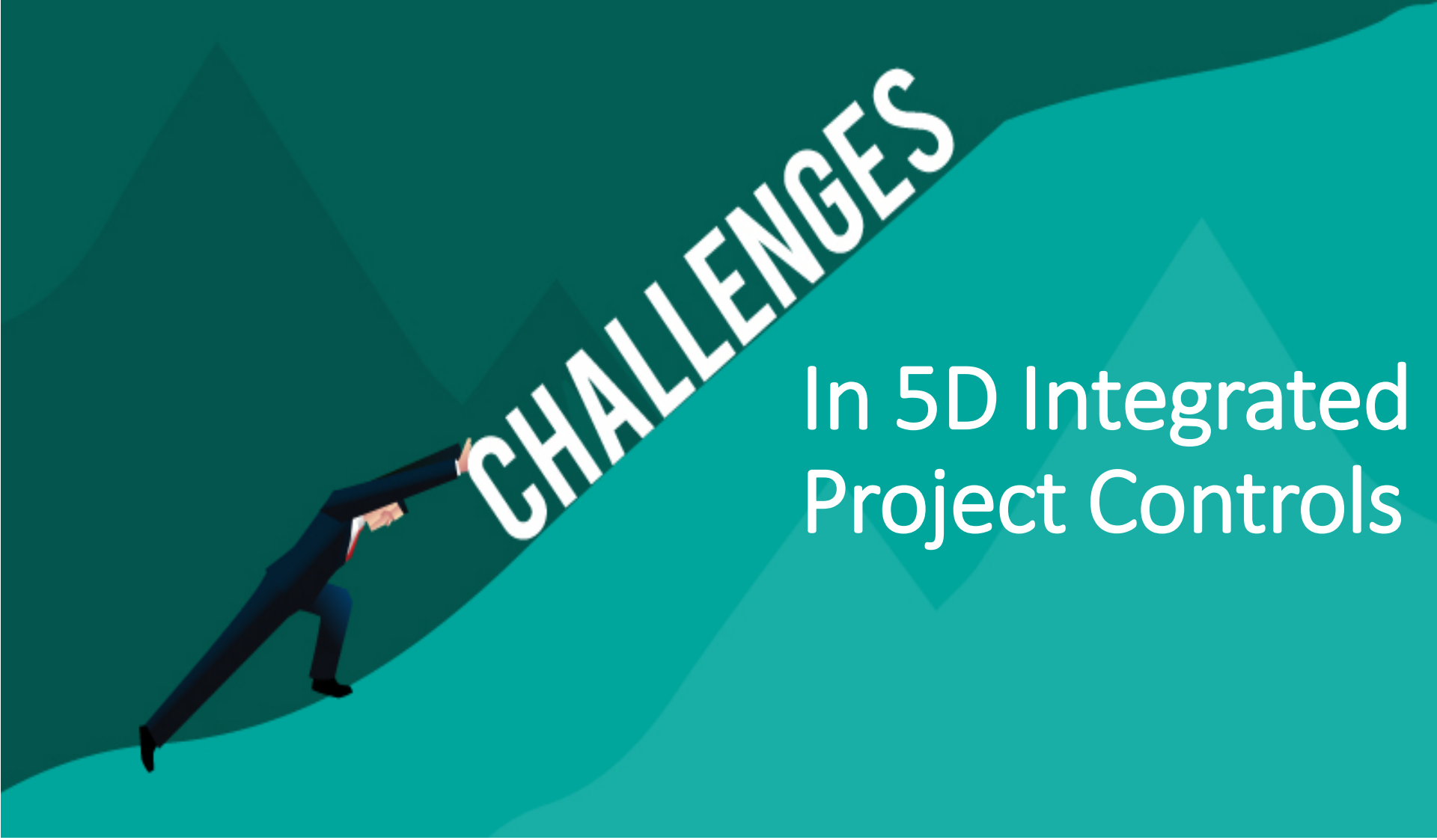
What is your **BIM** strategy?

What is your **VDC** strategy?

What is your **IoT** strategy?

RON PERKINS

RPERKINS@JOBSITETECHGROUP.COM



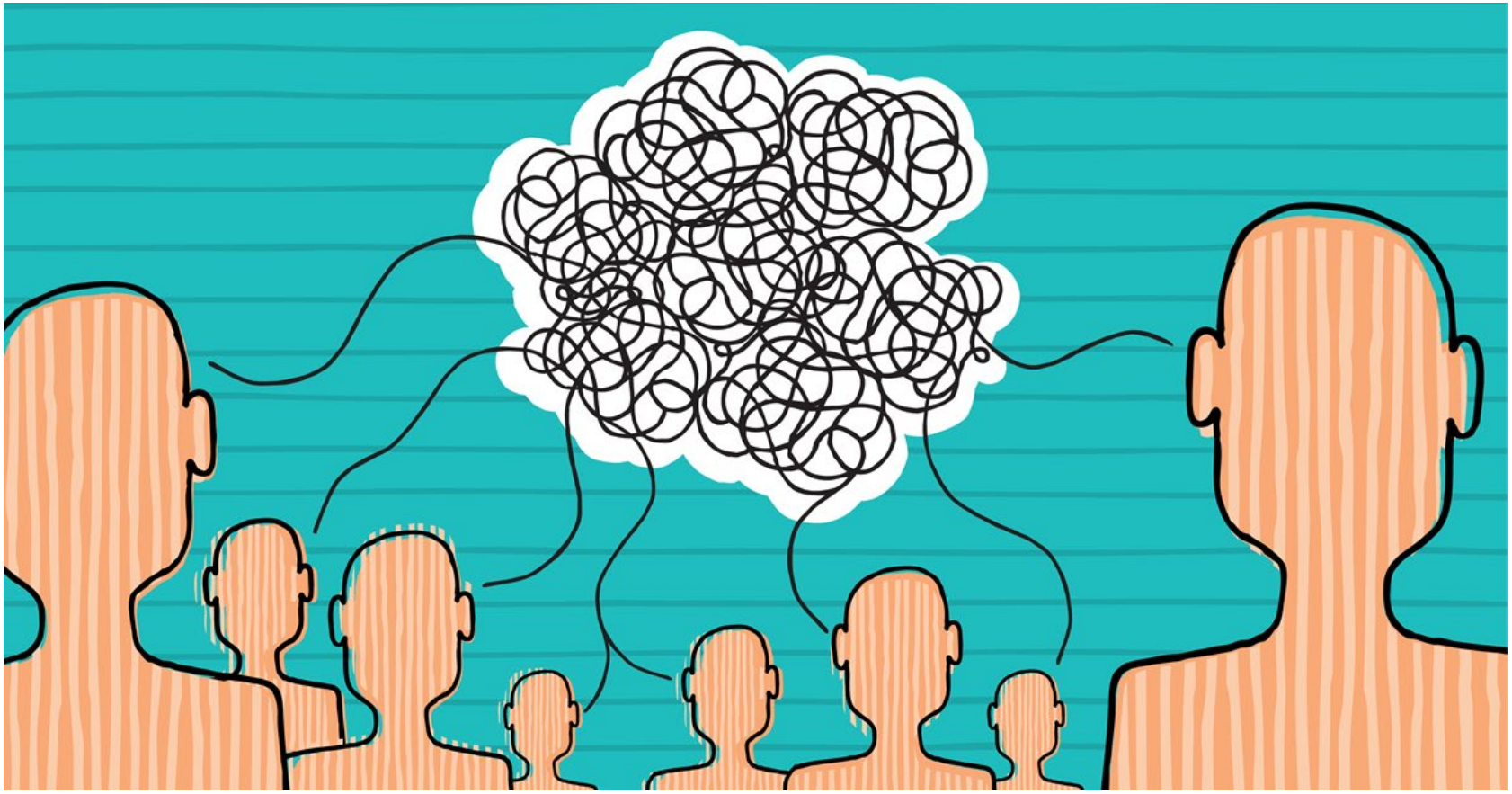
In 5D Integrated Project Controls

Dr. Pei Tang, Umesh Jois
JCMS, Inc.
January 25, 2019

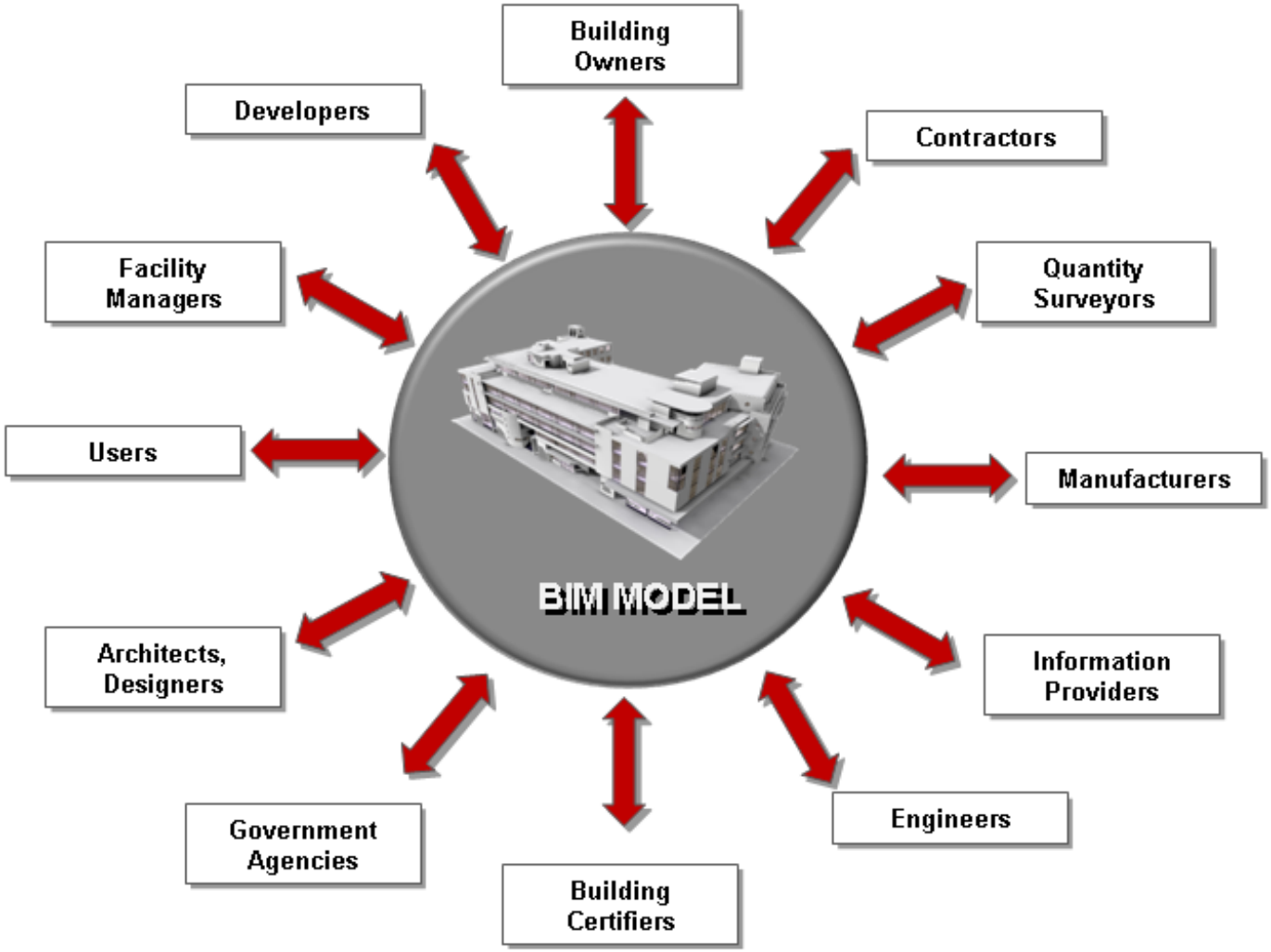
Project Controls Support Decision Making

Challenges in Project Controls (Data Collection, Modeling, and Analysis)

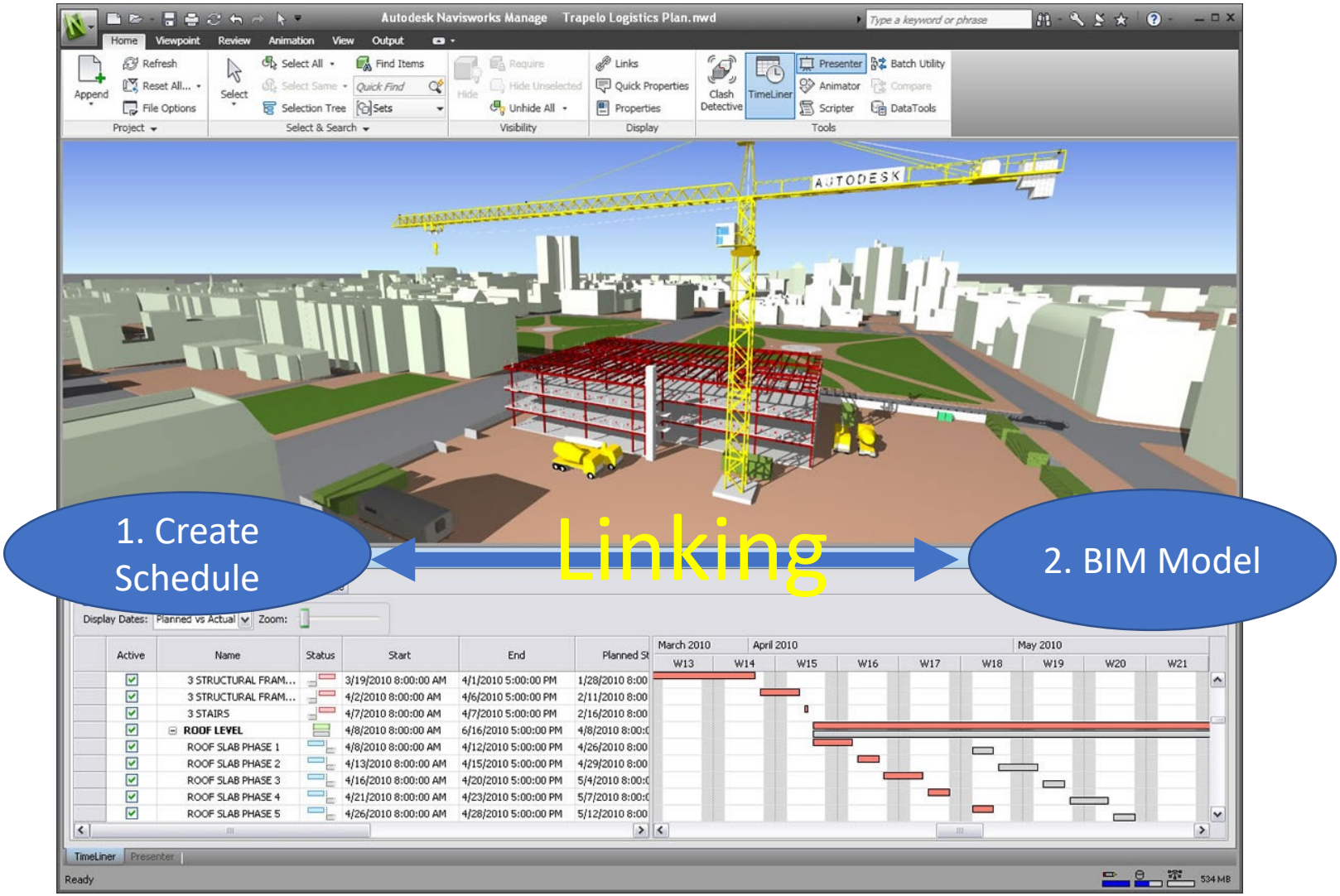
Poor Communication/Coordination Affects Data Collection



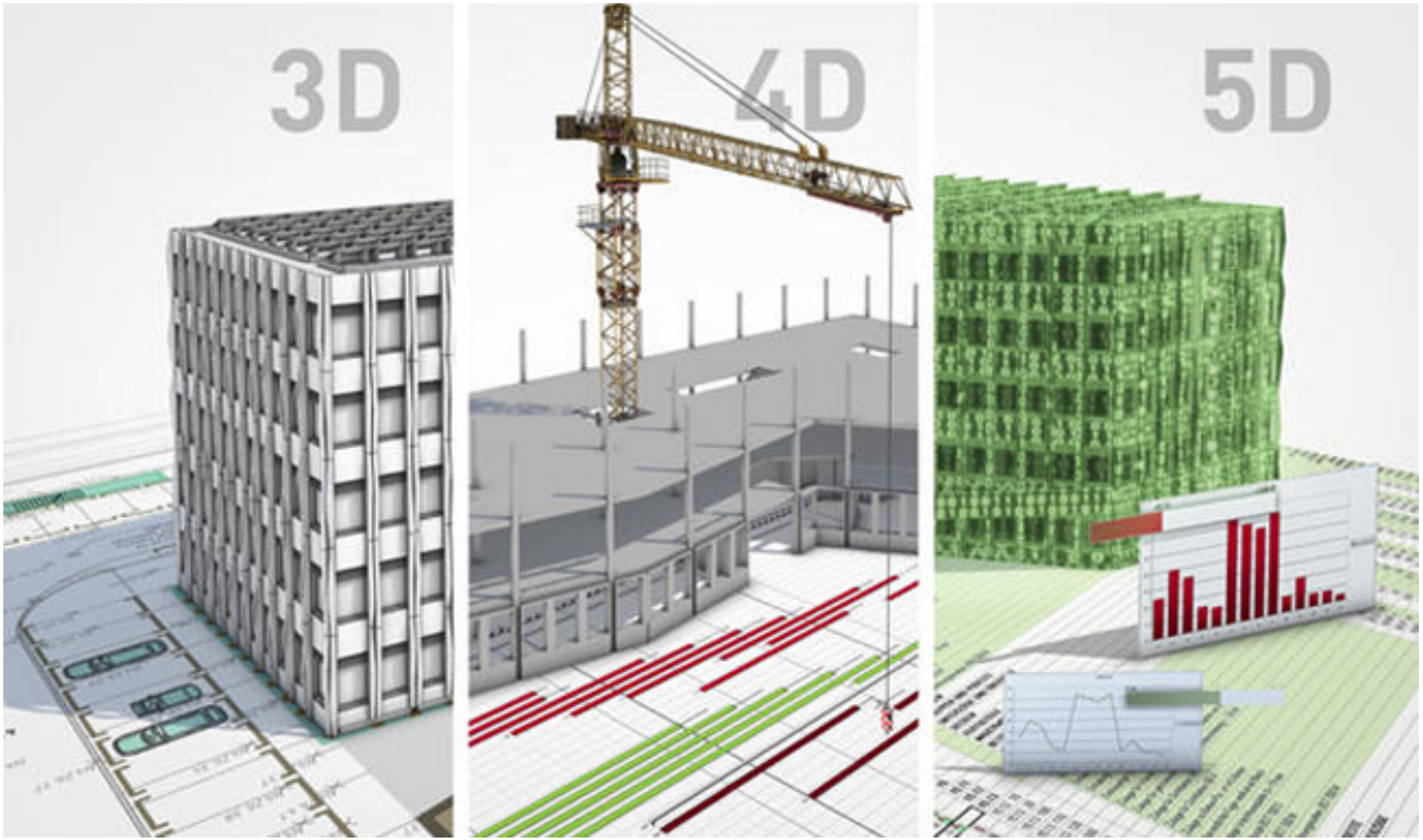
BIM Visualization & Sole Data Source Improve Project Controls



Existing 4D Practice - Animation



Few Successful 5D Cases



Limited Usage for Project Controls
Is Animation the Purpose for 4D?

Learn from 2D Planning and Scheduling

- **Contractors' Involvement**
- **Procedure and Results**
- **Animation is not the only result;**

Proposed 4D Practice

Results: **Animation & CPM Schedule**

Process: **Improved Communication & Coordination**

Other Challenges in 4D for Project Controls

- *Who Should Build 4D*
- *Level of Details*
- *Dynamic Updates*

We drive BIM,
Not BIM drives us!

Pain Points of Creating Contract Language for BIM for Bridges

Kelley C. Severns, PE, PMP
Bridge Engineering Research Lead - WSP USA

BIM - Bridge Industry

TRB TRANSPORTATION RESEARCH BOARD

AASHTO THE VOICE OF TRANSPORTATION

U.S. Department of Transportation Federal Highway Administration

EXCHANGE - Bridge Design Plans - Bid - Fabrication to Construction

Exchange Requirements
IFC Bridge Design to Construction Information Exchange US have been developed.

Industry Outreach
Workshop hosted by FHWA for the bridge design industry was held in August 2015.

Standards Roadmap
NCHRP study to develop a roadmap and workshop to share with industry was held in May 2016.

Implement IFC-Bridge
The next step is to implement IFC within the bridge community to exchange bridge information.

Deploy for Construction
The final step is to update contracting frameworks for design and construction

Gaining Momentum

Establish standards, guidelines, or manuals to facilitate the wide use of IFC as an exchange standard

Develop the national standard MVD, data definitions, and data requirements for the model life cycle for all data exchanges

Collaborate with stakeholders to provide timely update of IFC data dictionary for common bridge elements

Collaborate with buildingSMART and software vendors to design and offer suitable training

Establish a forum/expert hub for practitioners in the bridge industry to promote the common modeling formats and share experiences

Develop a template of BIM for Bridges and Structures-specific contractual provisions for managing risks associated with IFC-BIM for bridges and structures.

U.S. Department of Transportation
Federal Highway Administration

Contract Language

Data Exchange Utility

Case Study

Industry Engagement

Final Report

Task A **Task B** **Task C** **Task D** **Task E**

Contact

Kelley C. Severns, PE, PMP
Kelley.Severns@wsp.com

Pain Points of Creating Contract Language for BIM for Bridges

Francesca Maier, PE
Principal - Fair Cape Consulting

Bigger Issues

Sustainable Program

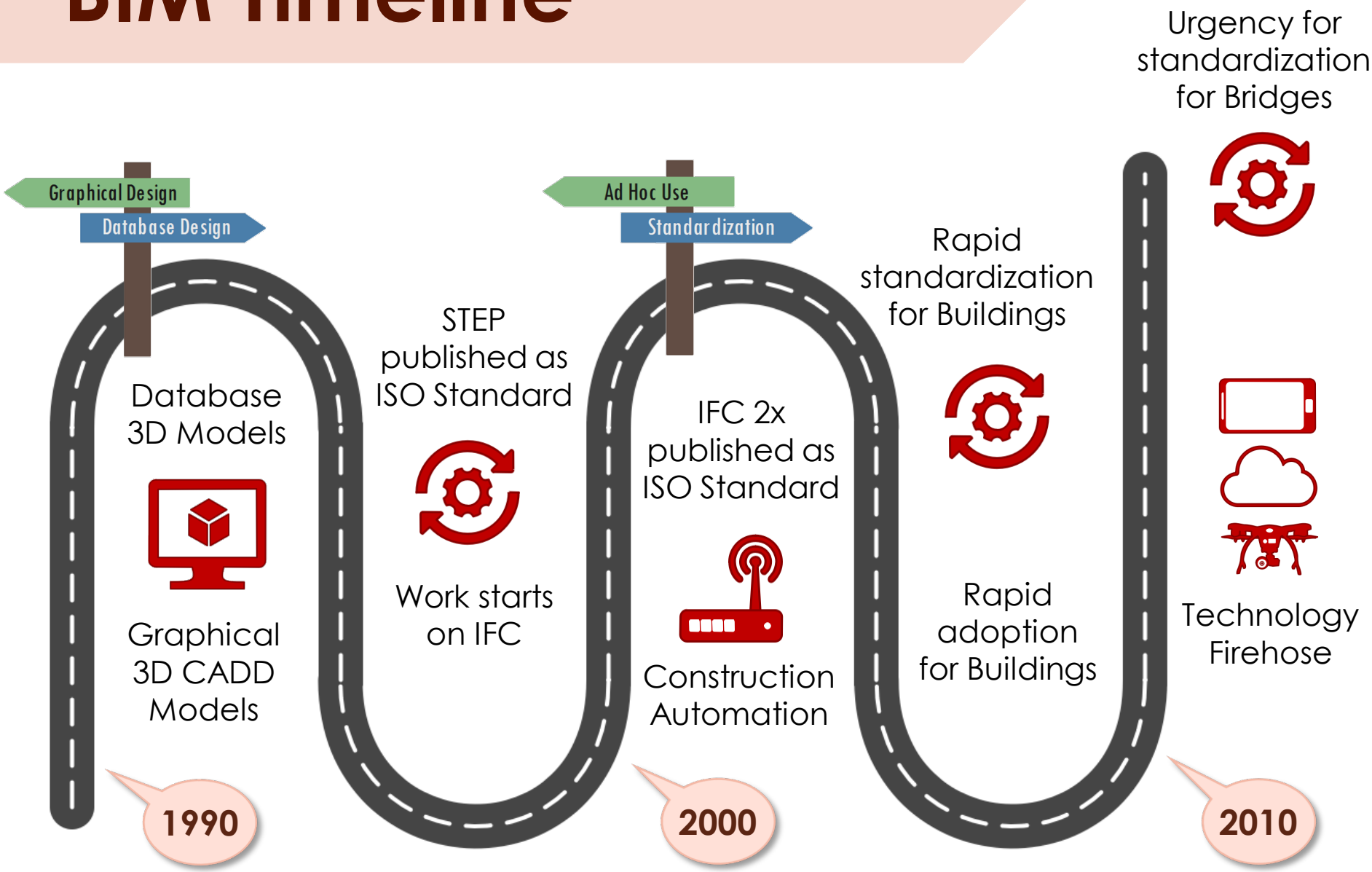
Fewer Claims

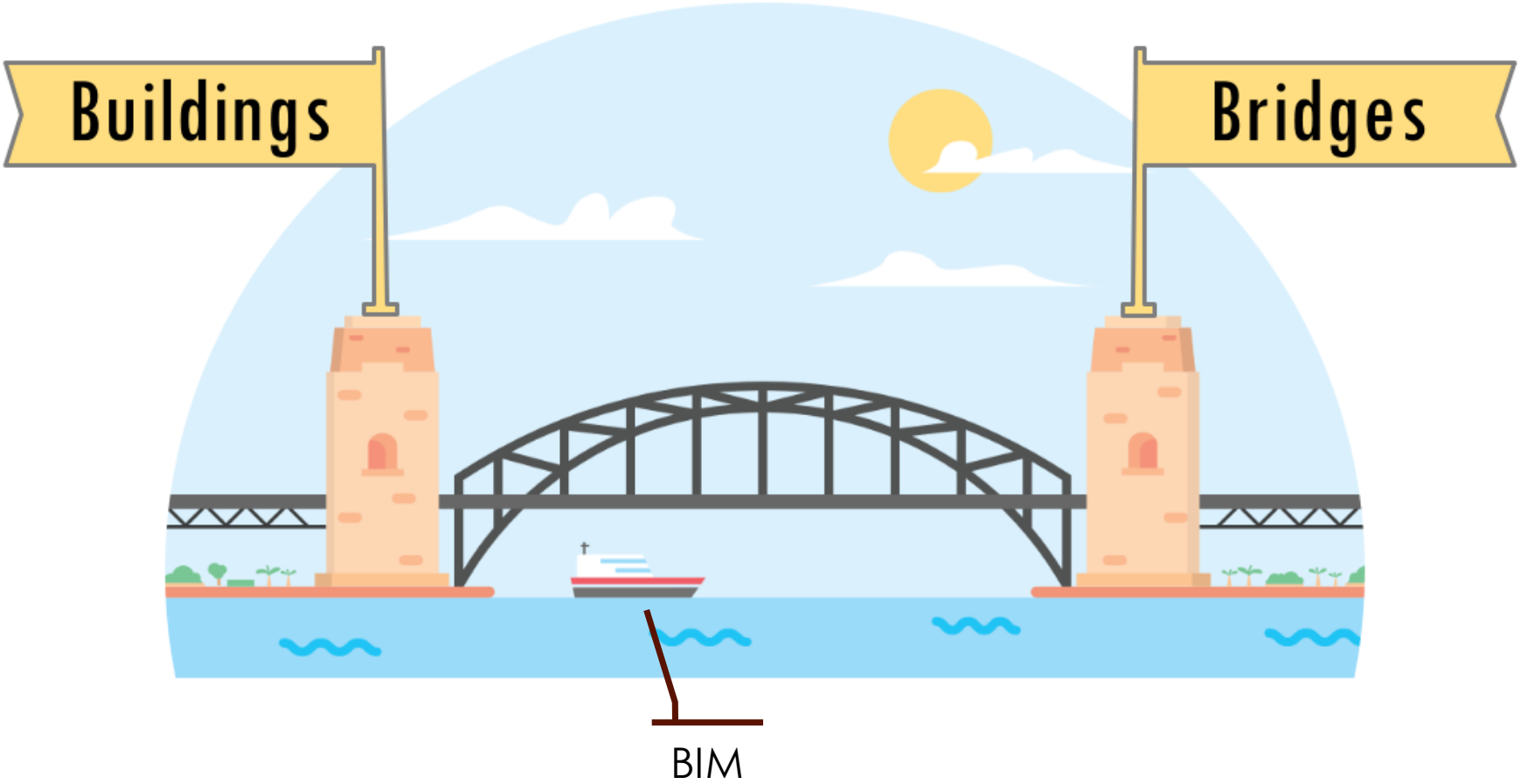
- Confidence and Mutual Trust
  - Repeatable Data
  - Transparency
- Fewer Issues
  - Real-Time Feedback
  - Digital prototyping

Staff Retention

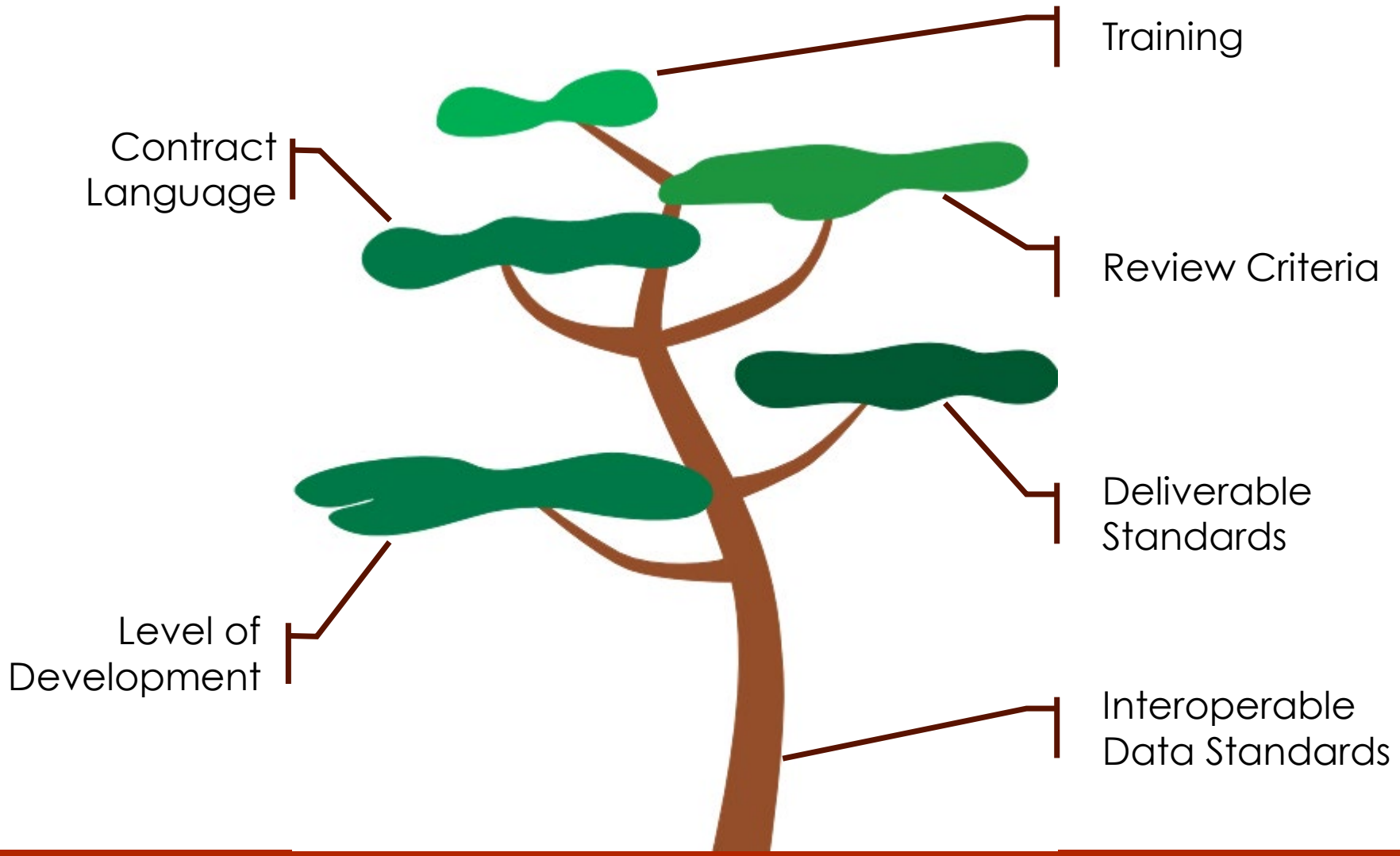
- Improved Safety
  - Less Exposure to Equipment
  - Defensive Body Position
- Job Satisfaction
  - Less Manual Data Entry
  - Collaboration

BIM Timeline

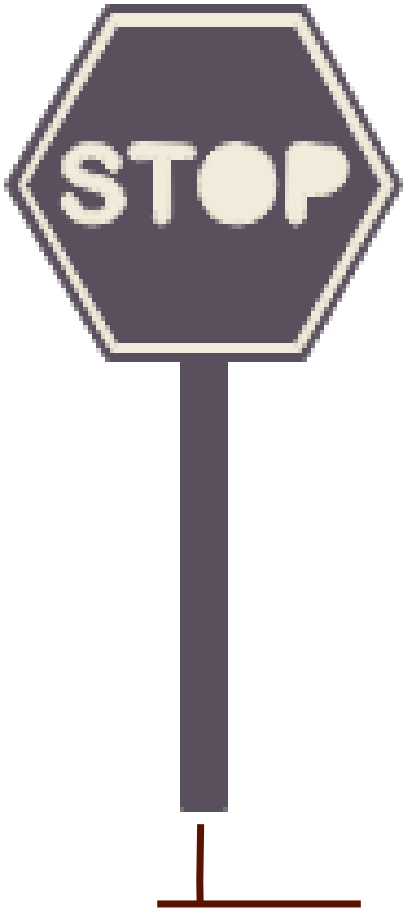



Buildings
Bridges
BIM

A New Framework



Level of Development

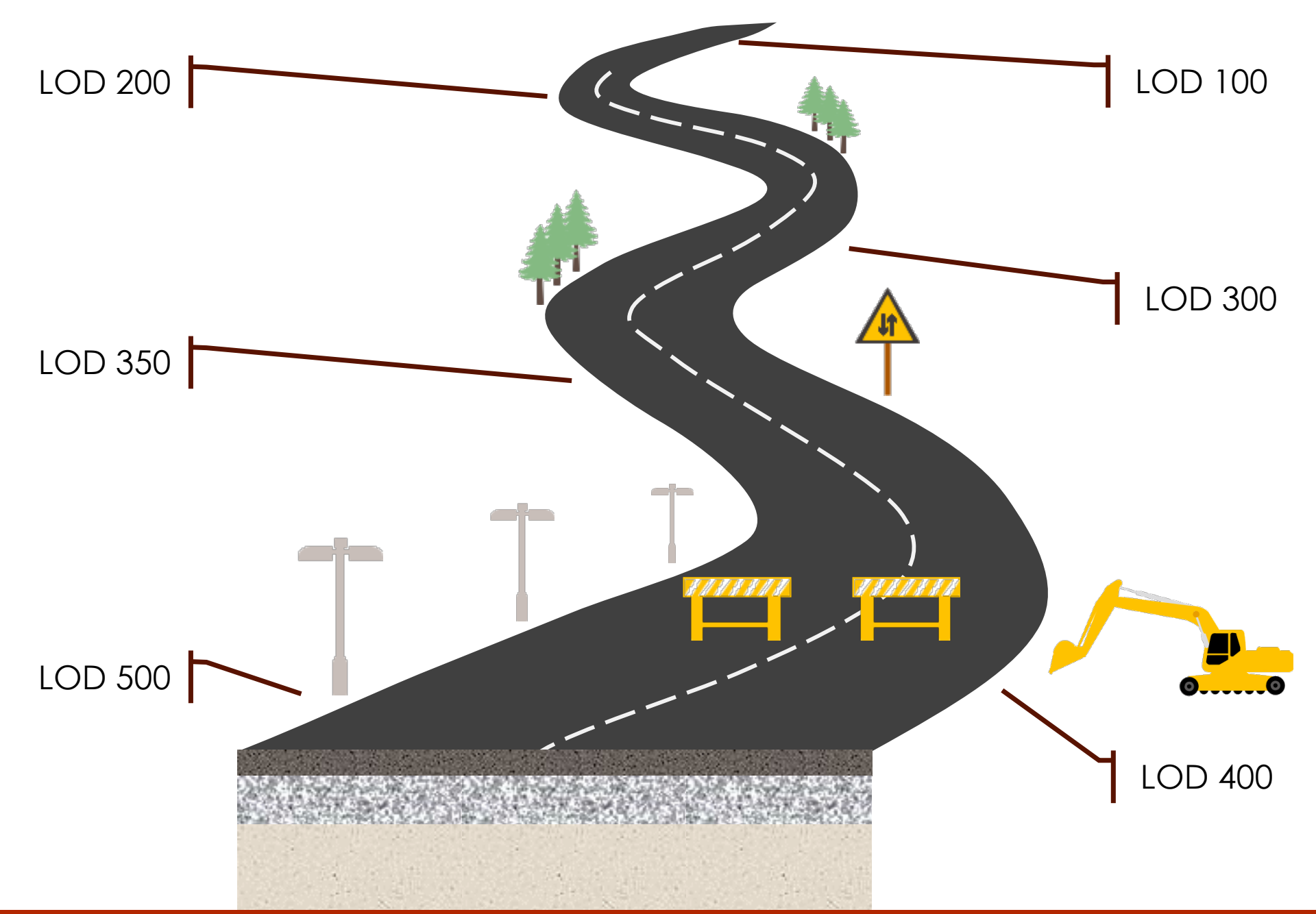


LOD 200

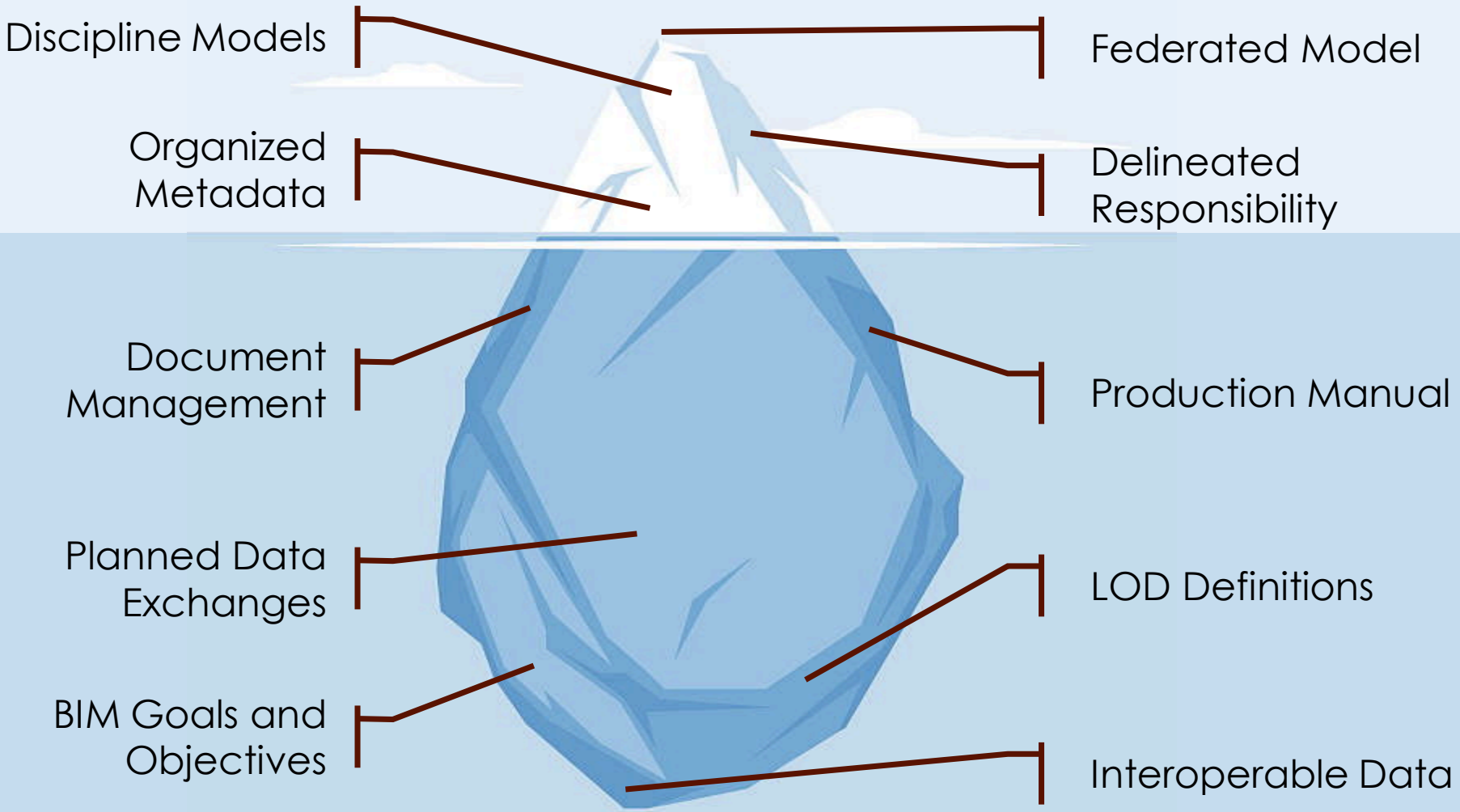
Attribute	Value
Asset ID	SR2R48543459
Location	46.311183,-119.270362
Sign Face	R-1
Sheeting Type	IV
Size	36" x 36"
Height	7'-6"
Post Asset ID	P384629340

Data Table

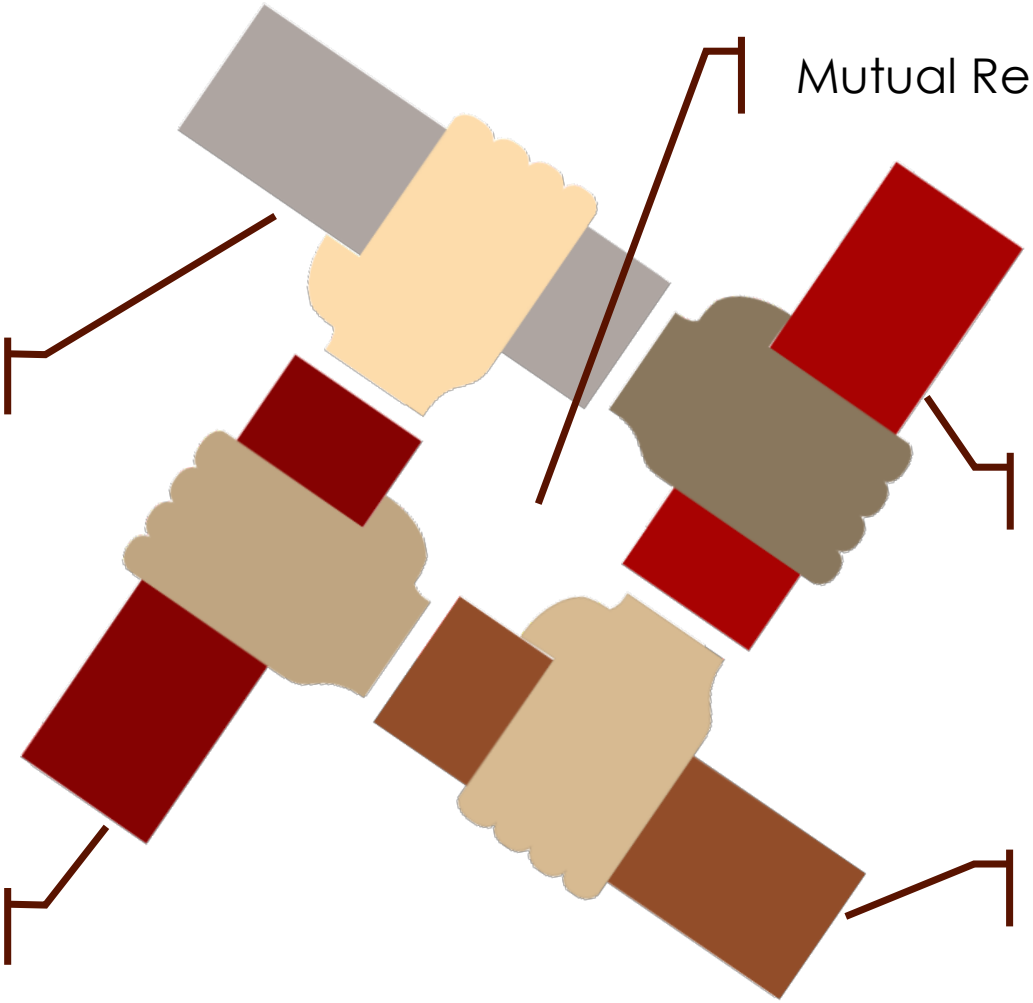
LOD 400


LOD 200
LOD 100
LOD 300
LOD 350
LOD 500
LOD 400

Deliverables



Contracting Issues



Mutual Reliance

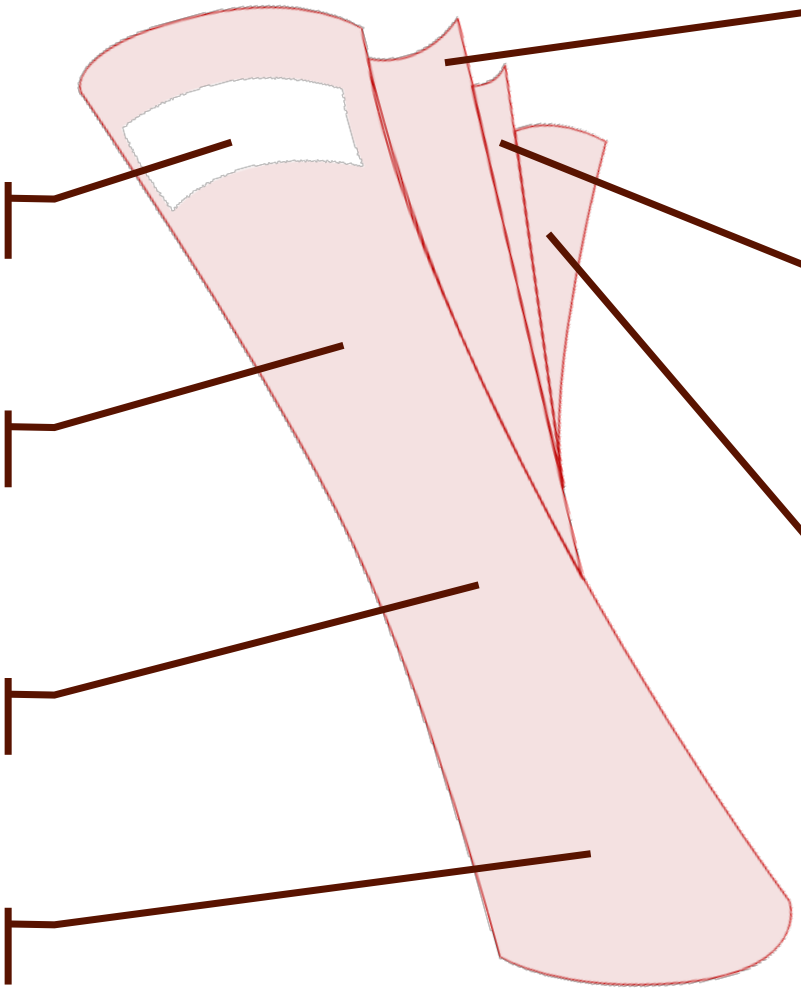
Consistency Across Contracts

Allocate New Liabilities

Joint Authorship

Limits of Liability

Specification Issues



Contact

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Fundamental pain point: Communication

- Communication, Collaboration, Coordination
  - Improve communication between GC and Sub on BIM projects
  - Differences in priority of stakeholders often proves to be a major hindrance to communication
  - Need to develop channels for effective communication to field creating the “Digital roundtrip”
- Interoperability
  - Multiple data sources are capturing large datasets from many different sources – particularly IoT technologies
  - Integration and sense making of this data remains a challenge.

Communicating with BIM

- BIM a language for communication:
  - Between stakeholders
  - Across different processes, from design to bidding, to construction and commissioning,
- A need for development of
  - Standards, governance, and specific contractual provisions in and around BIM.
  - Exchange formats and data models at the appropriate level of development and granularity
  - Stakeholders held accountable: reflected in contract documents.
- Practice caution in adopting standards from buildings to transportation.
- Need for interoperable data standards

BIM in Project Controls

- Underlying 4D models should reflect project and schedule realities
- Use of project controls methods using BIM only as successful as the correctness of the underlying models and information developed
- Uniform interpretation: how do model elements represent change orders, and perceived associated risks by each involved stakeholder.
- Involve contractors and sub-contractors in tying 3D and 4D models to schedule that can be used for project control.

Path Forward

Questions to be considered:

- What are the short-term, immediately resolvable challenges – low hanging fruit?
- What are the long-term challenges that require further knowledge development?
- What resources are necessary to address the short-term, and long-term challenges? This could include synthesis, problem statement ideas, or research directions