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3D MODELING 2.0

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CEO
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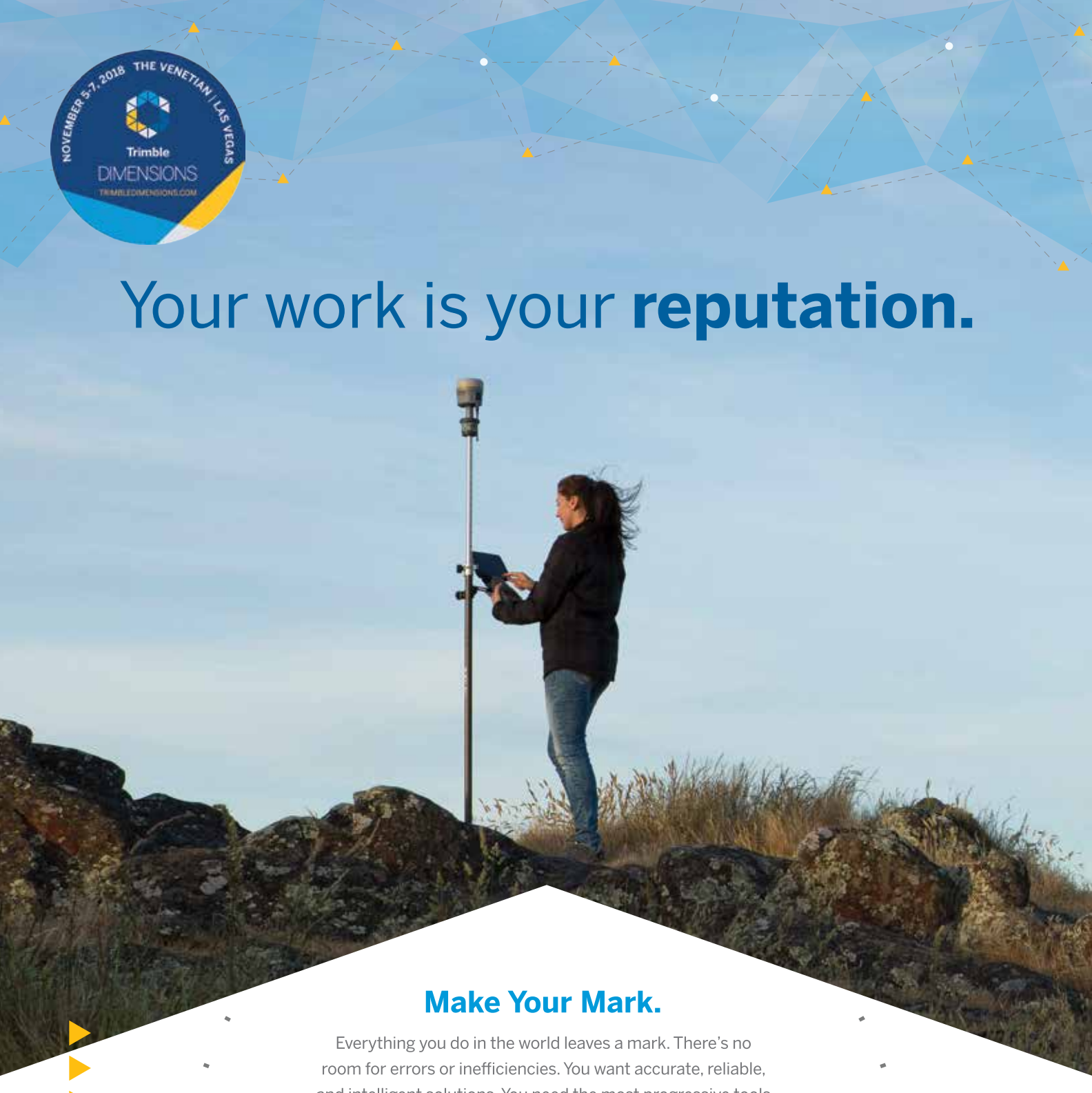

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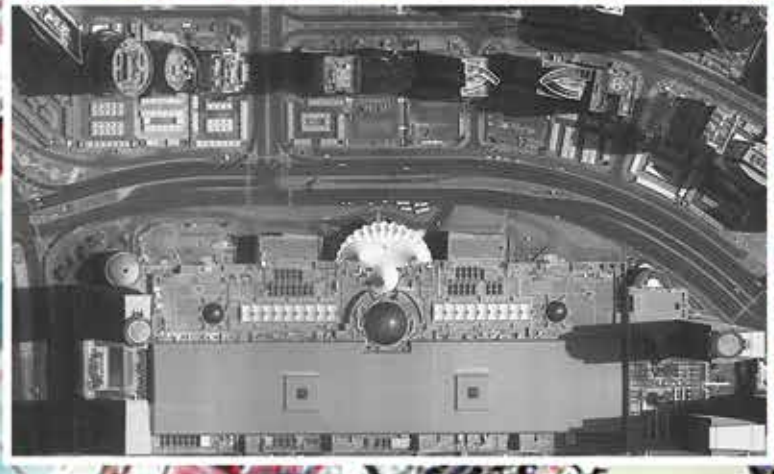

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Good things usually do not come free

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The interaction between Humankind and Nature needs to move from confrontation to accommodation. It is true that there is often a need to modify nature, like building a dam, creating canals, roads and buildings. However, this should not be viewed as 'taming' of nature, but working with nature so as to help humankind to achieve a desired quality of life. Very often an optimum solution may not be the best solution if it does not take into account natural factors. For example, builders view water bodies in urban areas as a waste of space and would prefer to fill them up and build commercial and residential complexes on the land fill. However, this disturbs natural drainage and can lead to flooding in times of heavy rain. Earthquake–prone areas have witnessed soil liquefaction and collapse of buildings in such land fill areas.

Building with Nature is the title of a seminal book on Landscape Architecture which stressed the importance of working with nature and incidentally gave a fillip to the development of Geographical Information Systems. Today, geospatial systems have developed far beyond just GIS and what is more, have seen convergence with many other software systems which are specific to different applications. Building Information Management, popularly known as BIM is one such software. BIM has moved several steps beyond 3D–CAD and provides an integrated system to manage the progress of construction activities in terms of work and cost. Integration of GIS and BIM, has been in progress for many years and enables the viewing of construction in the geospatial context. This not only helps in the proper siting of buildings and adjusting the construction to the landscape but also aids in the construction of smart buildings which maximize the use of natural illumination and temperature control, thus reducing the load on energy consumption and aiding conservation of resources.

What is more interesting is the ability to bring technologies like LiDAR and photogrammetry to obtain data about as-being-built information at specific stages of the construction and compare these with the original plan. Mistakes can be trapped early on and change requests can be evaluated better for its impact on the environment. Another application is in disaster management where reconstruction can be aided by the past record of the construction and evaluation of what can be recovered and what needs replacement. This can reduce the cost of reconstruction and also can be an aid to the settlement of insurance claims.

However, these benefits do not come cheap. Though there have been improvements in LiDAR data acquisition and photogrammetry and solutions are available to be run on smart phones on site, there is a cost of the hardware, software and training of the construction staff. There are technical issues as well. The integration of BIM and geospatial systems is still work in progress because of the fundamental differences in the definition of elements of an object. While geospatial 3D systems deal with surfaces, BIM deals with 3D objects and the mapping of one to the other is yet to achieve a stable standard. May be this is the reason why the construction industry is seen as a laggard in terms of investments in such technologies. However, in an industry plagued by cost and time overruns, the adoption of these technologies might repay the initial investment many fold.

REAL-TIME ENABLED SERVICES KEY TO SMART NATION

Singapore is looking at building a digital twin of the actual environment that will fuse all the location-based data, and enable public agencies as well as businesses to simulate and build upon the future, believes **Tan Boon Khai, CEO, Singapore Land Authority**

Digital transformation to make cities smarter is the most discussed topic around the world. What is the concept of Smart Nation and what measures are required to build a Smart Nation?

Smart Nation is all about transforming an economy through digital innovation that results in a world-class city with a government that gives citizens the best facilities possible and is responsive to their fast changing needs.

A good example is the world's first Smart Nation, Singapore. Singapore is embarking on a Smart Nation path primarily because land is a scarce resource in the small country. Today, Singapore is all of about 720 sq Km. Smart Nation will enable Singapore to be future-ready, by tackling future challenges and allowing it to plan and build right. 3D mapping helps us get accurate, concise and detailed data required for planning the smart nation. We started mapping Singapore in 3D format in 2014. And, I feel proud to say that we have successfully completed the task within the last couple of years. So, today as a city state, we have a complete picture of Singapore, as a whole, in 3D form.

3D maps are excellent mediums through which critical land data can be pulled together and be integrated together with the other sets of data. In mapping Singapore in 3D, we used two forms , one being airborne and the other one using

> The journey towards becoming a Smart Nation is an ongoing one. This journey cannot be ever termed 'complete' as data gets generated every day and we are able to extrapolate new information from new data every day. Sustainability is the ultimate goal, and that is what defines a Smart Nation.

validation from the streets. From the 3D maps integrated onto other platforms, we are able to extrapolate certain scenarios in order to project forward. A Smart Nation's ultimate goal is to benefit the citizens. Once we have the data available, we can also proliferate the data out into the public domain and citizens can use it for varied benefits in their daily lives.

The journey towards becoming a Smart Nation is an ongoing one. This journey cannot be ever termed 'complete' as data gets generated every day and we are able to extrapolate new information from new data every day. Sustainability is the ultimate goal, and that is what defines a Smart Nation.

Since you mentioned that land is in scarcity, how does Singapore value land?

We have various mechanisms, and various administration land systems that allow us to maximize land use in Singapore. We undertake land planning in great detail and we actually try to project our land use many years in advance. This enables us to create a model where our land use is sustainable and also recyclable.

How important is the role of geospatial data in the process of building Smart Cities?

In order to have a Smart City or a Smart Nation, we must have accurate geospatial data, and it all stems from the collection mechanisms that we have. Traditionally what we have is two dimensional data. But, the future is certainly about 3D and even 4D data, and we must be equipped to be able to extrapolate and view real-time data, which is the 4D data with the time element in it.

Effective land administration is also a necessary ingredient for Smart Cities. It is very important because ultimately whatever we build comes from the base of the land that we have. Land data is critical for planning and building right.

Singapore's Geospatial Master Plan is a push towards a Smarter Nation. Please elaborate.

One of the key challenges that we have today is to be able to plan futuristically. Singapore's Geospatial Master Plan aims to bring together three sectors — the public, the private as well as the public sector together in order to support Singapore's push towards a Smart Nation. By getting the private sector involved with public services, and developing the young to be interested in GIS, geography and location–based services and data, we aim to create an entire ecosystem that will fundamentally function on location based data. This way, going forward, the Smart Nation will not only be premised on technology, but will be really anchored on geospatial technology. Since geospatial data allows us to pinpoint accurately what we need to do and where we need to do it, geospatial technology will help us to get it right the first time. We will able to plan and execute with exact certainty.

Could you elaborate on the concept of 'Digital Twin' in context of Singapore?

We are in a very dense urban environment in Singapore. So, in order to be able to precisely locate where things are, businesses are, people are, we believe location based technology is quite fundamental. In fact, if you think about it, most of the data that you have today is layered upon location, based upon where people and businesses reside.

Since everything is based on geography, there is a lot of scope to examine how businesses and the public sector can come together to use location to everyone's advantage. They should think of ways to fuse their location data, such that ultimately all the services that are provided, whether it is for commercial or for social service, can be used for the benefit of citizens on the ground.

Singapore is looking at building a digital twin of the actual environment that will fuse all the location based data, and enable public agencies as well as businesses to simulate and build upon the future. As Jack Dangermond once said, it is like imagining yourself having a moving map – once you are able to visualize yourself on a moving map with a time dimension, you are able to proliferate more and more services as well as more and more value additions on that data.

The future of location is infinite. Location – based data coupled with infrastructure technology such as BIM has the potential to allow us to plan and build right, right from the beginning. Such integration can significantly help in resolving the challenge of making infrastructure future-ready. The processes can become more efficient, cause less wastage and ultimately enable the authorities to build and plan for a future that is sustainable and resilient.

Combination of location technology and disruptive technologies like AI, automation and Big Data is leading to new innovations. How can this collaboration benefit Smart Nation and Smart Cities?

Artificial Intelligence, automation and Big Data analytics have a big role to play in fostering digital transformation within the construction and other industries. With the vast amount of data that is coming in, it is quite impossible for humans to be able to sort and reconstitute a lot of the data. This is where technologies like artificial intelligence and data analytics play a vital role. With artificial intelligence as well as data analytics, we are able to see with one screen shot, what is important, what is significant, what needs to be addressed etc. These findings enable us to make quicker and better decisions. This is how human reaction will be like, going forward. With the aid of new technologies like AI, deep learning, Big Data analytics etc. we are able to make more accurate, fast and efficient decisions, leading to development of more productive strategies and initiatives for building Smart Nations and Smart Cities.

Singapore is looking at building a digital twin of the actual environment that will fuse all the location-based data, and enable public agencies as well as businesses to simulate and build upon the future.

Siemens and Bentley Systems' PlantSight digital twin Cloud services

Siemens and Bentley Systems have announced the introduction of PlantSight, resulting from development together based on their highly complementary software portfolios. PlantSight is a digital solution to benefit customers through more efficient plant operations. PlantSight enables as-operated and up-to-date digital twins which synchronize with both physical reality and engineering data, creating a holistic digital context for consistently understood digital components across disparate data sources, for any operating plant. Plant operators benefit from high trustworthiness and quality of information for continuous operational readiness and more reliability.

Every real-world operating plant is characterized by cumulative evolution, both to its brownfield physical condition and to the varied types and formats of theoretically corresponding engineering data. With PlantSight, every process plant owner-operator can realize the benefits of as-operated digital twins — without disruption to their existing physical or virtual environment.

KEY FEATURES

- Provides with Cloud/Web-enabled visibility and access into existing data and tool interfaces.
- Operational and project-related engineering data is aligned seamlessly.
- The time and effort to federate and complete asset information will be significantly reduced, with plant documentation kept up to date.

HERE XYZ for fast management of location data

HERE Technologies has announced the availability of HERE XYZ, a real-time, interoperable and open location data management service. The service, currently in Beta, fills a major gap for mapmakers and developers of location-aware applications by providing live access to uploaded data, complete flexibility in rendering tools, and Cloud services to share your location data with the world in an instant.

HERE XYZ is built for a broad range of developers and users, from students to small and medium businesses, large enterprises, data journalists and cartographers. Developers in large organizations can make rich, interactive maps and location-aware applications that benefit from the robust tools and capabilities of HERE XYZ. It allows developers and map makers to maximize their creative energy by making it easy to manage location data.

KEY FEATURES

- Built around a powerful and versatile XYZ Hub API that is delivered as a Cloud service.
- Developers can invoke the XYZ Hub API directly or explore it via the HERE Command Line Interface HERE CLI.
- Casual mappers can use the XYZ Hub API, via a web-based graphical interface called XYZ Studio.

FARO introduces new 6DoF laser tracker platform

FARO released the next generation of FARO Laser Trackers, the 6DoF Vantage product family with 6Probe. The Laser Tracker is a fully integrated hand-held probe for probing hidden, hard-to-reach features in hard-to-reach locations. Together, the TrackArm super 6DoF and the 6Probe offer the most complete solution portfolio for every measurement need. They address a wide range of large-scale metrology applications across a variety of manufacturing focused industries including automotive, aerospace, construction, heavy equipment, etc.

The 6DoF FARO Vantage product family includes two high-performance models, the VantageE6 with an operating range of 35 meters and the VantageS6 with an operating range of 80 meters.

KEY FEATURES

- Both Vantage models include ActiveSeek™ functionality with wide-angle viewing.
- Allows users to confidently move from one location to the next without concern.
- Improves general productivity by allowing users to start the actual measurement process faster and makes sophisticated 3D measurement accessible to all.

A PICTURE IS WORTH A THOUSAND WORDS

Even before Neil Armstrong took that 'giant leap for mankind', space has been considered cool. And journalism has for years been considered a cool profession. So, when two 'cool' things come together, we can expect fireworks!

By Anusuya Datta

BBC Africa poured through satellite imagery of many years to match the landmarks in a video to prove exactly where and when the killings took place and who were responsible

Image 1: DigitalGlobe provided the "smokin gun" image to Associated Press that showed two trawlers loading slave-caught seafood onto a commercial cargo ship.

Image 2: Landsat and Sentinel images show 30 years of change in Amazon rainforests.

In July 2018, a disturbing video began circulating on social media. It shows two women and two young children being led at gunpoint away from a village by a group of soldiers. The victims are blindfolded before they are shot point blank 22 times. The social media posts claimed them to be from Cameroon but the government of Cameroon initially dismissed the video as "fake news".

The video showed a terrain that could be from anywhere in the world, and the people could be anywhere from Africa. But BBC Africa Eye did a thorough investigation through forensic analysis of the footage. Among other things, they poured through satellite imagery of many years trying to match them with the landmarks in the video to prove exactly where and when this incident took place and who were responsible. The Cameroon government was forced to issue a statement clarifying their earlier stand and announced that a number of soldiers have been arrested and are under investigation now.

Satellite imagery has become an indispensable tool in journalism. Be it fact-finding or gauging the impact of a particular situation, reporting on climate events or conflict zones, because of the unbiased insights they provide, they are being extensively used by professional journalists today.

Taking journalism to new orbits

Technological advancements and path-breaking innovations have ushered in a new era of earth observation, making satellites more relevant to businesses and public good. This is not only changing the way we study Earth but also taking journalism to new orbits. Let's see how.

Establishing correlations: You have a story, but you need confirmations, correlations to connect the dots, tying up loose ends or clues for where and when. As we saw with BBC's expose of the murders in Cameroon, satellite imagery is capable of providing this kind of intelligence. And more.

"After a tip off from a Cameroonian source, we found an exact match for that ridge line on Google Earth," BBC News Africa revealed on Twitter. "Once we had the general location, we looked at other details in the film — tracks, buildings, trees — and matched them precisely to features visible on satellite imagery," it added.

That is when the team approached DigitalGlobe, a Maxar Group company. "We poured through images of six years and looking for clues and were able to able to pinpoint the month and year by matching them with the presence of objects like buildings, trees or roads," explains **Steve Wood, Senior Analyst, Maxar News Bureau**.

Similarly, the Pulitzer prize winning story of Associated Press which exposed a human trafficking ring in 2015 was tracked with DigitalGlobe cameras. After months of going around in circles chasing a trail of human traffickers in the waters of Indonesia and Papua New Guinea, AP requested DigitalGlobe to train its satellites on a designated area in the deep seas. The now-famous "smokin gun" image (*See Image 1*) caught two trawlers loading slave-caught seafood onto a commercial cargo ship. More than 2,000 enslaved men were freed; Indonesia government launched a massive investigation; US laws regarding import of fish were changed.

Breaking news: This is as simple as having an exclusive incriminating photo in your hand. Satellite imagery by Planet shocked the world when it exposed secret Iranian facilities developing nuclear rockets. The imagery not only captured ongoing construction in the facility in the desert but also captured strange marks on the sand of what looked very similar to rocket landings or takeoffs.

Climate change: Monitoring climate activities is one of the very prominent use of satellite imagery and is used extensively to show change in a particular piece of land compared to an earlier time period. For instance, ESA used Landsat and Sentinel data to show 30 years of change in Amazon rainforests. (*See Image 2*). In this set of images, red shows vegetation. Increasing patches of brown on the right image shows alarming deforestation. This is of great concern since the Brazilian rainforests play an important role in global climate. And unlike other forests, rainforests don't grow back.

Change detection: Reuters used imagery from Planet to track expansion and condition of Rohingya refugee camps in Bangladesh. The story, called "Life in the Camps", which won the Data Journalism Award 2018 for data visualization, showed how the camps have grown at an alarming speed in a few months. There are thousands of people packed in the shelters that lack basic hygiene, or even food or water.

Similarly, in Turkey or the conflict-prone South Sudan, satellite imagery have been used to track and report on the miserable conditions in refugee camps.

Covering war zones: Satellite imagery has become an effective tool for reporting in conflict zones — be it for pinpointing collateral damages or human rights violations. In the ongoing conflict in Middle East, satellite imagery identified strongholds of the ISIS, the extent of devastation in Aleppo, or the ravaged archeological and heritage sites.

For instance, this set of images (*See Image 3*) pre- and post-liberation of Ramadi from ISIS, shows widescale devastation. According

Image 3: Liberation of Ramadi from ISIS: Pre and post images show widescale devastation.

to analysis of satellite imagery by the United Nations, nearly 2,000 buildings, streets or bridges, were destroyed between July 2014 and end of January 2016.

Tracking terror or authoritarian regimes: In places like terrorist held areas like where ISIS, Boko Haram or Taliban operate, which is inaccessible to media or civilian authorities, satellite imagery can give the scale of atrocities or damages.

Similarly, satellites are the only source of information on what is happening inside North Korea, a country cut off from most of the world. EO imagery have for years been used to track and report on not only DPRK's missile development activities, but also for tracking general life in the country — state of electrification, vegetation, housing, etc.

Access to the inaccessible: In disaster zones where immediate human visit is impossible, satellite imagery can give insight into the damages or warn for worse to come. For instance, DigitalGlobe took the picture of the explosion at the Fukushima nuclear plant barely 3 minutes after the first reactor blew up on March 11, 2011. This image was instrumental in telling the world about the actual situation on ground at Fukushima when the area was inaccessible.

Tracking natural disasters: Satellite photos can reveal the devastation and damages following dangerous events like volcanoes, earthquakes or floods. For instance, a set of before and after imagery (*See Image 4*) shows how residential areas along the coastline in Indonesia completely disappeared following the devastating tsunami in the last week of September 2018.

Forewarning for weather events: National Space agencies like NASA, ESA, ISRO, etc. regularly give updates on major weather events and impending natural disasters. Media houses can track such warnings to amplify to the local population for evacuation and exigencies, or to disaster management authorities to take proper action.

Adding a visual element: One could simply use them for adding a stunning visual effect in a story on some major event. For instance, this 9/11 image of the World Trade Centre (*See Image 5*) captured from International Space Station by NASA Astronaut Frank Culbertson, the only American off the planet at that time, shows a plume of smoke coming from the site.

Satellites have been used to image the crowd at Barack Obama's inauguration ceremony in 2009, participants at the women's march in 2017 following the inauguration of President Donald Trump or even the stadiums and crowd at major sports events such as Olympics or FIFA World Cup.

Services at your fingertips

Despite the humongous costs associated with putting each satellite in place and operating them, there are several sources of data which come absolutely free. NASA's Landsat imagery is freely available on USGS website while ESA's Copernicus dataset is available via the Sentinel hub. The Indian space agency ISRO's Bhuvan portal is a great resource for free imagery, but a lot of it could be dated. Google Earth is the most popular for seamless availability but remember it is not always available at great resolution and could have errors due to stitching problems. Commercial satellite providers like DigitalGlobe and Airbus give some data for free, mostly during natural disasters. Planet has a news section where one can get imagery as well as tools.

Other than the standard data, there are some specialized services also for journalists that one could opt for.

Maxar News Bureau: This is a partnership of the Maxar group with trusted media organizations. The bureau provides services in two ways — push and pull. In the push form, Maxar sends out standard set of imageries of select events/happenings to registered media houses for publication. The pull part is "a unique concierge kind of a service wherein

Image 4: Satellite images show how residential areas along the coastline in Indonesia completely disappeared following the devastating earthquake and tsunam in September 2018.

Image 5: 9/11 image captured from International Space Station by NASA Astronaut Frank Culbertson, the only American off the planet at that time, shows a plume of smoke.

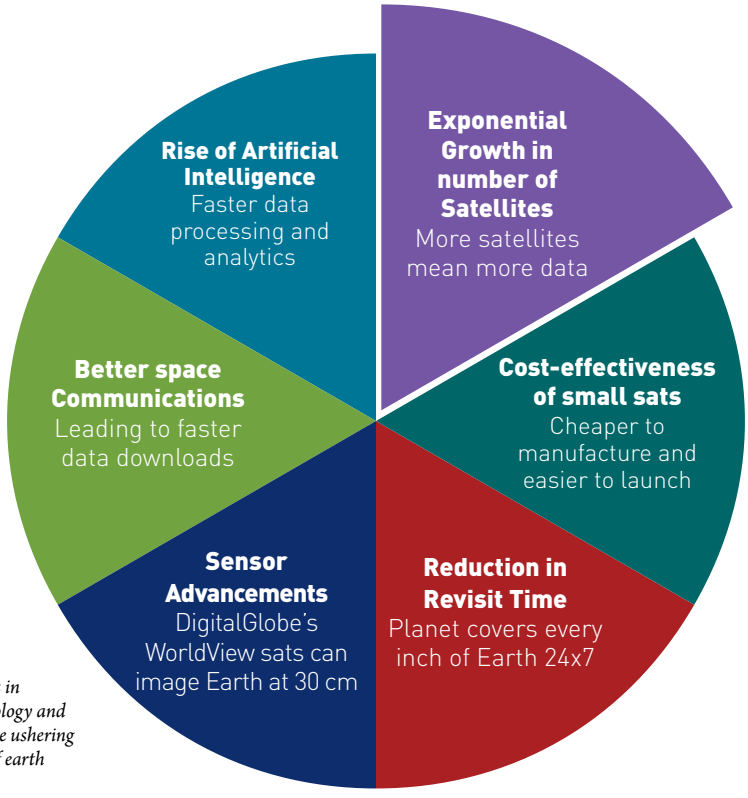
Maxar digs up exclusive datasets for a news organization or provides its own imagery analysts to work dedicatedly with journalists to find the hidden meaning in unraveling a story via use of satellite images," explains **Turner Brinton, Director, Public Relations, Maxar Technologies**.

Tasking of satellites: This again is a unique service from Maxar where a media organization needs to keep watch over a particular piece of land at a certain given time. One just needs to contact the Maxar News Bureau to task DigitalGlobe satellites on the area of interest. Of course, this comes at a price.

Analytical tools: There are several simple analytics tools online that can help analyze images and decipher the story. For instance, Planet Compare lets people select two images and put them into a slider for the purpose of comparison. Similarly, Planet Timelapse lets people select multiple images and create an animated story of change. "Planet has around 500 images for every given location on Earth's landmass — a massive dataset documenting immense change. We created these tools for journalists to use the data to monitor world events and get unbiased information about what was happening around the world," highlights **Will Marshall, CEO, Planet**.

One can also take help from tools such as Tomnod, GeoHive, OpenStreetMap, Esri's Living Atlas. Tomnod is a volunteer driven initiative which uses DigitalGlobe's satellite imagery and builds on crowdsourcing data, and is open and free for use. In March 2014 Tomnod offered satellite images to the public for identification following the disappearance of a Malaysian Airlines plane. The site was down for two days due to high traffic (100,000 visits per minute).

OpenStreetMap has a huge dataset which is open and has over 4 million registered users today. The Humanitarian OpenStreetMap Team in particular focuses on crisis mapping around the globe making extensive use of satellite imagery donated by a variety of organizations. Esri's Living Atlas of the World gives access to maps and imagery layers from Esri, Esri partners, and thousands of ArcGIS users from around the world. Some of this is open and some accessible for ArcGIS licensees.



Advancements in satellite technology and innovations are ushering in a new era of earth observation

Visualization tools: Journalists also have the option to use many easily available tools to present their imagery-heavy stories in an attractive way. Other than Esri Story Maps which are hugely popular and easy to use, there are many free and open source tools such as TimeLine JS, Odyssey.js, Thinglink, Mattermap, Widgetic etc to present stories in an engaging format.

3D and augmented reality tools: Increasingly being used in weather stories to show effects of, say, a hurricane striking a city, a lot of these are open source, free and easy to use.

Guidelines for beginners

Even though satellites are opening up new frontiers in journalism by providing reporters with a 'Bird's Eye' view of things and the availability of incontrovertible data and precise information, there are some guidelines one must keep in mind.

Don't drag imagery just for the heck for it: Satellite imagery shouldn't be used simply because it's cool even when it doesn't add any value to a story. For purely decorative purposes, simple photos are always better. Even when something has happened somewhere, it is better to use a map to give the spatial context if your imagery is not adding any intelligence to the story.

Don't dig into too technical datasets: National space agencies like NASA or ESA have satellites which use radar or other scientific instruments to measure ice, wind, ocean etc. One needs experts to analyze these specialized datasets. Therefore, such imagery should be accessed only in cases where the media team has data analysts who can read such imagery. The best option is to fall back on NASA/ESA-generated stories on these topics (they actually do a lot of such stories!) or else speak to an expert.

Know you are lucky to have a satellite flying by: But be ready to be disappointed also. Sometimes you may not get anything of a particular area at a particular time — due to time, resolution of the satellite flying by, cloud cover etc. If you have the resources, you could ask DigitalGlobe to task a satellite, but that again is for future times.

Satellites cannot monitor an area many times through the day: Despite the reduction in revisit times, the best-case example is Planet which can monitor all of earth only once a day.

They can't get much insight at night: Clouds and smoke can also impede satellites. There are radar satellites which can look through clouds or image even at night. But again, unless someone is there to analyze those images, it won't be possible for a layman to read them.

Resolution matters: Know what you want; know what details you want. If you are looking at a flood-hit city or a quake-hit terrain, civil government satellites like Landsat and Sentinel are excellent free sources of data. "To understand human-scale activity, like what's going on at a construction site, high-resolution imagery is necessary," adds Brinton.

And this may sound silly, but a must for beginners — once you have chosen your image, there is no way you can Photoshop it later to make it "clearer".

Even high-res has limitations: Remember, even 30 cm resolution of WorldView 3 and 4 from DigitalGlobe can give you only so much. For instance, satellite images can detect people, but can't identify them; they can detect vehicles on the road but can't identify the model.

Surely not rocket science

Many journalists still operate with the mindset that imagery is for just visualization — which is the last stage while presenting a story — when imagery could be your primary set of data many a time.

There are several ways to use satellites to report on important aspects, especially when combined with other reporting methods and data sources. Reporting on disasters or change detection stories are simple. For investigative stories, things can take weeks or months to develop, and not all investigations are fruitful. So be patient. As Brinton wraps up, "Contacting us early in the reporting process is the best way to figure out whether we'll be able to help."

So good luck!

Anusuya Datta, Executive Editor
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CAN COMPUTERS DESIGN BUILDINGS?

Many argue that computers don't have an aesthetic sense as humans do. But with machine learning, if computers are fed with the right parameters, they will be able to recognize what people find aesthetically pleasing.

By Sarah Hisham

We're living in a world where computers can calculate our taxes, drive our cars, and book our holidays. Could it also design our buildings? Back in 2013, a study by researchers at University of Oxford has given architects a mere 1.8% chance of being automated. This is because 'creative tasks' which involve a high degree of human manipulation and human perception are difficult to automate.

However, just because certain types of creative occupations can't easily be replaced, doesn't mean that their industries won't see disruption. With the advent of BIM, mixed reality, 3D printing, and other emerging technologies, architects are uniquely placed in the entire digital transformation of construction ecosystem.

CAD vs BIM

During the '80s and '90s, CAD software has replaced the drafting board for architects. Although the software acts as a 'digital' drafting board, architects still need to decide what kind of drawing they're making — plan, section or elevation, before they start drawing. The drawings are created and edited independently.

BIM, on the other hand, allows architects to create a complete building design in documentation package. Plans, sections and elevations can be produced from a single unified model. Such models can contain many project-related data, synchronized with live preview function of the building model. For architects, BIM software will be a single production tool, which comes close to automated design.

Phil Langley, Director, Digital Delivery, Bryden Wood, believes that BIM is much more powerful than just a documentation tool. "BIM is a technology that helps people collect, collate and organize all sorts of information which includes the building fabric (and its performance). It can also include the ways in which built assets might be actually experienced and used by people. The models should themselves become resources of data that can be layered and added to over time to capture many different aspects of the lifecycle and should be seen as repositories of data that can be used to fuel more advanced and sophisticated digital design techniques."

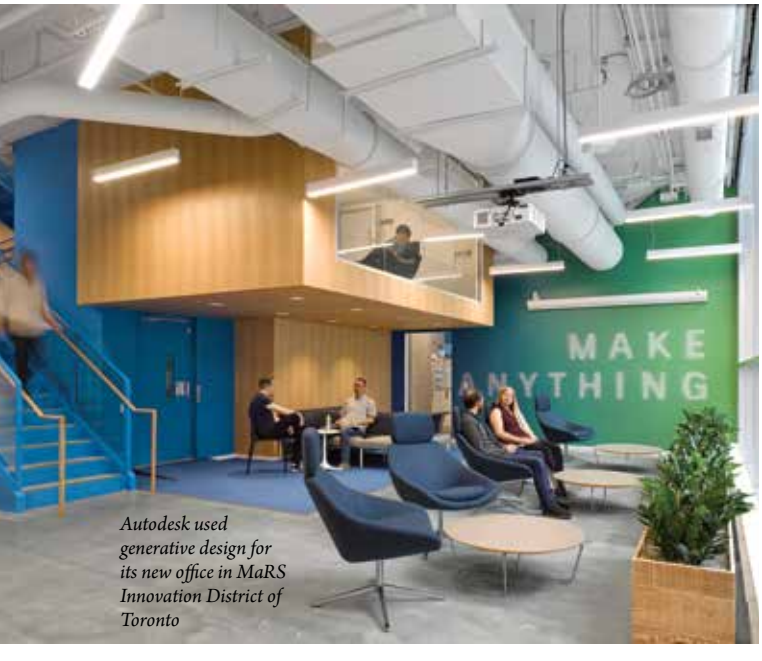
Sasha Crotty, Sr. Product Manager, Revit Platform & Services, Autodesk echoes a similar view, when she says architects haven't fully taken advantage of BIM's capability of capturing design intent and understanding human process behind design. "There is so much knowledge that is trapped inside of past projects sitting on servers around the world just waiting to be reused. The question really is — can automation help make architects more effective so that they can contribute more of their core design skills and knowledge to improve the built environment?"

Autodesk and Google are two of several technology companies pursuing the potential of automated design. Autodesk introduces its experimental design platform, Project Dreamcatcher, which it called 'the next generation of CAD'. Dreamcatcher is a generative design system that enables designers to craft a definition of their design problem through goals and constraints. The system generates thousands of design options that meet specified goals, allowing designers to explore trade-offs between many alternative approaches and select design solutions for manufacture.

While designing its new office and research space in the MaRS Innovation District of Toronto, Autodesk used generative design. The design team took into consideration the requests of all the occupants of the office and their desire for proximity to other teams, the kitchen, or the availability of light. Software made it possible to take all of these factors into consideration to find a set of optimal options that satisfied as many criteria as possible. This enabled the design team to directly incorporate the human factor into their design and make the building entirely custom to the occupants.

Similarly, Sichuan Provincial Architectural Design and Research Institute used AECOsim Building Designer's BIM advancements to enhance information exchange among disciplines and ensure timely collection, update, management, and data application. The software enabled the institute to shorten the project period by 60 percent, reduced design errors by 80%, and increased design depth by 50 percent.

In 2014, Flux, the first startup spun out of Google X laboratory, launched its platform that lets the building industry design eco-friendly homes by drawing on big data. It used AI to cut waste in the design process, and allowing users to easily share information. The popular platform, however, was shut down at the end of March this year, despite having raised $40 million in funding. The company announced that it will be transitioning to a new, as-of-yet unknown business model.



Autodesk used generative design for its new office in MaRS Innovation District of Toronto

So can computers really replace architects?

Many argue that computers don't have an aesthetic sense as humans do. But with machine learning, if computers are fed with the right parameters, they will be able to recognize what people find aesthetically pleasing.

Andy Smith, Director, Product Management, Building Solutions, Bentley Systems agrees that computers are very good at solving defined tasks, like engineering calculations, and can make even some judgements on quality. However, computers will not be able to composite the five human senses anytime soon and really understand a building's poetry of emotion. "As designers sit down and start thinking about designing a building, they think about the five human senses. Also, the human architect needs to communicate the design intent to the client, explain why he or she chose certain things, and then evaluate the responses of the client's emotions and business sense to the design. That is a human interaction that needs to happen."

Randy Deutsch AIA, LEED AP, Associate Director, Graduate Studies, School of Architecture, University of Illinois Urbana-Champaign holds a slightly different view. "Generative design has its

own aesthetic, and for many it's an acquired taste. Today, these designs appear to the trained eye to be somewhat counter-intuitive — for example, where material and voids are placed in a 3D-printing process based on the machine's inner logic which most of us don't have access to, and the result is often gothic in style — which for some, may be apt for our return-to-Middle-Ages politics. Here, there is nothing for us humans to do but to accept the aesthetic of optimization (however defined by those providing the computer input) because ostensibly what the machine generates is perfect — and it is up to us humans to allow the aesthetic to grow on us."

Architecture consists of vast amounts of contract documents and models with repetitive parts. Even today, these fragments are already increasingly reliant upon technology and outsourcing. As machines gain in intelligence, less and less human intervention will be required to assemble those documents and models.

"Automation is going to give architects more opportunity to investigate more design options and more time to consider the human factors that make up 'good' design. Architects will be able to consider energy, prior art, and constructability in near real-time to better understand the impact of their design decisions," says Crotty.

Dale Sinclair, Director, Architecture, Technical Practice, AECOM agrees "By automating aspects of the design process, such as creating multidisciplinary digital libraries that contain fabrication-ready information, more time can be spent on the design effort that makes a building unique

Architecture consists of vast amounts of contract documents. As machines gain in intelligence, less and less human intervention will be required

Sichuan Provincial Architectural Design and Research Institute used BIM advancements to enhance information exchange among disciplines and ensure timely collection, update, management, and data application.

in response to the client's brief and relevant to its environment. With the repeatable tasks that don't add value to the design process being automated, the overall process will create better and faster information for manufacturing."

From an academic point of view, Deutsch shares one interesting drawback of automation. "Recent graduates and emerging professionals in the design industry are concerned that by automating basic, repeatable tasks — known as the deskilling of the profession — will mean that they won't have the opportunity to learn foundational, fundamental steps that all would-be architects have learned in the past in becoming full-fledged design professionals. Even if doing so meant that they were freed-up to design more, they want to be assured that they learn the fundamentals of putting a building together — and fear that automating too much of the design work processes would mean that they will miss-out on this formative step in becoming an architect."

Is automation going to lead to unemployment?

Smith believes the need for human interaction with clients is not going to go away anytime soon. "What will change, however, is the kind of work that humans will do. We will have to morph our skill sets to fit in. Educating the industry about automated design and BIM processes, and how our skill sets fit in, will be important too."

"In the future, greater emphasis on process and multidisciplinary workflow will be required to enable new ways of working that facilitate the creative process whilst ensuring timely and accurate information for making buildings. This will lead to new business models and to the need for new skill sets," underlines Sinclair.

Langley agrees "As an industry we need to develop, nurture and value hybrid skills in our companies — the old disciplinary distinctions are less relevant and we need to find ways to integrate different background and abilities into what we produce." Automation will not degrade, let alone replace, the creativity of architectural practice. Rather it is helping architects modernize their legacy business and reform architecture as a stronger profession in the digital era.

"Computers are like 'digital companions' that help us to think in different ways and to encounter and explore different worlds of possibilities. I think it is a symbiotic relationship in which each side 'learns' from the other. Computers won't replace architects (or designers and engineers more widely), but they can help us to change the way that we approach design," says Langley.

Sinclair offers a scenario in another creative industry that could be easier to relate to. "Musicians have embraced new instruments from the electric guitar to synthesizers and onwards to automated composing tools, as delivery of their outputs has shifted from albums to streaming. Yet the role of the composer remains unaltered."

"Challenge to all architects will be switching from using software as a tool to collaborating with it to come up with optimal designs using their shared knowledge and experience. They will need to partner with their software to capture the goals and the constraints of the design. This partnership will help guide them to the outcome that they desire," points out Crotty.

Moving forward, project teams must embrace 3D design reviews making them commonplace, keeping information live and relevant. Sinclair also points out that BIM needs new workflow. "We see too many projects looking at workflow akin to that used on CAD projects. Those undertaking the lead designer role need to consider how to better connect the geometry and data in models to engineering analysis software and the non-model information, such as project strategies, in the new more complex information landscape."

Technologies like smart city infrastructure and human-scale adoption of IoT devices and networks will mean that the availability of data that can be combined with BIM data repository will increase exponentially. This is a huge opportunity to push the envelope of what architects can achieve with automated design.

As Langley signs off: "Automation in design should be disruptive — we should not simply be encoding our normal behaviors and practices. It should challenge us to do things differently."

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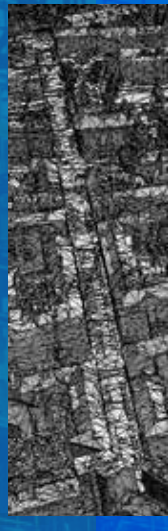
3D MODELING 2.0

With the focus on sustainable living and smart housings of the future, real-time 3D modeling is expected to play an instrumental role in designing and reimagining the contours of construction.

By Aditya Chaturvedi



The construction industry is on the cusp of a disruption. As projects get larger and complex, the growing stress on environment sensitivity has also seen a demand for sustainable construction. Coupled with this, shortage of skilled labor and introduction of automated machines mean there is an urgent need for new ways of thinking and working.

And thinking it is. The rise of the great computer power in a world where the real and virtual worlds are often colliding, and merging, are changing the way the world's infrastructure is designed and made.

Real-time 3D modeling is the hottest trend in the construction and allied sectors. It is the latest in a series of high-end technologies that are transforming the construction sector.

What is real-time 3D modeling?

Real-time 3D modeling has a host of benefits over conventional CAD or BIM 3D. While the latter is about creating a digital model of an asset before it is built, the former is all about creating a digital model of an asset or an environment that is already built in real time using a combination of LiDAR, photogrammetry and other emerging technologies.

"3D modeling for buildings or infrastructure projects employs an intermediate digital representation using any number of reality capture techniques and technologies such as LiDAR and drone photogrammetry. The digital representation represents a snapshot in time of the project site for highly accurate, contextual, and rich visualization," says **Michael Mizuno, Senior Product Manager, Reality Solutions, Autodesk.**

"Recent advances in digital photography and photogrammetric processing, Cloud-based computing, and high-speed scanning have combined to enable the development of cost-effective 3D models," points out **Mark Nichols, General Manager, Trimble Navigation**.

Low cost per measurement, capability of surveying a large area quickly and at high resolution, and with just one survey extracting data multiple times, are some of the main

advantages of 3D modeling. Combination of high-quality imagery with the model helps in easy understanding of the situation and requires less complex interpretation than paper or 2D models.

Real-time 3D modeling provides a very fast and cost-effective way of sharing the existing state of an asset with an engineering team so that they can make design, construction or operational decisions using a digital engineering model, explains **Phil Christensen, Senior Vice President, Reality Modeling and Cloud Services, Bentley Systems**.

3D Reality Meshes with ContextCapture

Further, "3D-enabled visualization of areas that don't have camera coverage [blind spots] are useful for quick decisions in case of any kind of emergencies such as fire, accidents, change of routes," points out **Hanuman Chodagam, DGM, U&G BU, Cyient**.

Real-time modeling would also be instrumental in designing smart urban habitats. Geo-enabling a city makes it easier for the city administrators to understand the problem and enables them to make faster and effective decisions by visualizing and analyzing 3D models. "Many professionals and city departments involved in urban planning and development are benefiting from the convergence of 3D city data and intelligent 3D solutions by integrating all types of geospatial contextual information right from the sky through satellite imagery to underground via radar information," adds Chodagam.

Return of Investment deterring adoption?

Construction industry is capital intensive and cost considerations are crucial. For the popularization of both BIM and 3D modeling, the sum of initial investment and the RoI are factors which could dissuade many companies from embracing these technologies.

However, as per experts, the initial apparent high costs on BIM and 3D modeling are commensurated by time saved, and savings via better resource allocation and optimization of manpower. "If a 3D reality model enables an engineer to work without having to visit the site of the asset, an organization can save 80% or more," underlines Christensen.

As Nichols explains, using real-time 3D modeling in conjunction with mixed reality devices to help in making better decisions at the outset of a project can have a huge RoI, but the RoI will vary according to project based on both the project complexity and the skill level of the project team.

Then there are other variable factors as well, including the management of the project, its accurate status, possible budget overruns etc. "3D real-time modeling solution offers better decision-making and situational awareness, a unified collaborative environment across domains and departments, increased operational efficiency [by up to 20%'], effective monitoring of projects [by visualizing], therefore reducing costs and time, or increasing revenues (such as property tax by up to 30%)," feels Chodagam.

From the vantage point of construction industry and city planners, any solution is beneficial only if the outcome is tangible. What adds to the appeal of 3D modeling is that it is outcome-oriented as well. Real-time 3D model provides a digital context for a proposed new building or an infrastructure project and can help influence better design of the building's location and exterior.

"Better understanding of the surrounding area during the design process can result in exterior design changes that ensure the exterior of a building has a style that fits the surroundings," explains Nichols.

According to **Michael Burenkov, Product Manager (Mass Data Software), Topcon Positioning Systems,** improved understanding of the context around the proposed building site (surrounding buildings, vegetation, etc.) could influence architectural design. Analysis of shifting sunlight and shade during the day/night cycle could influence placement of windows and solar panels.

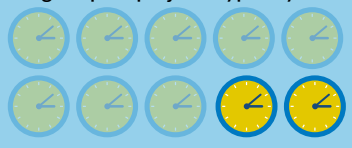
"3D modeling solutions are relatively new and promising tools that are supporting city architects and engineers to digitally model the different elements of a building in real-time and quickly understand how specific

> "3D modeling for buildings or infrastructure projects employs an intermediate digital representation using any number of reality capture techniques and technologies such as LiDAR and drone photogrammetry.

Michael Mizuno
Senior Product Manager
Reality Solutions, Autodesk

The Construction Industry is Ripe for Disruption

Large capital projects typically take

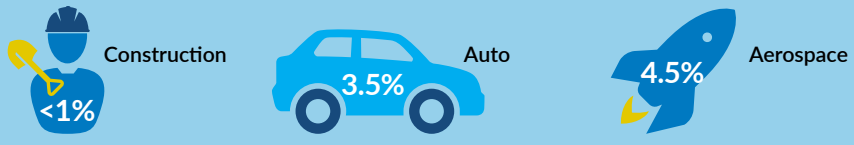


20% longer to finish...

...and are up to

80% over budget,

and R&D spending in construction runs well behind other industries.



Note: Figure represents average percent of revenues

5 big ideas are poised to disrupt construction

1. **Higher definition surveying and geolocation**
2. **5-D Building Information Modeling**
3. **Digital collaboration and mobility**
4. **The Internet of Things & advanced analytics**
5. **Future-proof design and construction**

For the industry to do better it needs to embrace 4 principles

1. **Transparency and risk sharing in contracts**
2. **Return-on-investment orientation**
3. **Simplicity and intuitiveness in the design of new solutions**
4. **Change management**

Source: McKinsey & Company

changes in design or construction models will impact other variables such as structure, load, energy efficiency and the fiscal bottom line," Chodagam adds.

Where 3D modeling fits in infrastructure lifecycle?

The utility of 3D modeling is at multiple levels but out of the four phases in the infrastructure lifecycle — plan, design, construct and operate — the usage varies based on requirements and the project type.

3D modeling with reality capture can be used throughout the lifecycle of an infrastructure project — capturing the existing conditions, detecting potential issues early on, verifying design intent against construction, and having data from the construction and maintenance phases drive design decisions on future projects, explains Mizuno. "We're focused on connecting all phases of a project through better collaboration, data management, and highly accurate and efficient reality data."

Initially, due to high cost, 3D modeling was mostly employed in the maintenance phase of high-value assets such as oil and gas refineries, hospitals, semiconductor fabs, explains Burenkov. However, "As technology democratized, we now see greater adoption in planning and construction phases."

Chodagam finds 3D modeling to be useful during the initiation and planning phase where users can visualize the actual outcome of an infra model — may the subject be a city building, a bridge, or a road. It is extensively used during the project monitoring and control phase as well for

> "Recent advances in digital photography & photogrammetric processing, Cloud-based computing, and high-speed scanning have combined to enable the development of cost-effective 3D models.

Mark Nichols
General Manager
Trimble Navigation

> 3D-enabled visualization of areas that doesn't have camera coverage [blind spots] are useful for quick decisions in case of any kind of emergencies such as fire, accidents, change of routes.

Hanuman Chodagam
DGM, U&G BU, Cyient

illustrating real-time scenarios and changes that take place over a period of time.

However, Christensen is quick to point out that its use in asset inspection is growing quickly. "Reality modeling is applied throughout all phases of the project, including urban models for conceptual planning and more detailed models for detailed engineering designs for transportation, construction monitoring, and asset-life inspection and management," he adds.

Nichols of Trimble also feels that while the most obvious uses are at the planning and design phases, which are where adoption is highest, the technology has potential to improve efficiency during the construction and the operations and maintenance phases as well.

Burenkov feels 3D modeling allows for much better quality control during the construction phase. "Instead of spot checking installation tolerances of a small percentage of elements such as structural steel, complete coverage can be achieved in an automated manner."

Using reality-captured data has the benefit of widely covering spatial information from a job site. However, the raw data can sometimes be very large and can pose sharing and storage challenges. The value of this data is dependent on how quickly the insights from it make it to the those relying on it, explains Mizuno.

How smooth will be the transition?

When it comes to making 3D modeling real time, it might sound just like a very normal upgrade of 3D modeling after adding a real-time component. But it is not as simple. To make sure that real-time 3D modeling functions smoothly as well as those using it are able to adapt to it smoothly, it is essential that the transition is smooth. This is one area where contentious opinions may arise, depending on the size, scale of the projects and the expertise of a particular company.

Nichols uses the analogy of transition from standard television to high-definition television where the content richness in enhanced, to point out the vast difference in quality between 3D modeling and real time 3D modeling. "The transition would be seamless because the reality model from the users' perspective is simply a richer 3D model, provided that the suppliers deliver the tools to use the models across the phases of construction," he adds.

Christensen believes that a seamless transition from 3D modeling to real-time 3D modeling is not only possible, but it is already happening and that too very fast. "We have integrated 3D reality models into our design engineering workflows. So yes, designers creating BIM models can now work in the context of their digital 3D reality model without leaving their design environment," he says.

Burkenov begs to differ here since he believes any complex system cannot have a seamless transition. "This transition will not be seamless. Digital coordination around traditional 3D models (BIM) is not an entirely solved issue. Seamless integration of reality models adds an additional layer of complexity to an already complex system," he elaborates.

What is the role of emerging technologies?

Emerging technologies like LiDAR, drones, mobile mapping, location intelligence etc. are expected to both popularize and boost 3D modeling of structures in real time, making the process more precise and versatile.

3D modeling in real time is a combination of host of methods including conventional surveying, digital photography, and laser scanning.

"Photogrammetry based on digital photos has been an incredibly useful addition to the reality modeling mix since it doesn't require any special equipment and gives a visually intuitive result that is a lot easier for most people to understand than a point cloud," says Christensen.

The main advantage of photogrammetry is that it depends totally on sensors. Digital cameras are inexpensive, small, and widely-available. Current progress in computer vision algorithms and increased access to greater computational resources (GPUs and Cloud computing) automated processing and popularized photogrammetry as the tool of choice for UAV applications. But this doesn't mean photogrammetry doesn't have its downsides. "Indirect measurement approach relies on lengthy post-processing with widely variable output quality. While LiDAR sensors are typically larger and more expensive, they compare favorably in these respects," believes Burenkov.

In the future, miniaturization and cost reduction of LiDAR technology, driven primarily by the needs of the autonomous automotive navigation market would ultimately shift this comparison in favor of LiDAR.

Model capture creation directly using cellphone is possible now and soon the ability to mix photos and LiDAR point cloud to capture 3D reality models would be realized. This would mean that a person on the site would be able to get a real-time 3D reality model using cellphone. Leveraging visual fidelity of photos and high-resolution LiDAR images to create 3D reality model too would be possible very soon.

"With faster tools for data acquisition such as mobile mapping systems and faster

> If a 3D reality model enables an engineer to work without having to visit the site of the asset, an organization can save 80% or more.

Phil Christensen
Senior Vice President, Reality Modeling and Cloud Services, Bentley Systems

> Improved understanding of the context around the proposed building site (surrounding buildings, vegetation, etc.) could influence architectural design. Analysis of shifting sunlight and shade during the day/night cycle could influence placement of windows and solar panels.

Michael Burenkov
Product Manager (Mass Data Software), Topcon Positioning Systems

processing, models can be kept up to date much easier than in the past. However we are many years away from true real-time models due to the volumes of data involved, the speed of communications, and the speed of processing," stresses Nichols.

How AI and machine learning will be a disruptor?

Virtually no technology today is immune to the advances in the fields of machine learning, deep learning and artificial intelligence, and 3D modeling too isn't far behind. AI-driven reality models would soon become a reality and construction industry has to be prepared for this tectonic shift.

"AI and machine learning are two crucial technologies for automating the information extraction phase of the overall workflow. Only when this greater degree of automation is achieved will we be able to unlock the full potential of 3D modeling technology," believes Burenkov.

Recent developments in virtual and augmented reality, photogrammetry, and integration of Web technologies with GIS, satellite imagery and location data via GPS have opened up opportunities for large-scale urban landscape visualization and 3D virtual development for cities. It is noteworthy that the synergistic confluence of all these technologies would add more value and infuse dynamism in 3D modeling.

3D city experience is the key to any city's development concerning the current growth of urbanization and infrastructure. 3D virtual modeling, visualization, dissemination, and management of urban infrastructure is one of the disruptive opportunities in the geospatial arena across the world that has innovations and challenges as well, underlines Chodagam. He adds that intelligent 3D models are the most discussed opportunities in geospatial space, which has their own significance, benefits and complexities.

With increasing uptake of BIM and 3D modeling, there would be a rise in IoT-based construction platforms as well. IoT is expected to transform the construction industry forever. Currently it is in nascent stages but with ongoing research it is expected that advances would be made at a rapid pace.

As Mizuno of Autodesk points out that sensor data displayed on models provide safety information in specific locations, and can help facility management teams make their buildings more efficient.

We are also seeing AR/VR/MR becoming more than a tool for comparing the real world and design. Design, coordination, execution, and facility management will all be steps in construction that could benefit from mixed reality.

The combination of BIM with real-time 3D models enhanced by the Internet of Things would bring a great value for information to understand the question of 'where' and 'when'; of any incident or situation. This greatly enhances collaboration and communication across disciplines and communities. "Such combined 3D solutions offer a unified collaborative environment for cities, natively supporting standards such as Building Information Modeling and Geographic Information System," stresses Chodagam.

What is the future?

Exploding population, shrinking spaces and crumbling infrastructure in cities leaves us with no other option but adopting some drastic and disruptive measures. Large scale urbanization will lead to a massive amount of infrastructure of all kinds delivered over the next 20 years. This will provide impetus to espousal of all aspects of digital engineering.

Construction industry's productivity has trailed that of other sectors for decades, and there is a $1.6 trillion opportunity to close the gap. This amount would meet about half of the world's annual infrastructure needs or boost global GDP by 2%. As Nichols points out, governments should leverage the benefits of real-time 3D modeling systems to inform and improve their planning processes, enabling better community engagement in the planning processes, enabled by the simpler understanding of the rich 3D models of the real world, merged with the proposed planning changes. As for what should be done to accelerate the pace of real-time 3D modeling adoption and increasing awareness in the industry, this is an issue for each of the industry suppliers to address.

If construction companies use existing incentives around R&D, they should be able to accelerate the adoption of real-time 3D modeling within their projects. There is also a continuing need for more education into what can be done and the best practices for applying real-time 3D modeling and this is where the industry and professional associations can collaborate and contribute. However,as Christensen stresses, ultimately, it is going to require engineering and construction companies to commit to investing in digital techniques and training.

The initial high cost might serve as a deterrent in adoption of real-time 3D modeling, but significant cost benefits accompanied by the mainstreaming of technologies like LiDAR, UAVs and AI would make things easier.

The coming years would see more offsite fabrication, machines/robots augmenting staff, remote project management, modulization, global BIM adoption, consolidated software, and much less software fragmentation. It needs to be seen if 3D modeling can be synchronized with these technologies that will drive the future.

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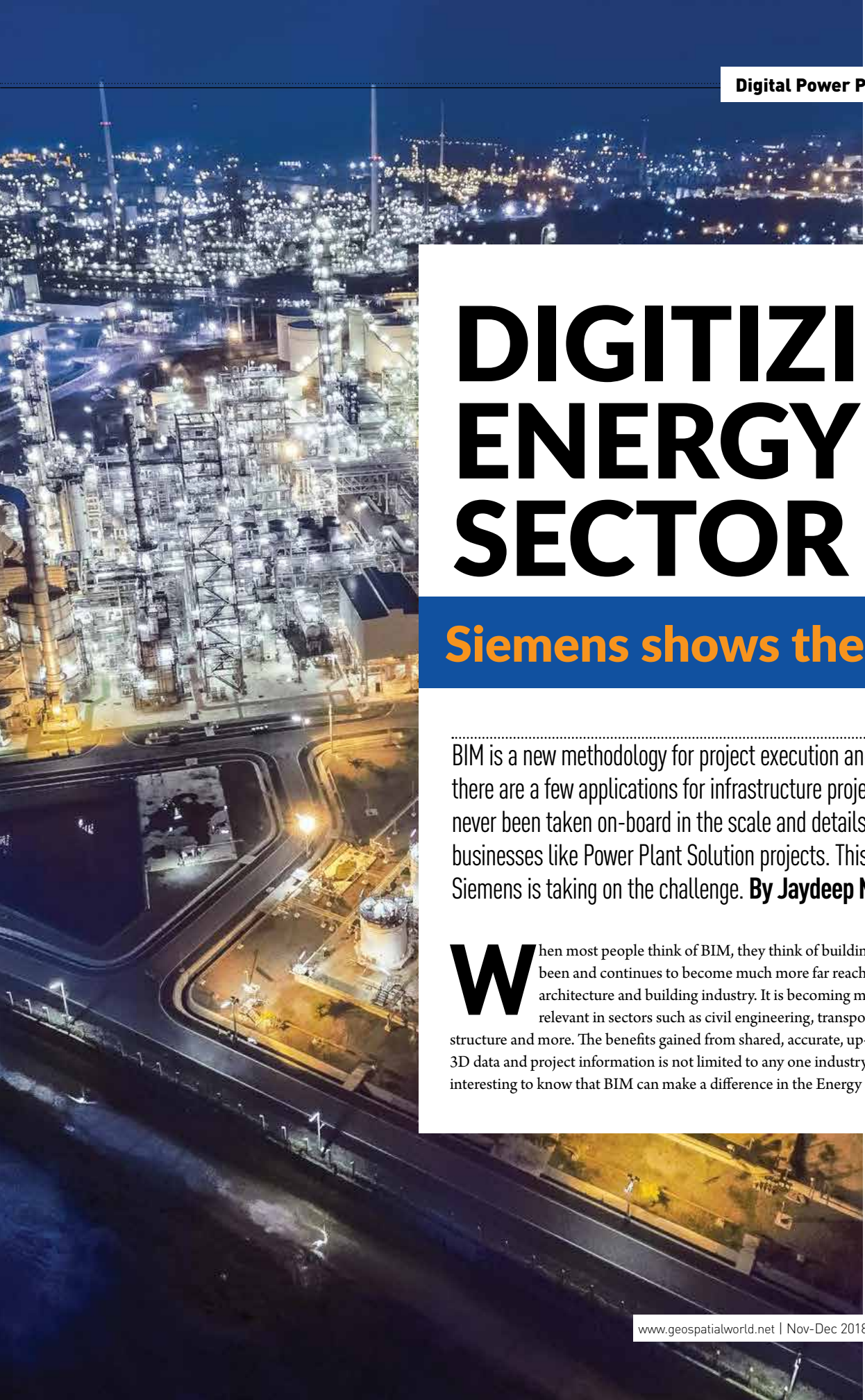

DIGITIZING ENERGY SECTOR

Siemens shows the way

BIM is a new methodology for project execution and though there are a few applications for infrastructure projects, it has never been taken on-board in the scale and details of large businesses like Power Plant Solution projects. This is where Siemens is taking on the challenge. **By Jaydeep Naha**

When most people think of BIM, they think of buildings. But BIM has been and continues to become much more far reaching than just the architecture and building industry. It is becoming more and more relevant in sectors such as civil engineering, transportation, infrastructure and more. The benefits gained from shared, accurate, up-to-date digital 3D data and project information is not limited to any one industry or trade. It is interesting to know that BIM can make a difference in the Energy sector as well.

Continuous progress is being made on how Siemen's digital power plant can be utilized further using the AR technology. Efforts are being made to upgrade the present generation 3D model power plant to 5D by incorporating cost information as 4th dimension and time schedule as 5th dimension

Being a technology driven company, Siemens has always tried to implement new technologies in its processes to bring down cost, optimize time schedule and ultimately bringing more value to the customer.

BIM is a new methodology for project execution and though there are a few applications for infrastructure projects, it has never been taken on-board in the scale and details of large businesses like power plant solution projects. This is where Siemens is taking on the challenge of not only developing a business model for the same, but also preparing the digital world for a refreshingly new execution philosophy that keeps up with the company's fast-track and futuristic ambitions of enabling the Energy sector with the depth of digital learnings to serve the Customer First approach.

Keeping this philosophy in mind, execution teams in Germany and India are working together for an advanced solution that would not only stabilize large scale project execution philosophies, but would also change the digitalization strategies that others would envy to follow.

Engineering in Siemens already uses the latest 3D plant engineering tool chain for their design activity. By implementing BIM methodology, the existing software tool chain will be even further improvised bringing in additional benefits.

What led to the idea?

It all started with the effort to understand the Erection and Commissioning group, by recognizing their needs, and learning what additional inputs they require to ease site activities with core focus on reducing time and cost.

Although, the project deliverables created by the engineering team, are accurate and as per latest state — of-the-art industry standard, much more could be achieved. Project scheduling, detailed activities are prepared focusing on engineering activity rather than erection and commissioning. There has always been a gap between erection schedule and actual engineering deliverables.

Expectation for the execution team is, when site work for a particular erection area starts, all the engineering inputs, progress, shipping and costing details should be available for that area.

Till recently the majority of the deliverables have been in the form of 2D documentation and excel sheets based on bill of quantities. Sometimes 3D models are shared but that is of not much use due to lack of intelligent data at site. Even though the 3D model developed at the engineering hub is intelligent enough, there remains a lot to improvise.

As the execution group is constantly striving to achieve lower cost and reduced execution time, in this effort, the team in Siemens is moving to a more digitalized platform where with the help of technology, execution activities can be more efficiently managed. Also, there has been a paradigm shift in the way execution activities are managed nowadays as both raw material and labor costs are increasing day by day.

With the continuous development of cloud computing, augmented reality and artificial intelligence, the technology is readily available to achieve this goal.

Bringing ideas to fruition

To accelerate its digital maturity, the execution team is currently working on modifying its approach in many cases.

It is focusing on area-based erection scheduling, emphasizing more on utilizing the 3D model, a virtual power plant or digital twin and augmented reality. For better utilization of man-hours available at site, both engineering and execution activity scheduling is being done per work area and engineering deliverables like material take-off, costing details, drawings and documents are being generated as per predefined work areas.

For ease of erection, the connection information is now also visualized with the help of review software. Using a handheld tablet and referring to the 3D model, the colleagues at site can now know exactly where a particular pipe spool will come or where in the plant a weld will be situated. In the 3D review model itself, information like spool numbering, Inch–Dia, weld category and weld sizes are available.

Parallelly, for better project coordination, better communication and fast tracking of repairing activities, augmented reality is also being implemented for direct communication between engineering offices and site offices. This has a tremendous potential of cost reduction and time saving when implemented with full potential. Continuous progress is being made on how Siemen's digital power plant can be utilized further using the AR technology. Efforts are being made to upgrade the present generation 3D model power plant to 5D by incorporating cost information as 4th dimension and time schedule as 5th dimension.

The ultimate goal is to a have a digital twin of an actual power plant, which will be a single source of information from concept, engineering, erection, commissioning and finally for operation and maintenance. Siemens is strongly motivated to get to the next generation of customer centric approach for business execution in the power plant business, and BIM would be an essential methodology for completing the journey.

Jaydeep Naha, General Manager
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for money?

and for

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Who Moved My Base?

JAVAD
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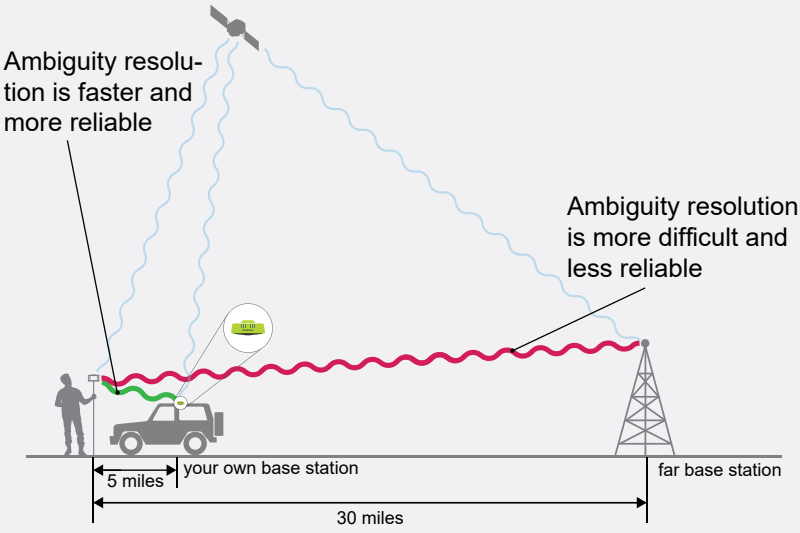
Advantages of your own base station and short baselines



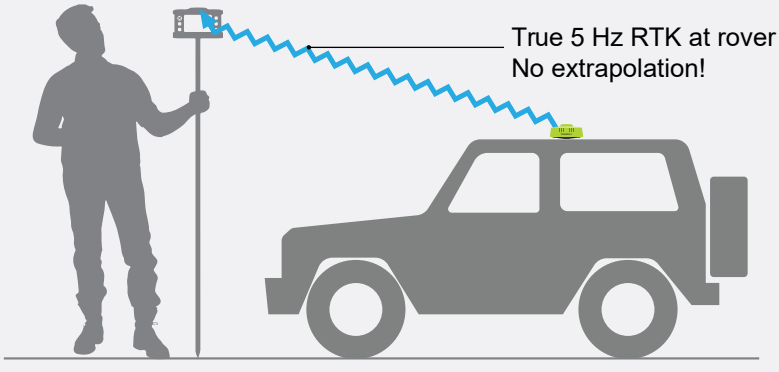
1. Shorter baselines provide significantly better **reliability** because the ambiguities are much easier to resolve and the correct ambiguity solution has an obvious contrast.

2. Shorter baseline has better **accuracy** because most of errors (like atmospheric and tropospheric effects) are common and cancel.

3. Shorter baseline ambiguities are resolved much **faster**. In longer baselines, incorrect ambiguities may pose as being correct in the statistical evaluations and it takes longer to isolate incorrect ambiguities.

4. Shorter baselines make it feasible to work in **difficult** areas (under tree canopy and in urban environments) because ambiguities have better contrast and are easier to resolve.

5. **Beast Mode RTK** is available only via our TRIUMPH-2 and TRIUMPH-1M base station. It makes ambiguity resolution up to 5 times faster because base station transmits base data 5 times per second. 5-Hz Beast Mode RTK is totally different from the up to 100-Hz RTK that is done by extrapolating the same 1-Hz data 100 times per second AFTER the ambiguities are fixed. This extrapolation technique does not improve the ambiguity resolution speed and is mainly used in applications like machine control after the ambiguities are fixed.



6. In addition to savings due to speed and reliability, it saves you RTN and communication charges. A complete system, Base + Rover + Radio + Controller & Controller Software, starts at **$19,990**. 0% financing available ($1,537.69 per month for 13 months) to active license US Professional Land Surveyors (PLS). Extended finance terms also available

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FL

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G’day, Mate!

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From the company who brought you the best GNSS receiver on the planet, our latest innovation will allow you to break away from decades-old methods of measurement and positioning. Why employ a workflow designed for yesterday’s gear?

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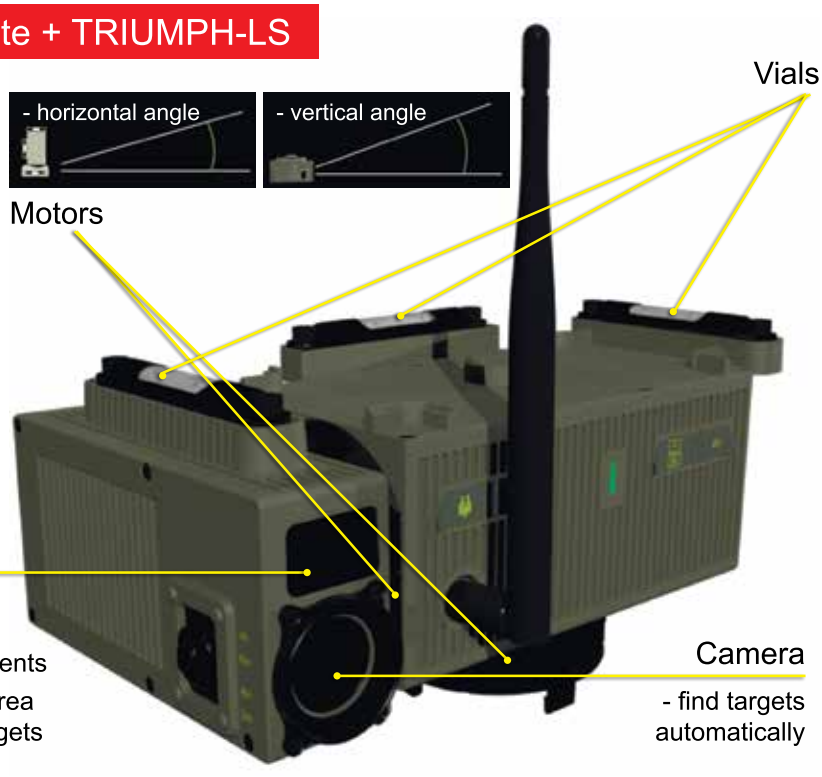
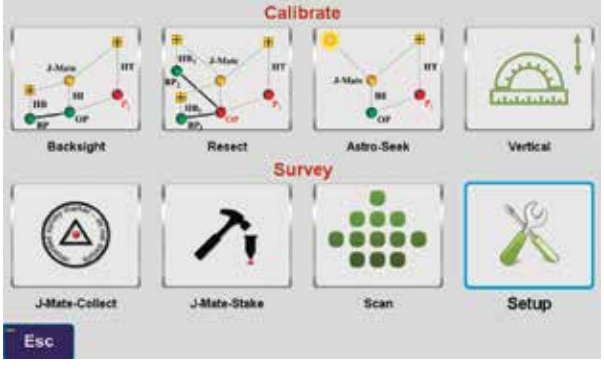
This is J-Mate

J-Mate features a **camera** that can also find targets automatically, and a **laser module** for accurate distance measurements. It scans and examines the area around the intended target to ensure reliable identification. Two **precision encoders** measure vertical and horizontal angles to the target. Three **precision vials** allow a visual check on levelness of the instrument.

Take control with J-Mate + TRIUMPH-LS

Similar to using conventional total stations, to use the J-Mate you need first to establish its accurate position and calibrate its vertical and horizontal encoders. Then proceed to shoot the unknown points. This is similar to using any total station, but we have improved and automated the process.





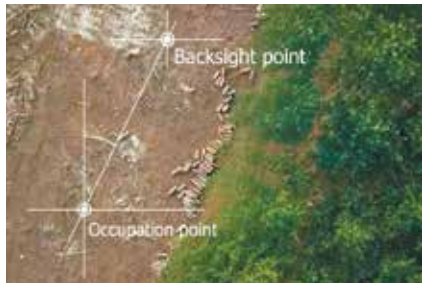
With J-Mate you can establish your occupied position via three different ways: 1) Backsight; 2) Resection; or 3) our new Astro-Seek (more of that later).

When you click the Setup icon of the J-Mate screen you get access to parameters that tunes J-Mate to your desire.

After the J-Mate is calibrated, you can proceed with your work as normal via the Collect or Stake icon.

Backsight icon

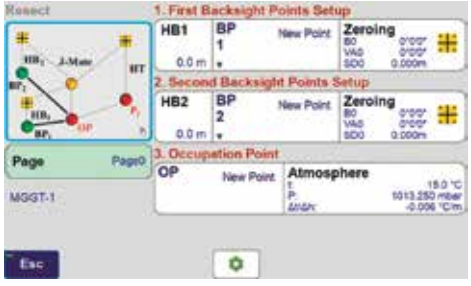
If GNSS signals are available at the job site, click the J-Mate Backsight icon.

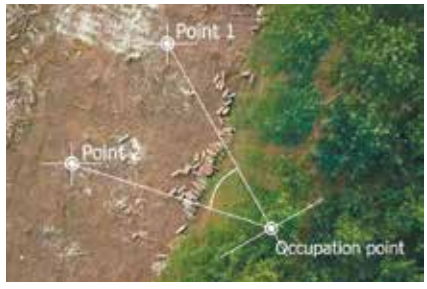


This screen appears which guides you to determine the accurate positions of the Occupation Point and the Backsight Point, to establish an azimuth and calibrate the J-Mate angular encoders.

Resect icon

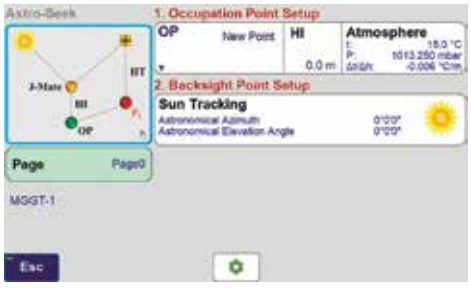
If GNSS signals are not available at the Occupation Point, click the “J-Mate-Resect” icon





Shoot two or more known points to establish an accurate position and calibrate the encoders. Then continue to shoot the unknown points.

Astro-Seek icon



And now our new feature!

We have added a new innovative feature to the J-Mate that it can automatically calibrate itself via its automatic Sun or other astronomical objects-Seeking feature.

J-Mate-Collect

After calibration is performed, click the J-Mate-Collect icon to shoot the unknown points.

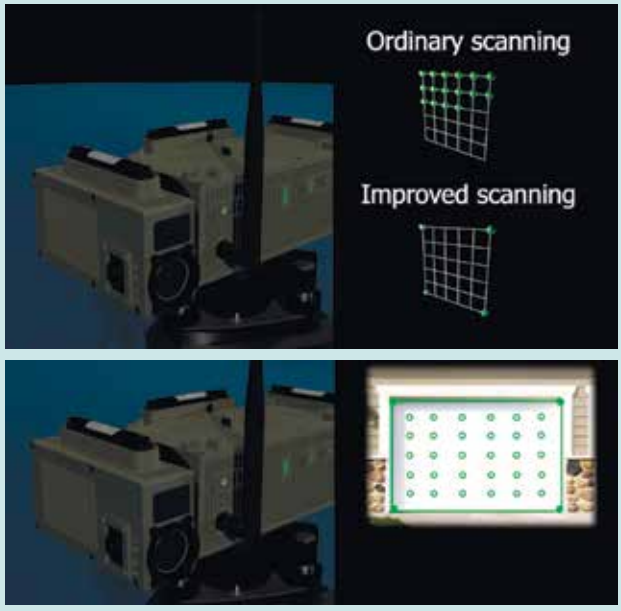
J-Mate-Stake

Click the J-Mate-Stake icon to use for stakeout.

The functions and features of the J-Mate stakeout are very similar to our conventional GNSS stakeout: RTK solutions guide you to the stake points. But with the J-Mate the camera follows the “+” sign that you carry and then the encoders and laser measurements (shown on screenshots) provide guidance to the stakeout features. This is similar to Visual Stakeout and other useful and innovative features of our TRIUMPH-LS GNSS RTK stakeout.

Smart laser scanner

J-Mate is also a camera-aided, smart laser scanner. The camera identifies redundant points that do not need to be scanned, but instead can be copied or interpolated from other readings without loss of information. That is, if the camera identifies a completely uniform flat area, it only scans the four corners of that area and interpolates in between. This feature can increase the effective speed of the scanner to much higher than its native 10-points-per-second speed.



The scanning feature can also be used to find items like wires and poles and "closest-in-view" items and shoot them automatically.

Seize the day with J-Mate + TRIUMPH-LS

And all components fit in this small carrying case.

So we have a "**Total GNSS**" with a "**Robotic Total Station**" and a "**Smart Laser Scanner**". We call it our **"Total Solution"** and it can be operated by one person to perform jobs.

Hybrid RTK

Triple-Check your RTK results and ...

It triple checks the accuracy of RTK solutions by post-processing and CORS processing. In addition, if RTK can't a get fix (because of bad environment or bad communication with Base) Hybrid RTK comes to your rescue... automatically.

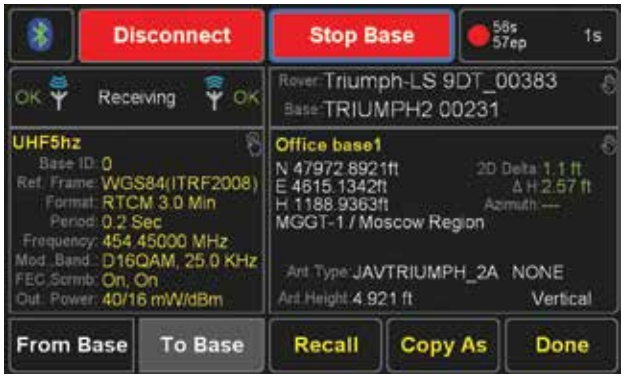
Nine Automatic Steps of Hybrid RTK

Confidence and Speed... Unlimited!

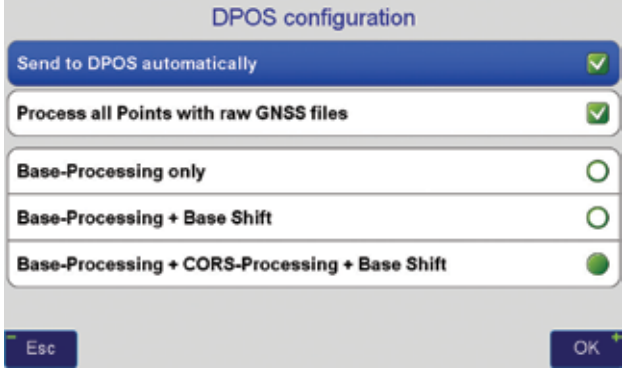
You do this

1 Downloading base data.

When your RTK job is finished, go to your base and in Base/Rover screen click "Stop Base". Base data will be downloaded to TRIUMPH-LS via fast Bluetooth automatically. All of the following steps will be performed automatically too when WiFi/Internet connection is established.



DPOS options



Automated steps

2 Base data downloaded.

3 Awaiting DPOS server connection.

4 Rover points and base data sent to DPOS. Awaiting DPOS to process base-rover.

5 Rover points processed with base (relative).

6 Base data sent to DPOS to be processed with CORS data. Awaiting CORS data.

7 Base processed with CORS and corrections applied. (Absolute)

8 Base and rover points sent for CORS processing.

9 Rover points individually processed with CORS data.


Where Have You Been With Your TRIUMPH-LS Lately
"Got some shots that he could not get with our gr5's."
"I often get 2 days of work done, in a day."
"Truly amazing with a 4" grape vine directly overhead and the tree cover."
"The LS has increased our productivity 2:1."
"I got some ridiculous 'fixes' today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it."
"Btw, pardon my French, but holy shit. I got some ridiculous 'fixes' today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it."
"I often get 2 days of work done, in a day."
"Since I got the Javad system, I go places NEVER BEFORE possible, and WITH confidence, because, the quality checks are there."
"This thing is bad ass!"

GEO-BIM DATA INTEGRATION: EASIER SAID THAN DONE?

The boundary between geo and BIM is getting fuzzy, but working with IFC models from practice shows that converting BIM data in a format useful in GIS and vice versa is still far from straightforward. **By Jantien Stoter, Ken Arroyo Ohori and Hugo Ledoux**

Geographical information systems (geo) data has traditionally been used to model and analyze the living environment at the scale of a city, and Building Information Modelling (BIM) data has been used for the design, construction and management of buildings. In recent years, the boundary between geo and BIM has been quickly getting fuzzy, and there is growing demand to combine both types of data in one integrated environment.

In an integrated environment, an architect (BIM) could take environmental variables (geo) into account while designing a building. And a municipality could then automatically check the design (BIM) against its environmental impact (geo), such as whether it is below the maximum building height, how exposed to noise its residents will be, and how much solar irradiation the building will receive. Building permission procedures would thus become both faster and more reliable, and furthermore 3D city models would be more detailed and up to date: the design of a permitted construction or building is a source for the 3D city model, with added information such as building materials and energy-related attributes that can be used for future planning

of the city as well as for the construction's life-cycle management.

What would it take to realize this vision?

In practice, this integration is not straightforward. Since the 1990s, people have been thinking about reusing BIM (at that time CAD) data in geo applications, and vice versa. But this reuse was still limited to project-based exchanges of data. Even nowadays, the integration of geo and BIM data is still far from straightforward. The geo and BIM worlds have many similarities, but also many differences in their purposes for gathering data, the way they geometrically model identical objects, the level of detail, the software they use, and their open standards: (City)GML and LandInfra/InfraGML for geo and IFC for BIM. Because of these differences, the BIM and Geo data also differ fundamentally from each other, consequently reuse is not trivial.

Semantic mapping

The solutions for the integration of BIM and geo data have so far mainly focused on 'mapping the semantics' of features in both data models, or converting geometric objects one-to-one. For example, software such as BIMserver, IfcExplorer and Safe FME all offer the possibility to convert IFC models to CityGML: all elements are converted without selection or post-processing, and geometries are simply converted to a Geo data structure.

This is not a problem for visualization, however, the semantics attached to the boundary surfaces used in geo (e.g. interior wall surface and exterior wall surface) differ from the one of the whole object in BIM (e.g. the solid wall). For meaningful use of IFC data in geo applications, spatial concepts such as 'rooms' must be reconstructed by converting, aggregating and simplifying walls and other related elements (modelled in BIM as volumes) into areas that are joined to form a closed volume, (*See Figure 1*).

What is the aim?

Geo-BIM integration is often brought as a solution, but in practice it is not easy to import any BIM data, structured in the open IFC format, in a meaningful way in geo software, and vice versa. Assuming that the differences between BIM and geo serve a specific purpose, Geonovum, in collaboration with BIM Loket and a number of important stakeholders (Rijkswaterstaat, Kadaster, the municipalities of Rotterdam and The Hague) started a GeoBIM project in 2017 in the Netherlands. This project helped the stakeholders to gain more insight into how BIM data is needed in geo-applications and the other way around, and how an open solution can be developed for these conversions (IFC <-> CityGML) to push the integration further. The research was carried out by research groups from the two respective worlds — 3D Geo-information at TU Delft and BIM at TU Eindhoven.

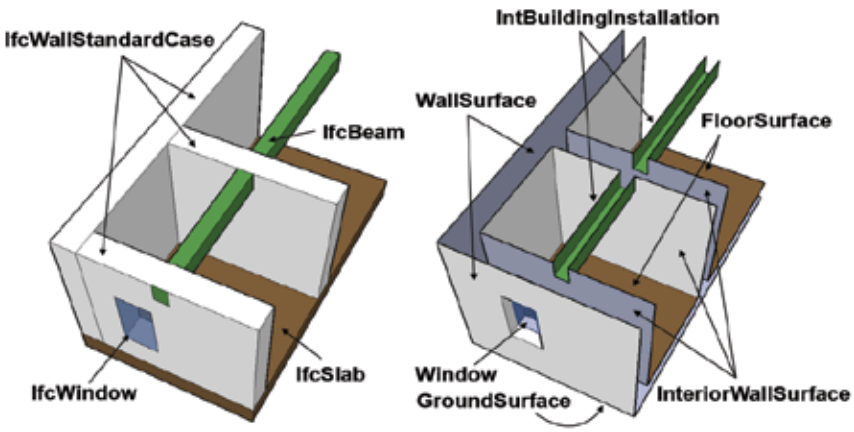


Figure 1: The different modelling approaches of BIM on one hand (a collection of volumetric elements) and geo on the other (spaces are modelled by means of observable surfaces). Source: Claus et al 2009.

Geometry differences between CityGML and IFC

The project focused on the conversion of the geometry because it is an aspect that seems to have been ignored by previous research (which focused mostly on semantics mapping). Being able to convert the geometry is a necessary step for the reuse of data in software from the other domain; simply mapping them is only a first step, but does not allow use of datasets.

CityGML contains 12 modules for different types of objects such as buildings, bridges, roads, and water (lakes and rivers). They all have an explicit geometry description in 3D. This means that the geometry is described on the basis of boundaries with coordinates. IFC files have many more classes, (more than 1000). Moreover, the geometry is almost never described through an explicit description of the boundary, but much more often by so-called 'implicit' geometry. This means that the geometry can be obtained through operations (scaling, translations, rotations, etc). An object is described, for example, on the basis of predefined parametric profiles, (*See Figure 2*).

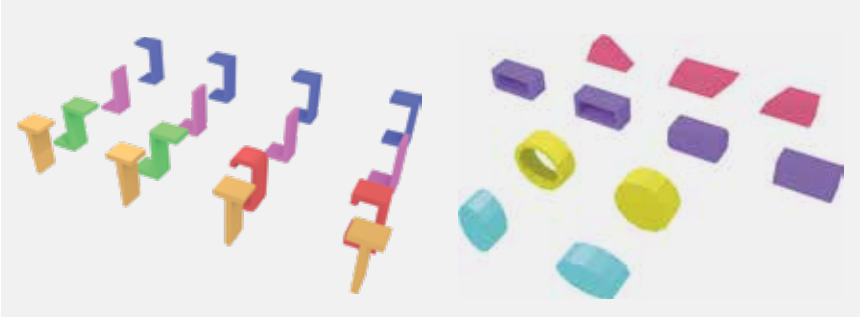


Figure 2: IFC has several predefined parametric profiles, such as those based on the characters U, L, Z, C and T (left) or based on trapezoids, rectangles, circles and ellipsoids (right).

The conversion method

The project focused on buildings and there were three IFC models available for (real world) designs in the municipality of The Hague with several thousand (!) elements per file, (*See Figure 3*). The conversion was developed with the help of two open-source libraries — IfcOpenShell and CGAL.

In the conversion, all relevant (volumetric) elements from the IFC files are converted to CityGML classes with associated geometry. Relevant here means all elements that, according to the IFC standard, form an "important functional part of a building" and are relevant in a Geo context, examples of these are IfcBeam, IfcDoor, IfcChimney, IfcColumn, etc.

purpose, the geometrical errors are not a problem.

Most common mistakes

The most common (geo) errors in IFC files were: non-planar surfaces, self-intersecting volumes, and intersections between two different elements. Especially the self-intersections were interesting (*See Figure 4*), because the IFC standard explicitly prohibits them. Apparently, this is not controlled by the BIM software used (or the export to IFC created these).

Further processing of the geometries (*as shown in Figure 1*) is only possible with correct geometries. Therefore, a detection and repair solution was developed for many

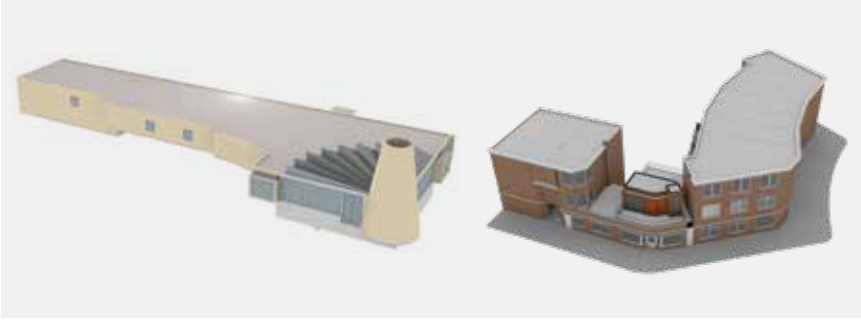


Figure 3: Two of the three IFC files used in the municipality of The Hague: CUVO Ockenburghstraat, courtesy of KOW architects (left) and Rabarberstraat 144, with thanks to Studioschaeffer (right).

Results

Visually, the results obtained were nice. But unfortunately, it had to be concluded that the IFC files, which were exported automatically from BIM software by the architects, contained so many errors (more than 150 per IFC file) that it proved impossible to generate error-free geo geometries that are needed for spatial analysis. Often the conversion was impossible because these invalid objects made the software crash.

These errors were mostly errors from a geo perspective; they pose not per se a problem for BIM professionals. Firstly, because most BIM software can handle these 'errors': implicit geometries are only errors after they have been converted to explicit geometries. And secondly, because BIM modellers are focused on designing a digital plan (and not making data for spatial analysis). For this

of these errors. A solution for all possible errors for the dozens of possible IFC geometry types, however, was not realistic in the scope of this project and consequently an automatic conversion from (any) IFC file to a file that can be used in Geo software was unfortunately not possible.

Another problem that made automatic conversion much more difficult than expected, is that IFC has so many classes and there are no or hardly any validation tools, that in practice IFC models can be very different for identical situations, even within the same file. For example, most walls or columns can be built by sweeping a profile of their base upwards but also by a side profile sideways.

A conversion that takes all possibilities into account is impossible to develop or only for (very) large companies.

In conclusion, a conversion of 'ideal' IFC models, generated in a controlled manner is possible (as also frequently studied in science). However, due to the 'errors' in real-world IFC models (often exported from BIM software) and the large variation in IFC models, automatic conversions to CityGML for spatial analysis with real-world IFC models are much less straightforward.

The Open Geospatial Consortium confirmed these challenges in a project on the use of IFC and CityGML in urban planning. They identified inconsistencies in coding IFC elements that complicate the transformation to CityGML and conclude that in order to adopt IFC in urban planning, a clear set of specifications needs to be set for the preparation of IFC files.

Guidelines

Instead of investing even more time in detecting and fixing even more errors for

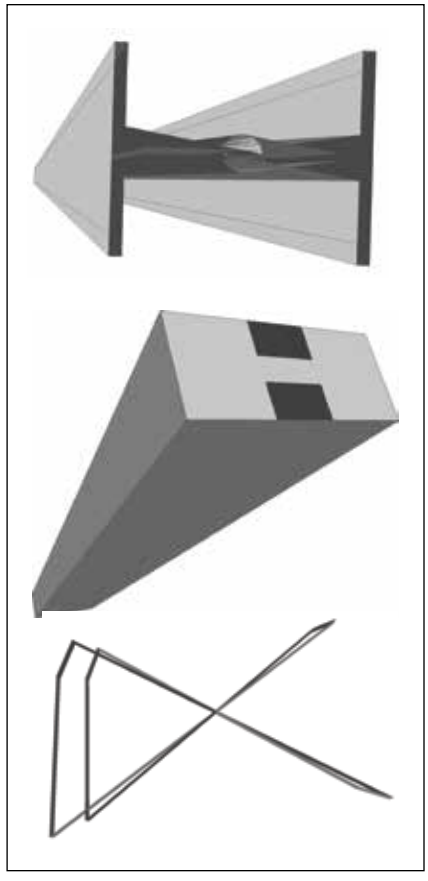


Figure 4: Three examples of errors found in the IFC files

Guidelines for preparing IFC data for better Geo-BIM integration

Correct use of IFC

The first obvious guideline for IFC modeling for geo is to strictly follow the available regulations for proper use of IFC and to have BIM software support these guidelines. The IFC standard, but also additional implementation guidelines prescribed by the international standardization organization buildingSMART, prescribe which IFC classes and attribute values are to be used in what cases. They also prescribe that redundant or intersecting objects should be avoided. Unfortunately, these guidelines are not always followed (and assured) in practice. Consequently, in practice standardized IFC data, which meet the guidelines required for automatic conversion, do hardly exist.

Georeferencing

Another important required guideline concerns the georeferencing of IFC data in a way that is understandable for BIM professionals. Although georeferencing is a fundamental requirement for using IFC data in geo at all, in practice georeferencing of BIM data is far from self-evident. In theory, latitude and longitude can be indicated in the IFC file with an offset from the North. However, in practice these values are often set to '0', or they refer to a completely wrong (probably a default) location or to an 'approximate' location (a point in the city in question).

Georeferencing is complicated by the fact that different versions of IFC have different notation values for the longitude: a positive value is in IFC2x3 east of the 0-meridian and in IFC4 west of the 0-meridian. For architects georeferencing is not always useful, because of their local focus. That is why making architects aware of the value of georeferencing, is an important part of the solution, helped by tools. For example, we developed a web service that reads an IFC model and then shows it at the location recorded in the IFC file.

The user can then see where her IFC file is positioned. If this location is incorrect, the user can indicate the correct location, after which the coordinate information in the IFC file will be overwritten.

Formal agreements about modelling methods

Other guidelines that are recommended for generating geometrically valid objects (and enforcing it with a greater availability of validation tools) and for modeling concepts that may not be relevant for an architect, but they are for spatial analysis, and which are very difficult to reconstruct afterwards, e.g. a (correct) geometric representation of 'spaces' (rooms, halls and stairways). A final guideline is to make formal agreements on how specific situations should be modeled with IFC. In addition, avoid as much as possible the generic class IfcBuildingElementProxy (which seems to be frequently used), but instead use one of the numerous specific classes, preferably a class that can be directly mapped with a CityGML class (such as IfcSlab).

even more possible IFC alternatives, it seemed better to formulate guidelines for modeling IFC data so that automatic conversion to Geo data becomes possible (as also recommended in the OGC project).

These guidelines (see box above) could be used as strict requirements for specific use cases, such as those from a licensing process, to more general guidelines that should apply at national or even international level to all IFC files in order to achieve better integration between the BIM and Geo world.

The focus is on preparing IFC data. Of course, it also needs to be considered how geo data can be prepared, so that it is better accessible to BIM applications.

It should be noted that it is mostly the end-user software that does the conversion from its own proprietary data format to IFC without the user having much control over the conversion. Therefore, support of these guidelines in mainstream BIM software will further help GeoBIM integration.

Finally

Geo-BIM integration offers many possibilities, as many studies, pilots and showcases have already shown. But working with IFC models from practice shows that converting BIM data in a format useful in Geo and vice versa is still far from straightforward. An unambiguous and specific modelling of IFC is necessary to be able to automatically convert a model from the BIM domain, consisting of a large number of geometrical elements (often with volumetric and parametrised geometries), to aggregated objects suitable for Geo analyses. Only then will the numerous potential applications of Geo-BIM integration become feasible. Making agreements for such restricted data, expressing these in open standards and strictly following these standards is an important first step.

Acknowledgement

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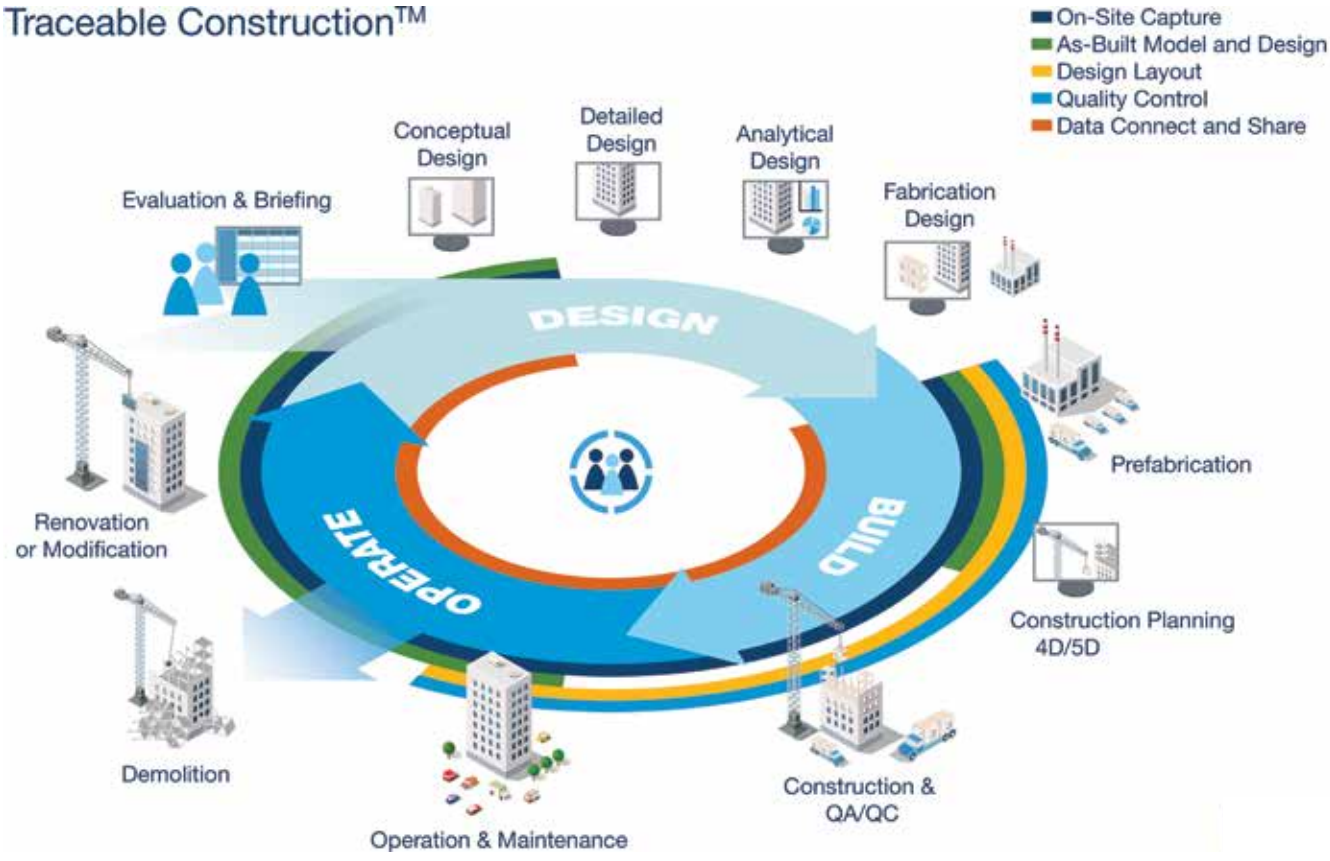
WHAT IF IT'S SIMPLER THAN IMAGINED?

The construction industry has always shied away from adopting new technologies. However, software developers today offer construction professionals the ability to continuously monitor a project with real-time comparisons against CAD designs.

The construction industry's lukewarm reception towards technology is a challenge that is well documented, and one that has held the market back from its full potential over the last couple of decades. According to KPMG's Global Construction Survey, where over 200 major project owners and contractors rated themselves on technology adoption, only 8% of these companies emerged as "cutting-edge visionaries".

While this minority group adeptly made use of various solutions such as



The Concept of Traceable Construction™ — an overview of traceability across the construction value chain.

project management information systems (PMIS), automated digital workflows, data and analytics, and Building Information Modeling (BIM), most others have remained conservative, choosing to rely on 'tested and proven' methods of project management. Often, companies cite lack of certainty in reaping the full benefits of new technology, vis-a-vis the costs and risks involved. For some others, it is the mere reluctance of stepping out of one's comfort zone that hinders innovation.

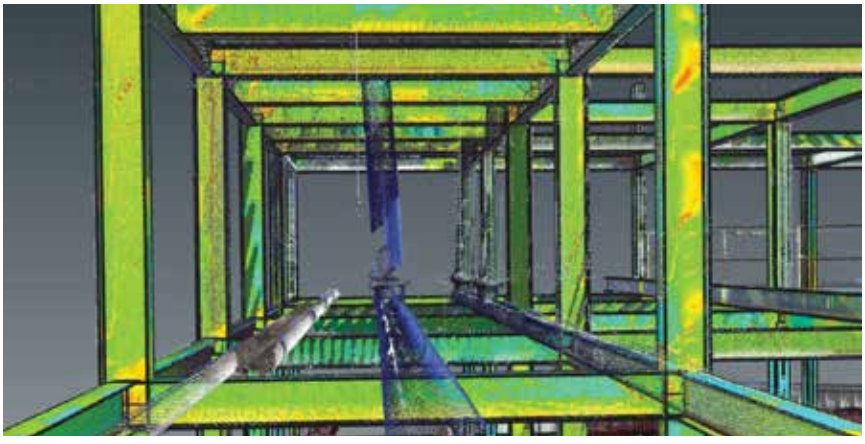
Digitization and BIM Implementation

Market observers believe that a new day is dawning for the industry, as companies increasingly recognize the positive impact that digital technology has on the full lifecycle of a building, beyond its construction stages. Government bodies around the world have begun promoting and mandating the use of BIM, in hopes of transforming industry practice, improving productivity levels, as well as boosting integration and collaboration across the construction value chain.

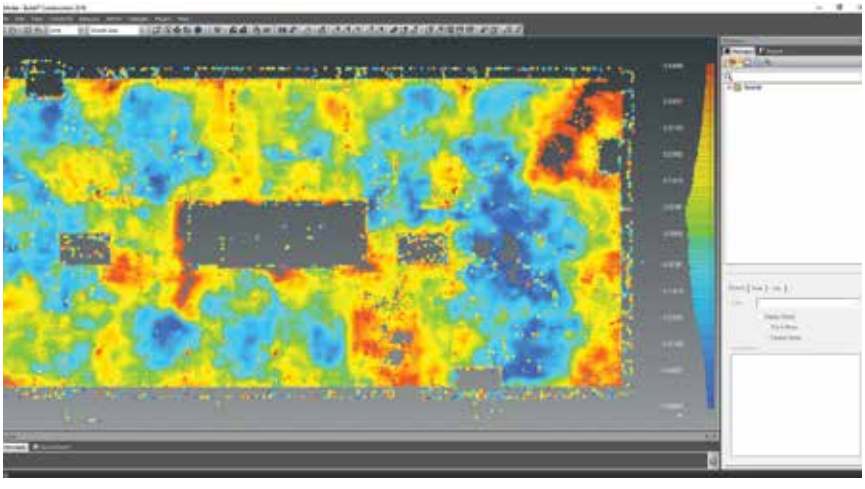
In essence, BIM is a digital representation of the physical and functional characteristics of a project, which forms a reliable basis for decisions during the project's lifecycle — right from the conceptual stage through preliminary and detailed design phases, to construction and as-built (or maintenance and occupancy management) stages. This information can be shared with various project member groups on demand, providing greater transparency and traceability across stages. But perhaps most attractive of all, BIM implementation offers project owners tangible benefits such as shorter project timelines, less material wastage, and increased profitability.

An easier approach to QA/QC in construction

Responding to the industry's need for a simpler and better way to harness the capabilities of BIM, software developers today offer construction professionals the ability to continuously monitor a project with real-time comparisons against CAD designs. Project owners and contractors can now confidently manage all quality assurance



Validate 3D scans to digital design files with a 3D analysis



Perform full digital tolerance evaluation of any project feature, such as floor flatness.

and quality control processes on a single platform, throughout building and facility lifecycles.

▷ Validate to design models

The ability to ensure buildings and structures are constructed exactly to design specifications is of paramount importance to architecture, engineering and construction (AEC) professionals. By comparing 3D scan data with design models at each stage, project owners can detect incorrect placements or missing features (e.g. walls, columns, beams, pipes) before it is too late. This reduces prolonged hours of manual validation to mere minutes, making construction QA/AC analysis a breeze.

▷ Tolerance evaluation

Keeping projects on schedule and minimizing any wastage within a project are also high priorities for AEC professionals. While cost and schedule overruns are the norm in the construction sector, companies should not be resigned

Concept of Traceable Construction

The transparency and traceability of a construction project offer great benefit to all project participants in terms of time and money. These factors are also essential for successful lean projects.

Today, project owners have access to efficient, forward-looking solutions that address a diverse range of needs in the various life phases of a building — whether it be design, build, or operate.

ON-SITE CAPTURE
High-speed data acquisition, on-site registration, and survey control

AS-BUILT MODEL & DESIGN:
Plan and design building projects based on as-built conditions

DESIGN LAYOUT:
Speed up workflow by projecting virtual templates for pre-fabrication or at construction sites

QUALITY CONTROL:
Perform immediate, real-time build and verify analysis throughout the entire project

DATA CONNECT & SHARE:
Communicate data across a building's life phases

Compare scans over time to capture structural changes (such as shift or drift) with 4D monitoring.

to accepting them. Today, it is possible to perform accurate measurements quickly and easily on key elements of a project, as frequently as is necessary. Contractors can routinely inspect construction work for adherence to building standards, whether for floor flatness/levelness, beam camber, or wall plumbness. In the grand scheme of things, these measurement tasks can help accelerate project schedules and reduce expensive scrap and rework.

▷ Positioning and monitoring

Beyond performing quality checks on building structures, project owners will find BIM useful for liability documentation, risk mitigation, and quality prefabrication. Comprehensive software solutions are now even equipped to verify shifts and movements, displaying changes over time with 4D analysis. AEC professionals can monitor adjacent buildings during construction and evaluate any site deformation (measure movement or settling over time). Additionally, companies can project design templates for prefabricated parts and assemblies with the help of a laser projector, or position structural elements and prefabricated parts in real time using laser trackers or total stations.

FARO BuildIT Construction Software enables laser scanner users to perform immediate, real-time build, and verify analysis throughout an entire project.

FARO BuildIT Construction Software

The FARO BuildIT Construction Software is a platform that seamlessly integrates the functions described above. The software enables laser scanner users to perform immediate, real-time build, and verify analysis throughout an entire project, facilitating a new level of cost management and operational efficiency.

Shaking the reputation

Slowly but surely, the Construction industry will make headway in shedding its image as one of the least digitized sectors. As various members of the AEC profession open up to technology adoption, equipment and software providers will offer even more solutions to meet the industry's needs, so that what seems impossible today may quickly become tomorrow's reality.

BK Chew, Product Marketing Associate Manager, FARO Technologies

A Story That Only Game Changing **Big Data** Can Tell

The capture of key real-time data points from field crews results in positive and lucrative outcomes on construction projects. Incorporating important effective construction management tools with easily accessed real-time predictive data, is a game changing solution to the longstanding ills plaguing the construction industry.

By Tiffany Hosey

Construction stakeholders are concerned about inadequate cost controls and poor construction management on projects." This reads like a complaint anyone today would make, given the innumerable construction projects with $50 million, $100 million or $1 billion cost overruns. Is it shocking that this sentiment was not expressed by a 21st century construction engineer, owner or superintendent? Instead, as cited in Philip Bruner's William Mitchell Law Review article, "The Historical Emergence of Construction Law," the complaint was made in the age of Vitruvius, chief engineer of Julius Caesar and Emperor Augustus in 24 BC.

Today, budget violations on new projects are common. In fact, almost universally, they are an accepted cost of doing business. However, it is perplexing to discover that the concerns expressed by construction stakeholders today reflect the same issues that date back over 2,000 years. That begs the question: why has the construction industry historically and consistently been plagued by cost overruns, ineffective construction management, schedule overruns and poor record keeping?

There are millions of lost data points created on a construction site throughout the lifecycle of a project; hundreds of data points created daily by field crew. They contain critical information that can protect owners, investors and subcontractors alike in the event of errors and/or omissions and can empower construction managers, quantity surveyors, owner's agents and superintendents to prevent or remediate problems before they develop into budget busting setbacks. Only in recent years, technologies have been created to harness and extract useful insights from this critical data in real time.

The capture of key real-time data points from field crews results in positive and lucrative outcomes on construction projects. Insurance carriers can especially benefit from a reduction of the risks associated with inadequately monitored field activities. When planning new projects, project estimators benefit from the ability to compare estimated costs to historical actual costs. Quantity surveyors and construction managers exercise tighter cost controls through portals that allow them to monitor subcontractor budgets for labor and materials received in real-time. Superintendents benefit from the consumption of real-time reports on data from materials received on site, completed construction activities to contracting dollars earned by each subcontractor. Project executives are enabled to more effectively analyze business processes and predict project profitability. Owners and their agents receive heightened transparency of construction progress and improved accountability. Lawyers are equipped with an evidence-based forensic audit trail of construction activities in cases of litigation.

Incorporating important effective construction management tools with easily accessed real-time predictive data, is a game-changing solution to the longstanding ills plaguing the construction industry. Competent and experienced construction stakeholders can improve profit margins and compress construction schedules with targeted real time, predictive data that signals or explains "why" things could or do go wrong.

There is a great deal of value in game-changing data that is easily navigable and accessible for the end user. Game-changing data include information that can be filtered to provide an analysis for or that can support the conclusions of end users. It incorporates and integrates information from the back office to the field. In some cases, game changing data can fill an experience or competency gap by providing objective conclusions that require no analysis. For example, if you take a critical path milestone that requires 20% of all doors in a building to be installed to maintain a construction schedule by a certain date, and technology, in real time, tracks the installation activities of the door contractor by location and marries that data to the CPMs to accurately monitor the percentage completion status on demand, objectively indisputable data is created. Either the door contractor is or is not on schedule.

Construction stakeholders are craving for a software platform that serves as the primary source of truth. Currently, construction stakeholders must access pieces of data from several different platforms to build a story and answer project questions or expend precious labor resources to quantify or validate project progress. Instead, a single integrated platform that captures new data points that lead to game changing solutions can eliminate or diminish confusion, provide a transparent audit trail of construction activities, lead to greater accountability, reveal best practices and tell stories that can propel construction out of 24 B.C. into 21 A.D.

'Game Changing' data drive improved labor productivity

In a 2017 report entitled "Reinventing Construction: A Route to Higher Productivity," the McKinsey Global Institute defined labor productivity as "the value added by construction workers (output in terms of structures created minus purchased materials) per hour of work and its growth over time, adjusted for inflation." The report explained that improvements in labor productivity can result in $1.6 trillion of additional economic value, which would add 2% to the global economy annually. It concludes that improvements in labor productivity parallel "shorter and more reliable construction schedules."

Technological improvements like BIM, Cloud document management, and a host of management level down, Cloud-based solutions that aid in project management, makeup the bulk of technological advancements that have been embraced widely. These tools fail to significantly affect labor productivity of field crews. Lagging is the embrace of technology advancements that reveal the details of real time field activities, i.e. the game-changing data tools described here, which would empower decision-makers to hone in on and combat the specific activities that negatively impact labor productivity.

The future story of construction

Precision has never been a hallmark of

Simple Data vs. Game Changing Data

"Game Changing Data" as used in this article is not the kind of data that is now becoming more routinely captured on construction projects. For example, there are widely embraced existing technology tools that:

1 Track daily RFIs and submittals;
2 Capture end of day pictures taken by superintendents who take a single snapshot of an entire structure;
3 Capture pictures taken before wall and ceiling close-in;
4 Document commissioning;
5 Record inspections;
6 Record safety inspections;
7 Allow easy access to contract documents and track revisions;
8 Track inventory from point of receipt to installation;
9 Digitize punchlisting; and
10 Store "As Builts," warranty documents, Operations and Maintenance manuals.

While these new tools are positive steps forward, siloed, they are not the new factors for game changing solutions.

1 New game changing solutions create data that produce real time information that can:
2 Allow individuals with oversight responsibility to monitor real time project progression to make proactive decisions that stave off economic losses and schedule creep;
3 Significantly reduce risk for insurance carriers concerned about excessive litigation for post-construction defect lawsuits initiated by building owners or occupants;
4 Protect contractors in claims disputes and from lost revenues in which poor record keeping would otherwise result;
5 Enable facilities managers to better predict the longevity of building assets and help developers and contractors better compare historical and estimated costs of construction with actual costs of construction;
6 Provide many of the answers to the "What happened?" questions raised by owners, attorneys and investors alike when looking backwards at projects that resulted in severe budget or schedule overruns; and
7 Reduce the time it takes for insurance carriers to process claims under Builder's Risk policies in the event of moderate to catastrophic losses.

Construction stakeholders are craving for a software platform that serves as the primary source of truth.

the construction process, and the emphasis here is solely on the process of construction. From planning a project to the actual process of building a structure, allowances in project pricing are routinely made for errors, omissions, imperfect design planning, inefficient inventory control, inadequate project team coordination, inaccurate cost estimates, insufficient oversight and accountability and inexperienced decision making. Project pricing and initial project scheduling cannot anticipate all economic losses and schedule creep attributable to unforeseen site conditions, labor shortages, unskilled subcontractor laborers and high turnover of experienced construction personnel.

These are widely accepted assumptions. However, these shortcomings can be significantly reduced if not altogether eliminated, with the collection of real-time game-changing data. This kind of transformative data provide insight into the source of materials, actual costs of construction, real-time percentage of completion calculations, real time project budget status, number of labor hours expended to install or construct items, real-time visual evidence of completed construction activities.

It also helps in identifying subcontractors responsible for building or installing individual assets, and producing a myriad of other information critical for decision-making and knowledge management that can empower construction stakeholders to pre-empt activities that can result in sliding deadlines, massive budget overruns, costly claims disputes, litigation, inferior construction results and lost profits.

Construction is an industry that impacts the lives of almost every person on the planet. From housing, commercial structures, hospitals, schools, sports and entertainment facilities, hotels and resorts, our lives are inexorably affected by construction activities. Technological innovations carry the potential of transforming world economies by reducing annual construction related losses from $1.6 trillion to relatively negligible amounts.

Tiffany Hosey, CEO, BuilDATAnalytics, t*iffany@ctbim.com*

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ADOPTION AROUND THE WORLD
HOW GOOD ARE WE?

The adoption of BIM is increasing worldwide as the construction industry is becoming largely aware of the benefits it offers.

By Shimonti Paul & Mahashreveta Choudhary

It was 1963 when Ivan Edward Sutherland, an American computer scientist and Internet pioneer, considered as the "father of computer graphics," developed "Sketchpad" the first computer-aided design (CAD) with the graphical user interface. Sketchpads led the way for human-computer interaction but more than that it broke the new ground for modelling programs in the construction industry.

During the '70s and '80s, Sketchpad further established the computational representation of geometry in terms of construction tech that allowed the ability to display and record shape information. With further developments taking place, Robert Aish published a paper in 1986 and documented the word Building Modelling which became Building Information Modelling or BIM that we now know today in a paper "*Automation in Construction*" published by G.A. Van Nederveen and F. Tolman in December 1992.

Since then the BIM is metamorphosing the construction industry. The world around is taking the technology hand on to get easy on the construction site. With urbanization taking new height every day and everywhere, and smart cities gaining momentum, countries around the world have now started paying more attention to its adoption. Adoption of BIM can make a country rich on the infrastructure side, making it set an example to others.

Let's have a look how different countries around the world are faring in BIM adoption.

United Kingdom

At this time, UK has the most striving and radical BIM strategy in the world that aims to enhance the global image of UK designers, contractors and product manufacture to translate winning new work, growth opportunities and increased employment in the country. If you are not BIM Level 2 complaint, you just cannot get your hands on any government project in the UK. So, just imagine the prominence of BIM in the UK.

The UK has a window of opportunity to capitalize on the success of its domestic program and to take on a global leadership role

in BIM exploitation, BIM service provision and BIM standards development.

The government's drive for BIM has accelerated the adoption rate. The UK government mandated BIM in April 2016 in every construction project which requires that all projects funded by central government be delivered with 'fully collaborative 3D BIM'. As the mandate has come into force, there has been a rise in levels of BIM adoption.

According to *National BIM Report 2018*, 20% of the industry has adopted BIM since 2016 mandate. Almost three-quarters are now using BIM, a 12% increase since last year, which is the highest year-on-year growth since 2014.

BIM is now an important factor for all larger organizations, and this is now sifting down to smaller organizations as well. Smaller practices are less likely to have adopted BIM than others. As per the report, 80% of medium practices (16 to 50 staff) and 78% of large practices (51+ staff) have adopted BIM. Yet two-thirds of smaller practices (with 15 or fewer staff) describe themselves as having adopted BIM. It looks like the benefits of BIM are there for practices of all sizes. Whilst 80% of practices carrying out health or education work have adopted BIM, and 83% of those doing 'mixed-use' work, practices carrying out less complex work use BIM too. 67% of those practices carrying out 'one-off new house, extension, conversion or alteration' have adopted BIM. Here BIM is not just limited to large practices or more complex projects but it is prevalent everywhere.

Singapore

In Singapore, BIM is identified as a key technology that eases its journey towards the smart nation. Thus, the Building and Construction Authority (BCA) and building SMART Singapore has been promoting the use of BIM in the construction industry. In 2010, BCA drafted a BIM Roadmap with the aspiring objective that at least 80% of the construction industry uses BIM by 2015. To make this successful it mandated BIM electronic submission making it compulsory for practitioners to submit architectural or engineering plans in the BIM format for regulatory approval.

In recent years, the government of Singapore, through the BCA, has highlighted productivity in the construction industry and initiated a Construction Productivity Roadmap to transform the construction industry and raise its productivity. Because of the potential to enhance construction productivity, driving BIM adoption has been seen as one strategic thrust.

The BCA came up with the second roadmap which aims to drive BIM collaboration throughout virtual design and construction. Under this, a new training program has been designed at all levels to create exciting and experiential learning for VDC. The roadmap focuses on the use of BIM for Facility Management and Smart City.

The US government has recently released a plan that includes $200 billion in federal money over the next decade to spur an additional $1.3 trillion in spending from cities, states and private companies on major infrastructure projects

USA

While actual BIM implementation and utilization of BIM took place in 1990s all around the world, the US started using it since 1970s. But, being an early adopter does not always work. The adoption rate of BIM gradually slowed in the US to a speed that countries that were slower in adoption took lessons from the United States and avoided some of the issues that the country encountered.

Till date there is no mandate from the government side to use BIM. Nonetheless, that doesn't mean the country is not taking the technology seriously. Many government departments have created their own criterion and published them to forums such as the National Institute of Building Sciences, but these standards are created independently with no relationship to one another. The US General Services Administration (GSA) formulated the National 3D-4D-BIM Program way back in 2003. This program established policy mandating BIM adoption for all Public Buildings Service projects.

Wisconsin became the first state to mandate BIM on publicly-funded projects with a budget of over $5 million. Moreover, success stories like the Los Angeles Community College District (LACCD) indicate the potential of BIM adoption.

Slowly but gradually, the US is moving on the right track in BIM adoption. Over the past years, BIM has become an important tool in US Architecture, Engineering and Construction (AEC) industry. Increased private funding of construction projects and the US government's aim to support investments in infrastructure, opportunities are awaiting companies specializing in BIM.

The US government has recently released a plan that includes $200 billion in federal money over the next decade to spur an additional $1.3 trillion in spending from cities, states and private companies on major infrastructure projects. With expenditure reaching over 1.1 billion US dollars in 2017, the United States is one of the largest construction markets worldwide. Key market characteristics such as a growing urban population and increased government spending pose a great opportunity for companies specializing in the latest technological achievements within the industry.

EU

The road to BIM implementation in Europe is making good progress. Companies, academics, professionals and governmental institutions are showing great interest in the technology. They are zealous to know how other geographies are implementing BIM so that they can have balanced understating of BIM and can also take lessons from them to implement it right in their own country. There are several targets, mandates and national strategies here to influence professionals so that they shift towards digitalization in the industry and have a common language of BIM. Europe understands that collaboration across borders and standardizing common practices is the key to success and the government is playing a good role in it.

In 2016, the EU BIM Task Group was established with an aim to bring together national efforts into a common aligned European approach so that a world-class digital construction sector could be developed. The task of the EU BIM Task Group was "to deliver a common European network aimed at aligning the use of Building Information Modelling in public works". The formation of the group has brought in exciting developments in the adoption of BIM in the continent. Different countries are moving at different pace.

France

In 2014, the French government launched a research and development project in the construction area called MINnD to develop BIM standards for infrastructure projects. In the same year, the government also decided to develop 500,000 houses using BIM by 2017. In 2015, the government allocated a budget of €20 million to digitize the building industry. The initiative was a part of the government's Digital Transition Plan for the construction industry.

Taking things further, in 2017, France mandated BIM. The official French standardization roadmap was made public in April 2017 as part of the French strategy for digitizing the construction industry. The objectives include improving the quality of exchanged data, deadlines and reducing overall project costs.

Germany

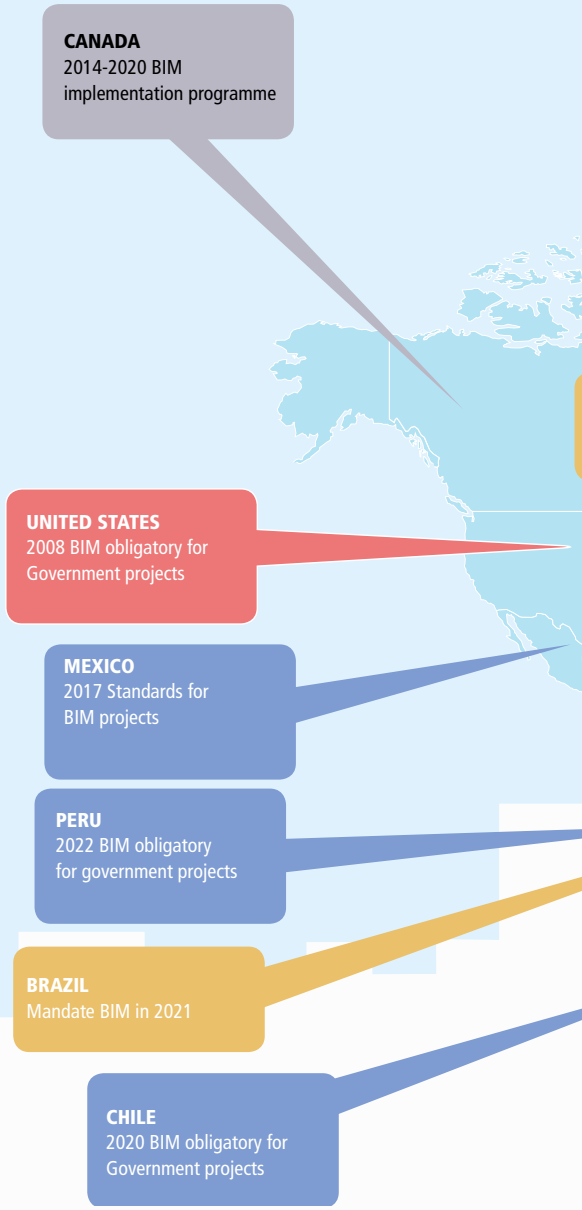
Keeping pace with the changing times, in 2015 the German government announced the formation of the Digital Building Platform — a BIM task group created by several industry-led organizations to develop a national BIM strategy. The official government statement talked of "standardizing of process and device descriptions, develop guidelines for digital planning methods and provide sample contracts." The government is playing a great role in BIM promotion and is all set to make it mandatory for public infrastructure projects by 2020.

Denmark

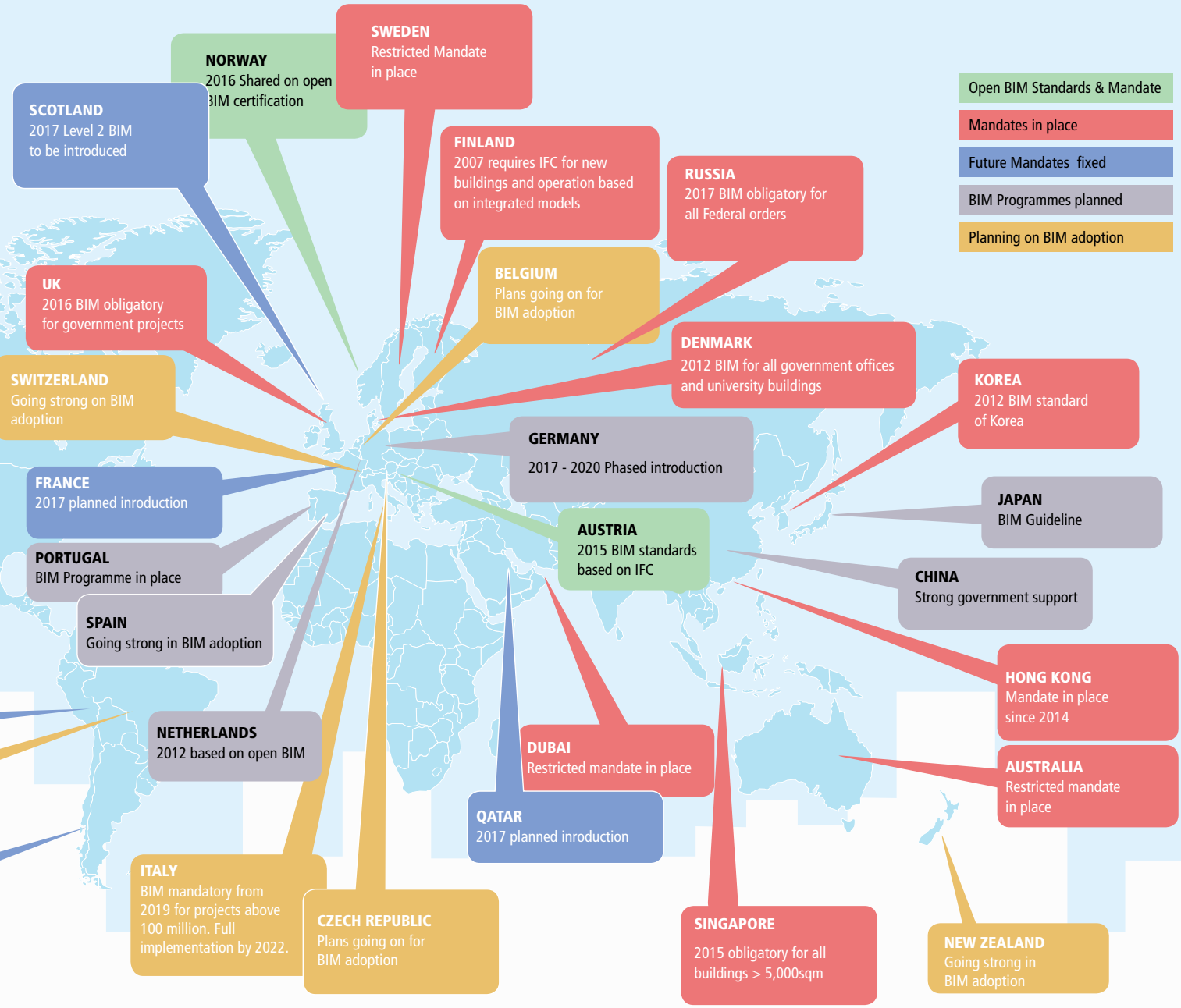
A strong demand for BIM due to the savings and quality of service it can offer is driving increasing BIM adoption in Denmark. Most, if not all, large-scale projects are increasingly using BIM in Denmark. Even municipalities are moving their portfolios over to digital platforms. The government has been a leading player in requiring BIM. Semi-government bodies set the standards and play a leading role in raising the bar to workable solutions. Classification systems are promoted, which sets the criteria for cross-disciplinary projects to flourish. Denmark is seen as an early adopter in BIM, VDC and prefabrication.

The Netherlands

BIM has seen an unprecedented uptake in the Dutch AEC industry. Fostered by large public clients (such as the Central Government Real Estate Agency), which prescribed the use of BIM, the Netherlands has one of the highest BIM



The road to BIM implementation in Europe is making good progress. Europe understands that collaboration across borders and standardizing common practices is the key to success and the government is playing a good role in it



Global BIM Regulation Evolution

Source:McAuley, B., Hore, A. and West R. (2017) BICP Global BIM Study – Lessons for Ireland's BIM Programme Published by Construction IT Alliance (CitA) Limited, 2017. doi:10.21427/D7M049

adoption rates in the world. A number of open protocols (or standards) for processes, data formats and/or semantics are in use that support the extent to which BIM systems can exchange, interpret and share data. VISI is a Dutch standard that forms the basis of communication and information exchange between building parties. COINS (Constructive Objects and the INtegration of processes and Systems) refers to a Dutch integrated, complementary standard for exchanging digital information and with support for Systems Engineering. CB-NL is a Dutch standard that connects object libraries for objects and spaces in the built environment.

As one of the biggest public clients in Europe and leader in BIM implementation today, Rijkswaterstaat, the Dutch General Directorate for Public Works and Water Management is responsible for design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. Having defined BIM as 'Better Information Management', the government agency is paving the road for using openBIM standards on all infrastructure projects in Europe.

Spain

BIM is not yet mandatory in Spain. However, the Spanish construction industry has also been subject to EU Directive 2014/24/UE. Since 2014, according to this directive, the member states are invited to encourage and require the use of BIM in construction projects financed by EU public funds as of 2016.

In 2015, the Ministerio de Fomento (Ministry of Development) created the "BIM Commision" with the main mission to establish a roadmap for the BIM methodology implementation in Spain. A strategic timetable for BIM implementation has been set. BIM use is supposed to be mandatory in public construction projects from December 2018 and in infrastructure projects by July 2019.

Austria

Austria started with BIM standards in 2015, and over the last years ASI (Austrian standards) has developed a series of standards for the implementation of BIM. The latest product is A 6241-2 introducing BIM Level 3 to the Austrian market. However, the adoption is not happening at the desired pace. Not many contractors are there who are able to work with BIM and not enough BIM coordinators are available today.

Norway

Norway has been one of the early adopters. Public sector BIM standards or requirements are already in place for Norway. It has been a partner in the development of openBIM standards and has worked with the 3D part of BIM on public projects for at least a decade. The Nordics are also making progress on Singapore-style systems to automate building approvals and planning permission.

Italy

The Italian Ministry of Infrastructure has introduced an initial plan for making BIM mandatory from 2019. But this would apply solely to projects above 100 million. Following this initial plan, the country is likely to see a full implementation by 2022. This is when BIM will become mandatory for all public procurement projects. However, smaller projects, such as residential buildings without special security requirements, will continue to be executed using the traditional methods.

Overall, BIM adoption is picking up in the EU. Many groups are driving a digital agenda for infrastructure. For having a future enabled construction sector within the respective country, some of them are even seeking UK's support.

China

There is enthusiasm in China about BIM but they still have a long way to go. China began its expedition of BIM information in the year 2001 when the Ministry of Construction, the predecessor of Ministry of Housing and Urban-Rural Development, MOHURD proposed Basic Points of Informatization Work in Construction Field in its 12th Five-Year plan. However, this was just a suggestion rather than mandate so the level of take-up in the early stages was slight. Since then MOHURD has delivered its thirteenth Five-Year Plan which runs from 2016 to 2020. According to the plan, by the end of 2020, a survey and design unit, premium and class building construction enterprise should master and realize BIM's integrated application with enterprise management system and other information technologies.

However, Hong Kong is a way ahead in BIM adoption. Many government departments here are now focusing on UK Level 2 Standards and providing training for the same.

Japan

Although the use of BIM has been spreading over past years, the progress of formal BIM implementation in Japan is slow. The Ministry of Land, Transport and Tourism (MLIT) is the Japanese government agency for building and construction. MLIT announced BIM pilot projects in 2010. It issued the BIM guideline in March 2014, which is the only national BIM Protocol by 2017. This MLIT BIM guideline is applied to the public projects when a contractor (architect or builder) implements BIM by his own decision, or when proposal-based technical studies are needed. The use of BIM is not mandatory as per this protocol.

The Japan Institute of Architects (JIA) issued a BIM guideline in July 2012. This

Around the world BIM adoption is becoming mandatory for better infrastructure.

protocol focuses on the concept and potential use of BIM. JIA BIM guideline provides much more extensive coverage than the MLIT guideline. Another BIM Protocol is the Standard Process Map for BIM Project issued by Architectural Institute of Japan in 2015.

Japan Federation of Construction Contractors (JFCC) has been working on centralizing the knowledge on BIM implementation by contractors and builders. After multiple publications for construction BIM, the summary of construction BIM in Japan was made available on November 2017 as "Encouragement of Construction BIM — a startup guide". The summary provides concrete examples on how to implement BIM in construction projects.

Even though multiple BIM Protocols are available in Japan, the adoption remains slow. To grow BIM adoption in construction, it is necessary to develop an industry-wide BIM Protocol based upon active information exchange.

UAE

In 2013, the Dubai Municipality issued circular (196), which mandated the use of BIM (Building Information Modelling) for architectural and MEP work on certain projects. This was subsequently widened by circular (207) in 2015 to include architectural and mechanical works for buildings that are above 20 floors, buildings, facilities and compounds with areas larger than 200 thousand square foot, buildings and special facilities like hospitals and universities, governmental projects, and projects by foreign offices. However, till date, few standards have been developed for the use of BIM in the UAE.

Keeping in view the benefits, the construction industry in the UAE is increasingly adopting BIM. A survey conducted in Herriot-Watt University in 2015 of over 500 AEC professionals working on UAE construction projects, revealed that 87% had used BIM in their organizations and 62% had used BIM for more than one project. 52% believed that BIM is going to be used commonly in the UAE in less than 5 years.

This progress has not, however, been accompanied with a standardization of the BIM process across the UAE construction industry. A lot remains to be done to enable higher adoption.

Australia

The BIM initiative in Australia is highly infrastructure-driven, with transport and infrastructure bodies coining the term 'digital engineering'. The level of BIM adoption here is wide-ranging and fragmented at the same time. The small continent is looking at detailed approaches to BIM in a very technologically savvy way. Some private sector clients are adopting BIM as 'business as usual' and are implementing technology at faster rates. In the public sector, standards, such as PAS1192-2 are being used as a basis for adoption. However, lack of skill and work in isolation is fragmenting the adoption.

In this, Australian government departments are playing a role too. Each department has its own process and strategy, working in isolation from other departments. This causes confusion in the supply chain, with companies left struggling to understand different approaches, processes and information requirements for each department and state. There is no consistent methodology to measure the level of maturity here, and thus both public and private sector clients are looking to the UK for support and guidance to leapfrog.

Brazil

Following a BIM roadmap, Brazil is going to mandate BIM in 2021.The Strategic Committee for the Implementation of BIM (CE-BIM) and a Technical Support Group (CAT-BIM) were established in Brazil in June 2017. The committee comprised of six ad hoc groups dealing with subjects of regulation and standardization, technological infrastructure, BIM platform, public purchases, training of human resources and communication.

Although BIM is not yet mandated at any level, industry reports such as "The Business Value of BIM for Construction in Major Global Markets", published by McGraw Gill Construction in 2013 and a study conducted by a local BIM consultant, show that BIM adoption is very advanced among contractors in Brazil (34 or 85% of the respondents from a total of 40 contractors). The same industry report shows that as opposed to other countries, the use of BIM in Brazil is focused more on cost control at the construction phase rather than on collaboration with owners.

India

Better late than never, this proverb fits rightly for India when it comes to BIM adoption.

The Architecture, Engineering, Construction, and Operation, (AECO) industry is the second largest industry in the country. To make it successful, slowly but gradually India is focusing on BIM. The country comprehends that BIM can be a very effective and cost-cutting technology, but it is still implementing it at the design level. Both the public and private sectors are very enthusiastic about BIM. In public sector, Nagpur Metro Rail project is the best example that adopted 5D BIM technology for the successful completion of the project.

Today, the understanding about BIM has increased in the country. Clients and the construction industry are aware that BIM can provide them with the minutest information involved in the construction of a building. However, the country needs to work on the awareness level. The majority of the users are limited to design and engineering organizations.

Just a matter of time

Keeping in view the tremendous benefits in terms of reduced cost, time and efficiency, the adoption of BIM brings to construction projects, almost every part of the world is readily embracing the technology. It's just a matter of time when BIM techniques will completely replace the traditional methods of construction, world over. We are now even moving towards adoption of AI in the construction industry!

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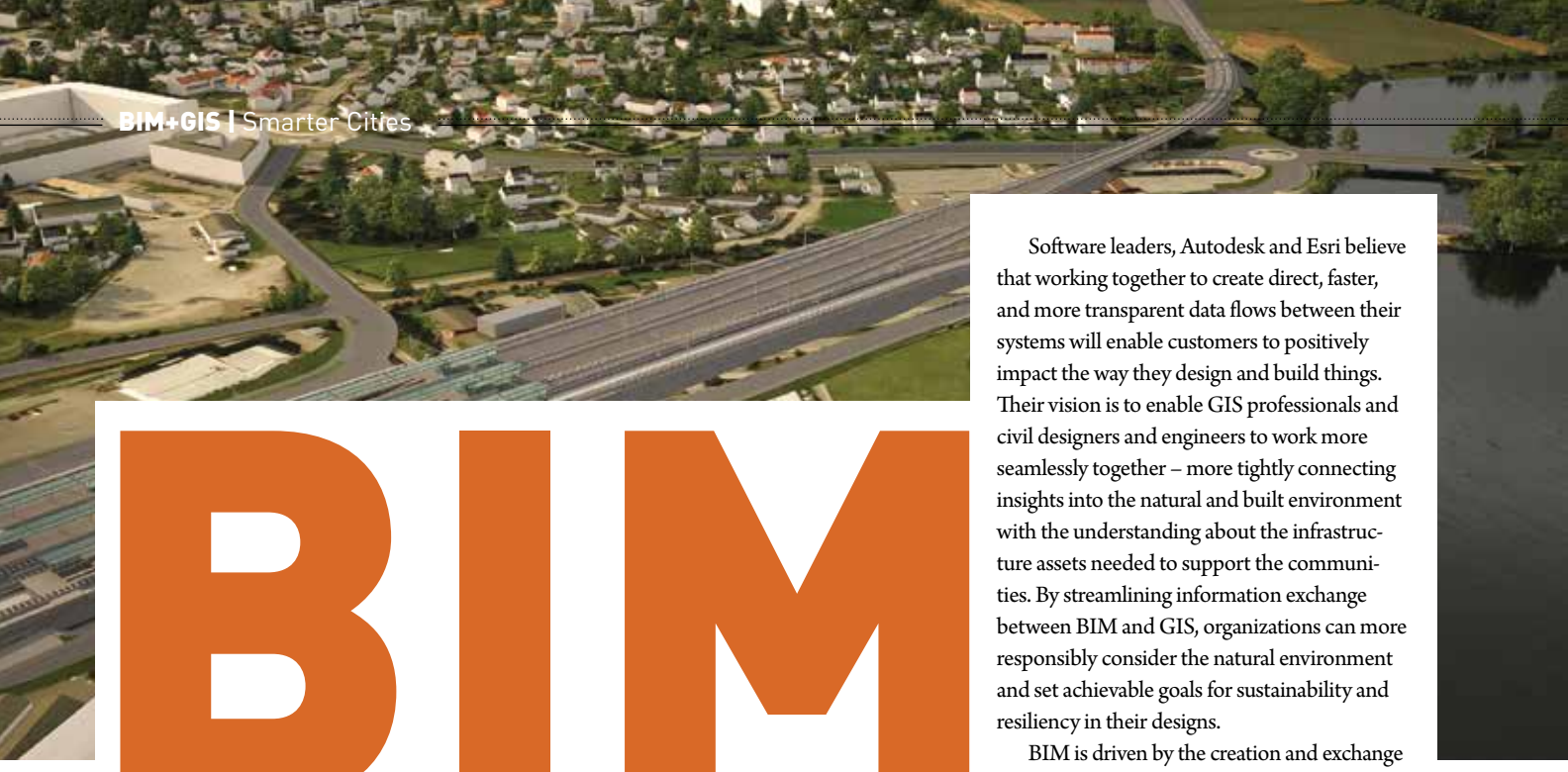

BIM FOR CIVIL ENGINEERING

In preliminary engineering, BIM tools and processes facilitate the creation of accurate 3D conditions and models of a project. Having these real-world context models help civil engineers identify potential problems and impacts earlier in the process. **By Karen Weiss**

BIM, or building information modeling, is a collaborative process driven by the creation and exchange of relevant digital information throughout the lifecycle of a built asset. In similar ways seen in building design and construction, civil engineers can take advantage of the benefits of BIM at all stages of an infrastructure project lifecycle.

For example, in preliminary engineering, BIM tools and processes can facilitate the creation of more accurate 3D conditions and models of a project. Having these real-world context models can help civil engineers identify potential problems and impacts of their design earlier in the process, when making changes is less costly overall.

Take the Eastside Tunnel project in New York City, for example. In that project, using BIM tools and a reality capture process to generate the existing conditions model of the Grand Central concourse, the LiRo Group was able to uncover over 800 serious issues.

In another project, the Istanbul Metropolitan Municipality was able to reduce the 18-month construction period on a project to 8.5 months by changing construction decisions in the preliminary design phase of the project.

One more example is the InterCity Sørli-Brumunddal project. According to Ramboll Sweco ANS, combining BIM workflows with tools to speed up processes for planning, design, decision making and approvals, enabled them to estimate savings of up to 30 percent in calendar time compared to more traditional design process.

BIM+GIS

The benefits of BIM processes are augmented by the availability of accurate data. Design teams can more easily make better, more informed decisions with high quality, reliable data. Enabling the use of this robust data model in design is where a tighter connection between GIS, or Geographic Information Systems, and BIM can play a central role.

Software leaders, Autodesk and Esri believe that working together to create direct, faster, and more transparent data flows between their systems will enable customers to positively impact the way they design and build things. Their vision is to enable GIS professionals and civil designers and engineers to work more seamlessly together – more tightly connecting insights into the natural and built environment with the understanding about the infrastructure assets needed to support the communities. By streamlining information exchange between BIM and GIS, organizations can more responsibly consider the natural environment and set achievable goals for sustainability and resiliency in their designs.

BIM is driven by the creation and exchange of relevant digital information through the lifecycle of a built asset. What could be more relevant than the integration of location intelligence and BIM model information? Creating an interface between GIS and BIM will help to lower costs, reduce waste, and facilitate the coordination of logistics scheduling. Authoritative information shared between designers, builders, and cities can ensure that projects finish on time, within budget and with less negative impact on the community.

More importantly, the collective set of information generated from these efforts can then be made available to future projects for regulation reporting, impact and risk analysis, and the like. Cities should be able to analyze and visualize all this robust data to monitor the health of their assets and inform ongoing maintenance requirements.

When it comes to the concept of smart cities, we should think of a smart city as one that uses data to make better, more informed decisions. It isn't simply about putting sensors on everything and monitoring the output of the sensors. Smart cities are those cities that use that data to help plan for, design, and build future infrastructure – using data and technology to help foster community engagement, make work easier, life better, and access to services faster.

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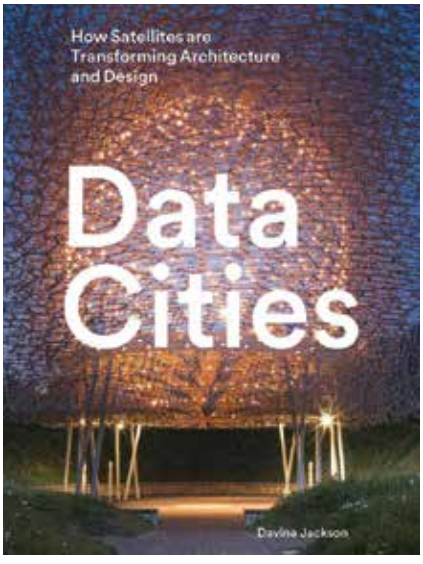
Data Cities: How Satellites are Transforming Architecture and Design



Book Review By / **Prof. Arup Dasgupta**

Authors / **Davina Jackson**

Publisher / **Lund Humpries**

Data Cities: How Satellites are Transforming Architecture and Design by Davina Jackson, published by Lund Humpries, UK in 2018 is an interesting take on the influence of geospatial technology on architecture and design. It does not look at the conventional interaction between geospatial and architecture and design, rather it looks at the interaction at a philosophical level and examines how the space age and its artefacts in general have influenced architects and their creations.

I am not quite sure what the author means when she talks of the "fear mongering years before Y2K" and "post-Internet era of urgent environmental challenges" which set her on a journey of discovery of the digitization of architecture, but her journey is remarkable. She states, the digitization of architecture was foretold as digitization affected the world in general. However, the book is more than about digitization. In fact digitization is disposed of in the first paragraph of the first chapter itself! "Space" in this book is more about the larger concept of place, situation and time viz-a-viz human perception rather than about something as mundane as "location".

The author brings in the term "spime" — a blend of "space" and "time" — which according to one definition is a neologism for a futuristic object, characteristic to the Internet of Things, that can be tracked through space and time throughout its lifetime. Looking at geospatial in this context we do see that spatial data collected over time does contain "coded messages about people, buildings, places, movements and nature's complex interactions". Light is not just what we can see but what sensors on satellites can see for us. A case is made for sci-tech architects who have to support sci-tech entrepreneurs and vice versa. Human habitat must now incorporate environmental factors and architects need to respect this as they design spaces. In short, architects need to move the world to 'livingry' as envisaged by Buckminister Fuller.

In Machines and Matter the author echoes the Fourth Industrial Revolution where computation and living beings merge to form a continuum. Thus, AI, robotics and automation influences the architectural world. Architecture must come alive and be one with nature and its inhabitants. Modelling, material and making makes a case for integrated modelling echoing the need for BIM and CIM to integrate with Natural Systems Modelling which is precisely what GIS helps to do. Use of different materials in building, specially locally available material is something that many have successfully experimented with. Beyond this, 3D printing brings in a new aspect where new materials and shapes can be added to the architecture.

The impact of climate change and destructive weather events aggravated by poor siting and use of inappropriate materials teaches an architect that a building should not be a foreign object put down on a location. Rather, it should blend with the environment, be ecologically sustainable and interact with the environment in a sustainable manner. Here again we see the role of Natural Systems Planning. An important point is the inadequacy of GIS to meet these modelling needs. While data handling is appreciated, the lack of tools does offset its utility for an architect.

This book is amazing in that it tries to bring together modern science and technology and architecture. Though some parallels are a bit contrived but the overall attempt to show how science and technology impacts architecture as much as it impacts other human endeavors is appreciated. After all architects design spaces using innovative techniques and materials and geospatial informs about and helps understand physical space. The twain should meet.

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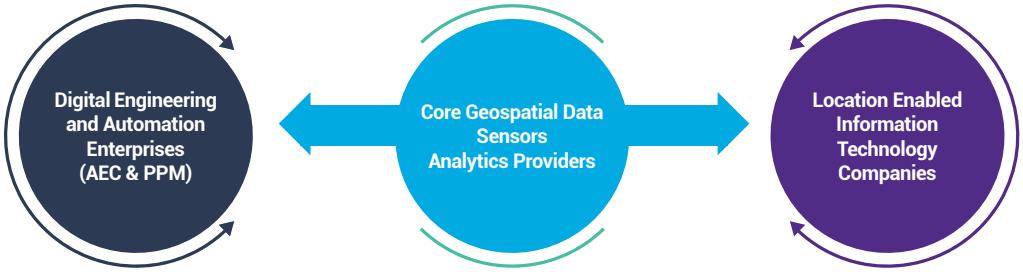

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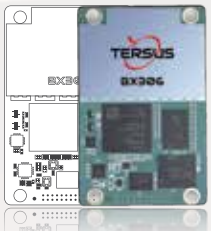
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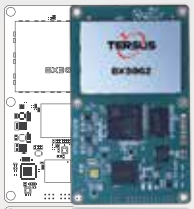
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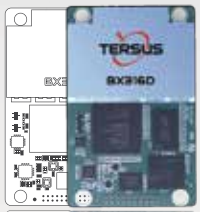
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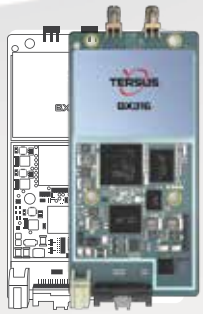
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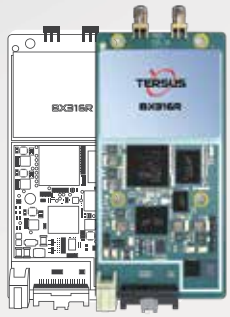
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