การประยุกต์ใช้ Building Information Modeling (BIM) ในงานวิศวกรรม

การประชุมสัมมนาถ่ายทอดองค์ความรู้ให้กับบุคลากรของกรมทางหลวงชนบท

วันศุกร์ที่ 21 สิงหาคม 2563

รองศาสตราจารย์ ดร.วีระศักดิ์ ลิขิตเรืองศิลป์

ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์

จุฬาลงกรณ์มหาวิทยาลัย

VeerasakL@Gmail.com

Facebook Page: **BIM Thailand**

Topics

1. Digital Transformation in Construction
2. Quick Review on BIM
3. BIM Applications
4. BIM for Infrastructure Projects
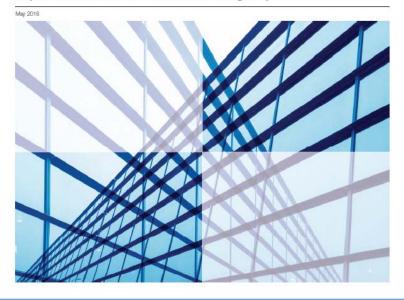5. Q&A

1
Digital Transformation in Construction

Industry Agenda

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Shaping the Future of Construction
A Breakthrough in Mindset and Technology

Prepared in collaboration with The Boston Consulting Group
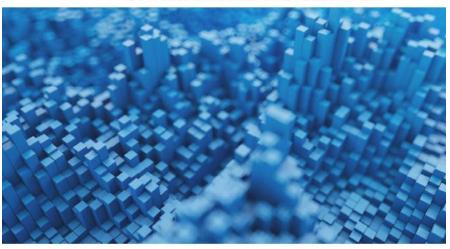
May 2016

McKinsey & Company

Capital Projects & Infrastructure Practice

Decoding digital transformation in construction

Few engineering and construction companies have captured the full benefit of digital. Five practices can help E&C companies move beyond isolated pilots and unlock digital's value across their enterprises.

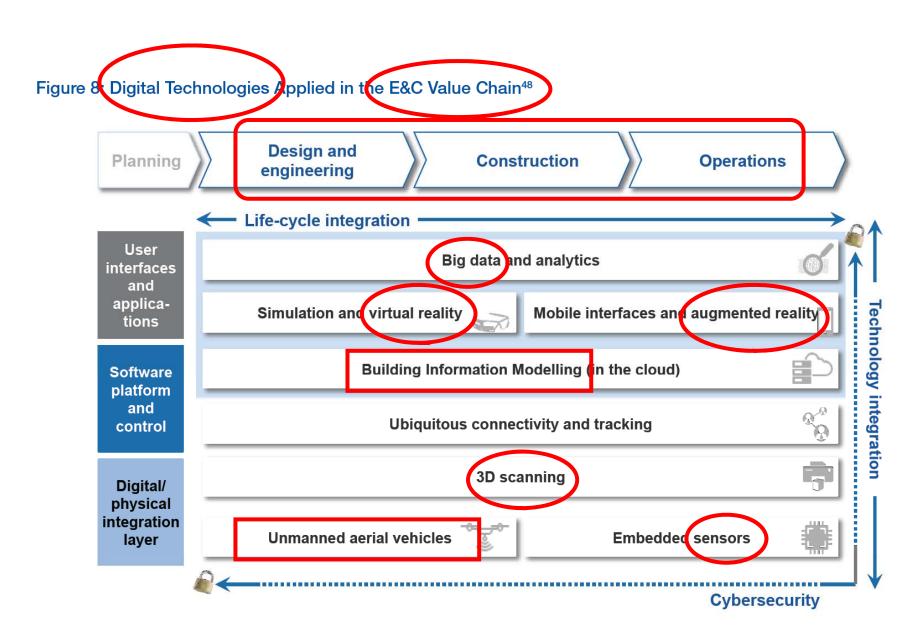by Jan Koeleman, Maria João Ribeirinho, David Rockhill, Erik Sjödin, and Gernot Strube

© From2016/Getty Images

August 2019

Figure 1: Industry Transformation Framework

(Future) Best practices

Actors — Company level

2.1 Technology, materials and tools

Advanced building and finishing materials	Standardized, modularized and prefabricated components	(Semi-)automated construction equipment
New construction technologies, e.g. 3D printing	Smart and life-cycle-optimizing equipment	Digital technologies and big data along the value chain

2.2 Processes and operations

Front-loaded and cost-conscious design and project planning	Innovative contracting models with balanced risk-sharing	A common and appropriate framework for project management
Enhanced management of subcontractors and suppliers	Lean and safe construction management and operations	Rigorous project monitoring (scope, time, cost)

2.3 Strategy and business model innovation

Differentiated business model and targeted consolidation and partnerships	Sustainable products with optimal life-cycle value	Internationalization strategy to increase scale

2.4 People, organization and culture

Strategic workforce planning, smart hiring, enhanced retention	Continuous training and knowledge management	High-performance organization, culture and incentive schemes

Sector level

3.1 Industry collaboration

Mutual consent on standards across the industry	More data exchange, benchmarking and best-practice sharing	Cross-industry collaboration along the value chain

3.2 Joint industry marketing

Industry-wide collaboration on employer marketing	Coordinated communication with civil society	Effective interaction with the public sector

Government

4.1 Regulation and policies

Harmonized building codes/standards and efficient permit processes	Market openness to international firms and SMEs	Promotion and funding of R&D, technol. adoption and education

4.2 Public procurement

Actively managed and staged project pipelines with reliable funding	Strict implementation of transparency and anti-corruption standards	Innovation-friendly and whole-life-cycle-oriented procurement

Shaping the Future of Construction: A Breakthrough in Mindset and Technology

Figure 8: Digital Technologies Applied in the E&C Value Chain[48]

| Planning | Design and engineering | Construction | Operations |

Life-cycle integration

User interfaces and applica-tions

- Big data and analytics
- Simulation and virtual reality
- Mobile interfaces and augmented reality

Software platform and control

- Building Information Modelling (in the cloud)
- Ubiquitous connectivity and tracking

Digital/ physical integration layer

- 3D scanning
- Unmanned aerial vehicles
- Embedded sensors

Technology integration

Cybersecurity

Note: The figure displays the main application areas of the respective digital technologies along the E&C value chain.
Source: World Economic Forum; The Boston Consulting Group

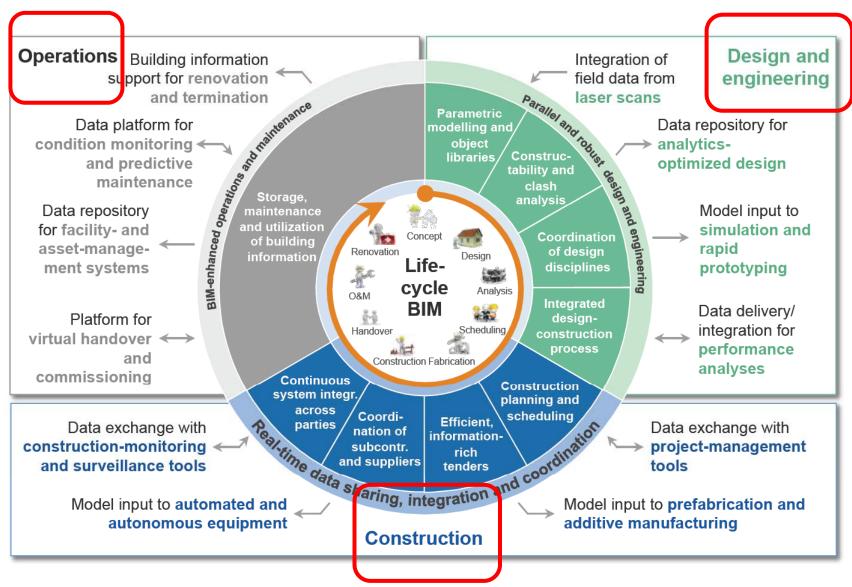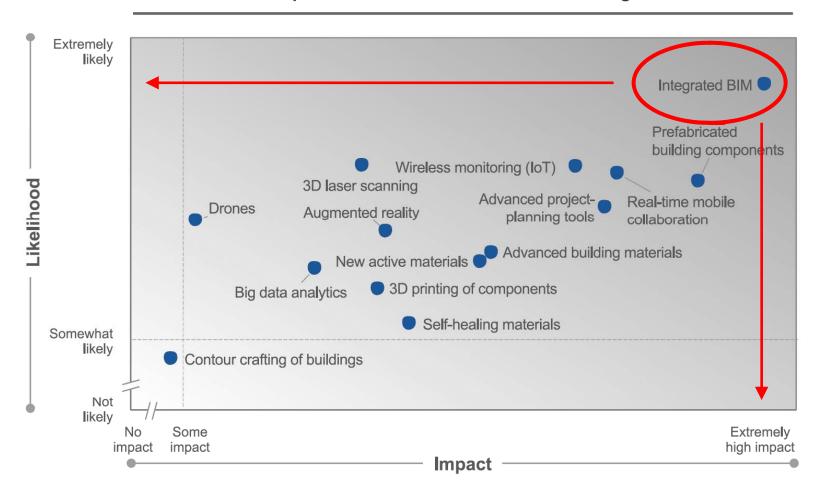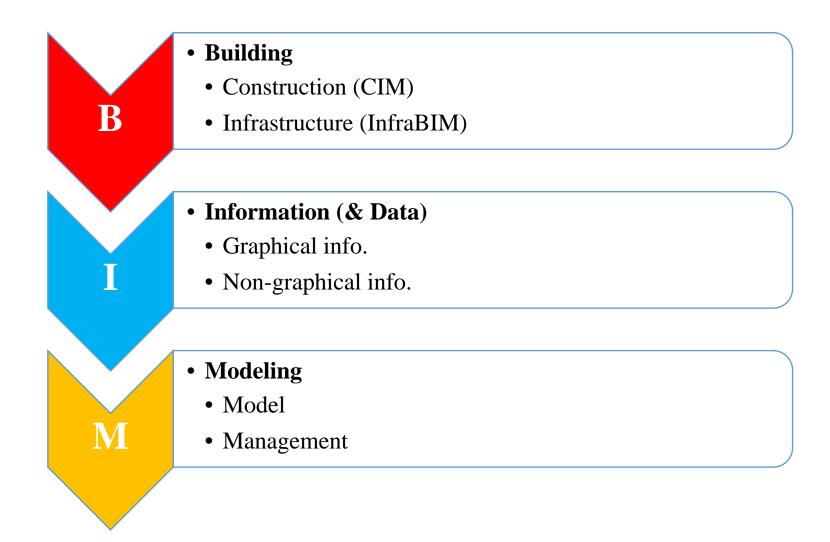## Figure 9: Applications of BIM along the E&C Value Chain[50]
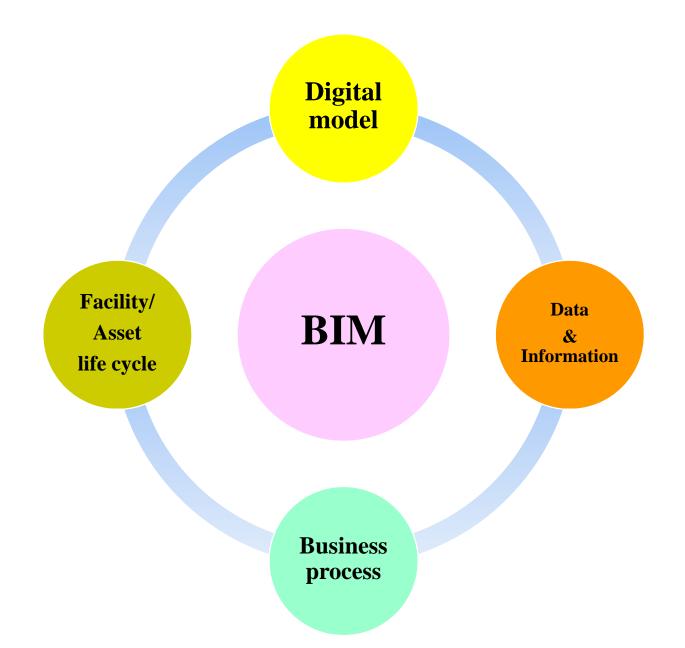
Impact-likelihood matrix of new technologies

Source: Future of Construction Survey

2
Quick Review on BIM

B
- **Building**
  - Construction (CIM)
  - Infrastructure (InfraBIM)

I
- **Information (& Data)**
  - Graphical info.
  - Non-graphical info.

M
- **Modeling**
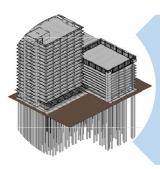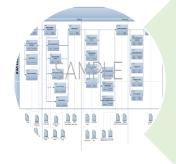 - Model
  - Management

Business Process

for generating and leveraging building data to design, construct, and operate the building during its life cycle

Digital Representation

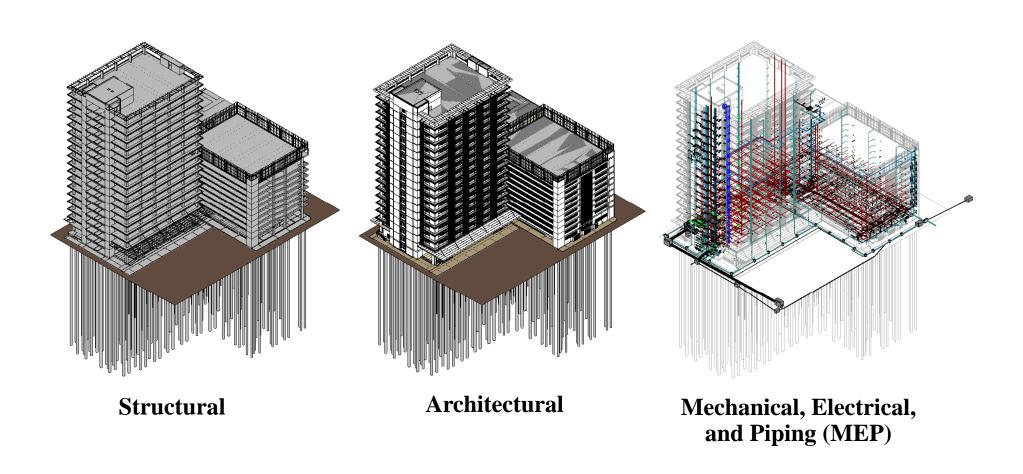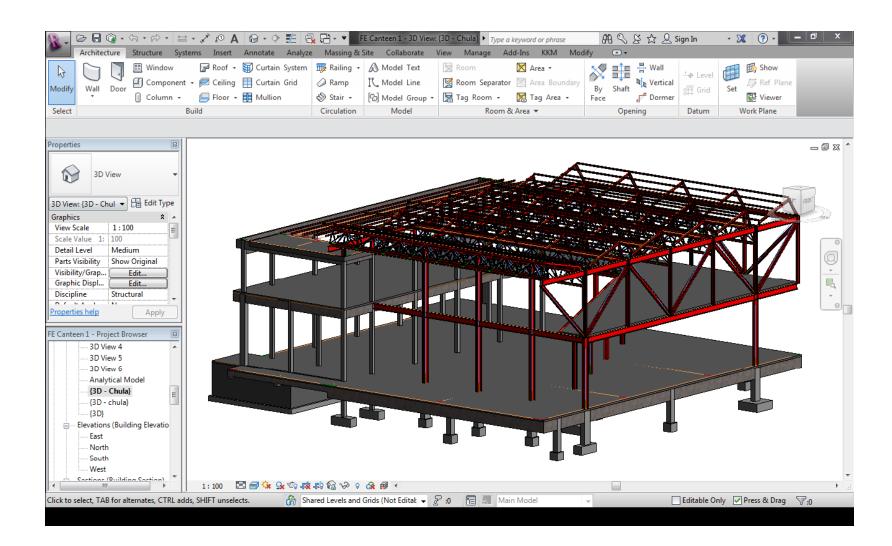of physical and functional characteristics of a facility

Organization & Control

of the business process by utilizing the information in the digital prototype to effect the sharing of information over the entire life cycle of an asset
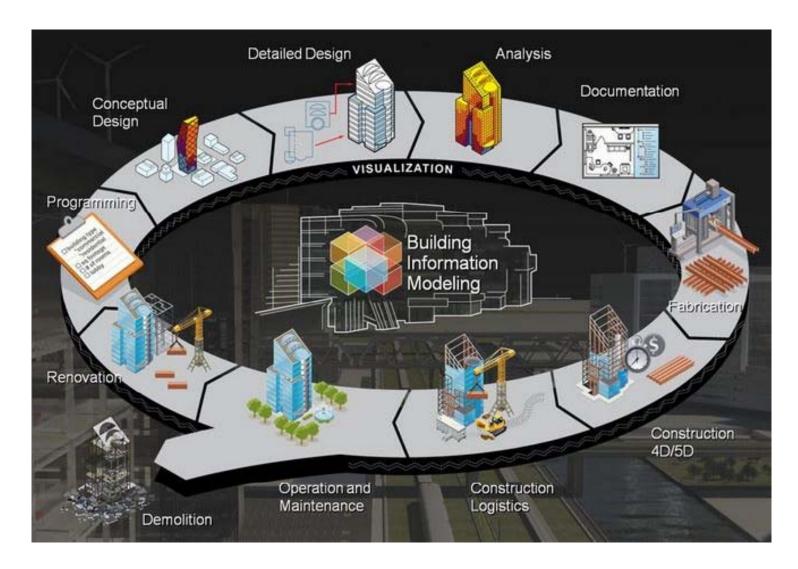
Source: National Institute of Building Sciences (2015)

BIM Models

Structural   **Architectural**   **Mechanical, Electrical, and Piping (MEP)**
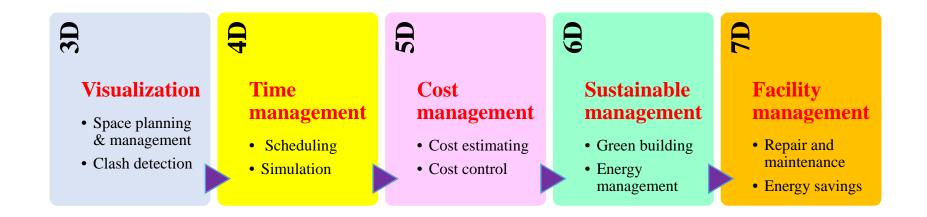
3
BIM Applications
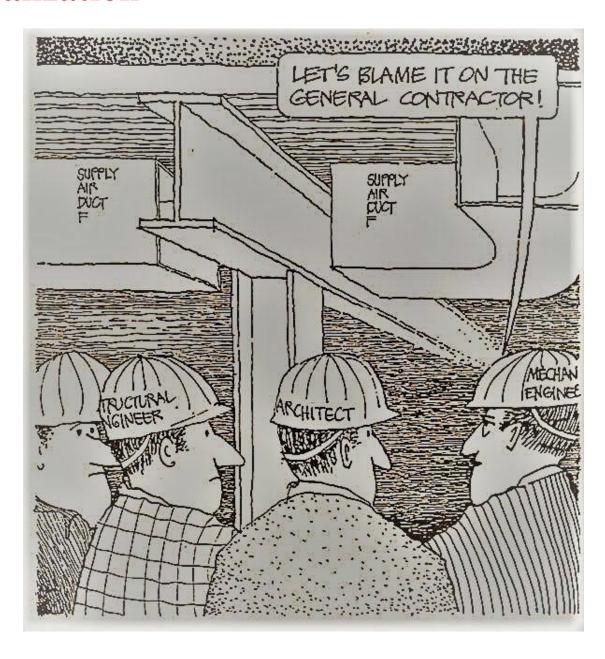
Source: https://thebimhub.com

3D

Visualization

- Space planning & management
- Clash detection

4D

Time management

- Scheduling
- Simulation

5D

Cost management

- Cost estimating
- Cost control

6D

Sustainable management

- Green building
- Energy management

7D

Facility management

- Repair and maintenance
- Energy savings

Dimensions of BIM Applications

3D - Visualization

อาคารปฏิบัติการ

ห้องน้ำชั้น **M – 2** : ท่อ **Waste** (สีน้ำตาล) **Soil** (สีน้ำตาล) **Vent** (สีเหลือง) ท่อน้ำดี (สีน้ำเงิน)
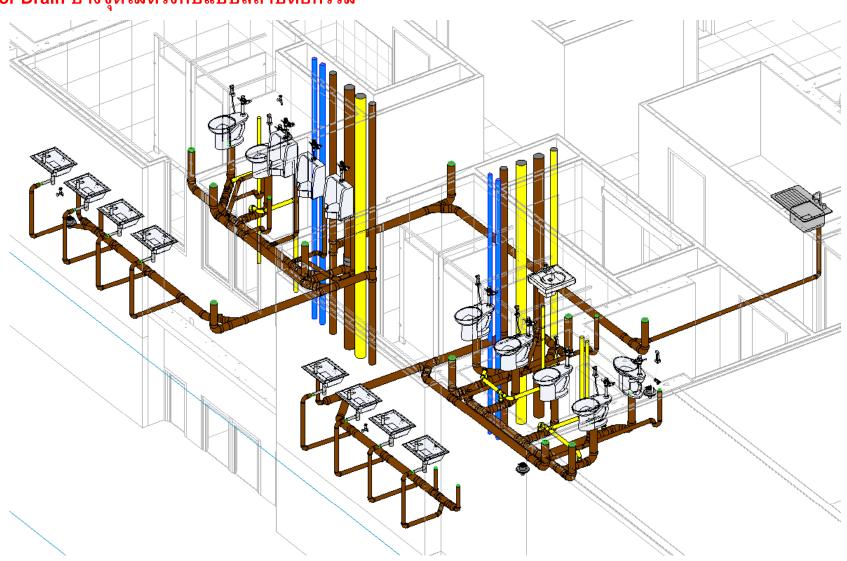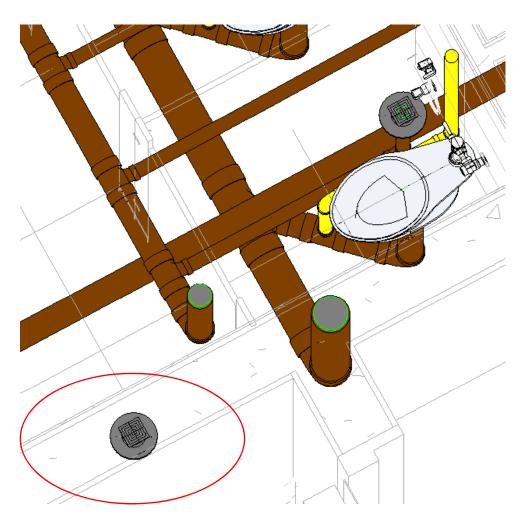
Floor Drain บางจุดไม่ตรงกับแบบสถาปัตยกรรม
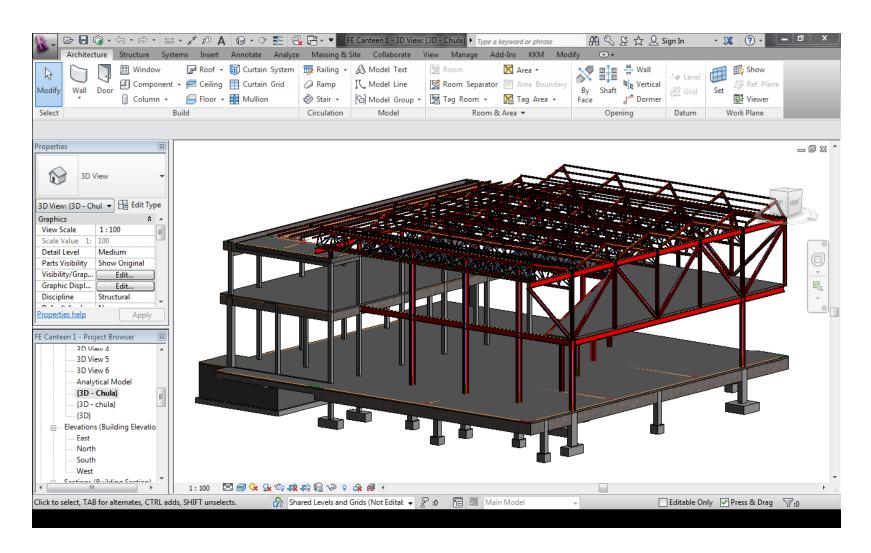
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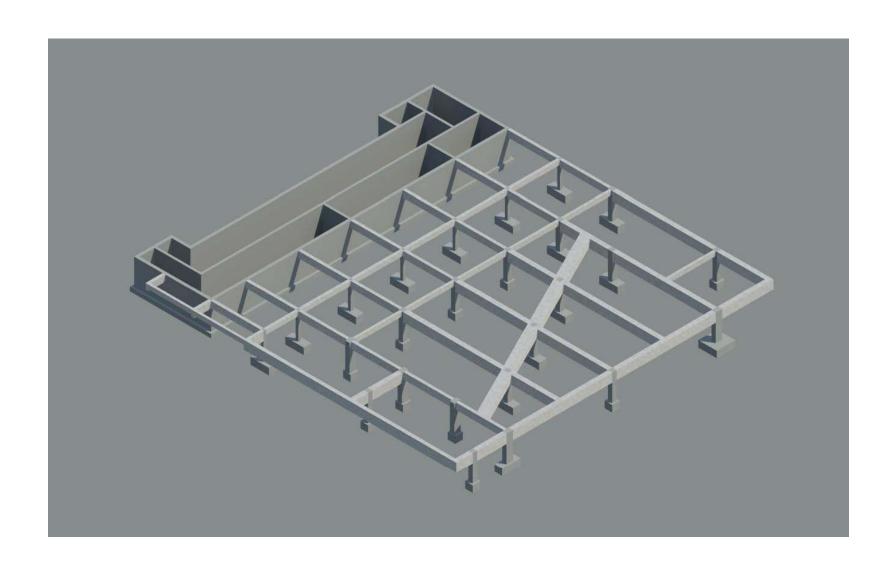
ห้องน้ำชั้น 1 : ท่อ **Waste** (สีน้ำตาล) **Soil** (สีน้ำตาล) **Vent** (สีเหลือง) ท่อน้ำดี (สีน้ำเงิน)
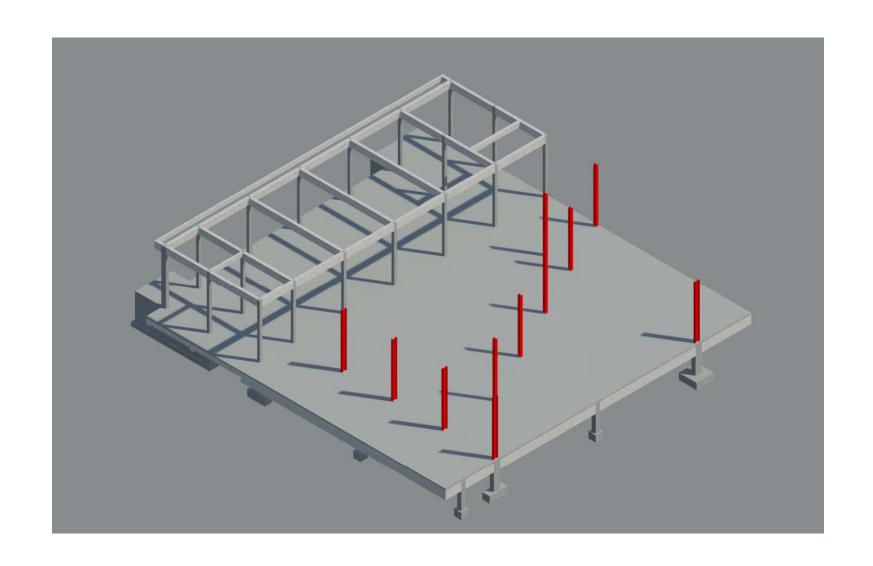
Floor Drain บางจุดไม่ตรงกับแบบสถาปัตยกรรม
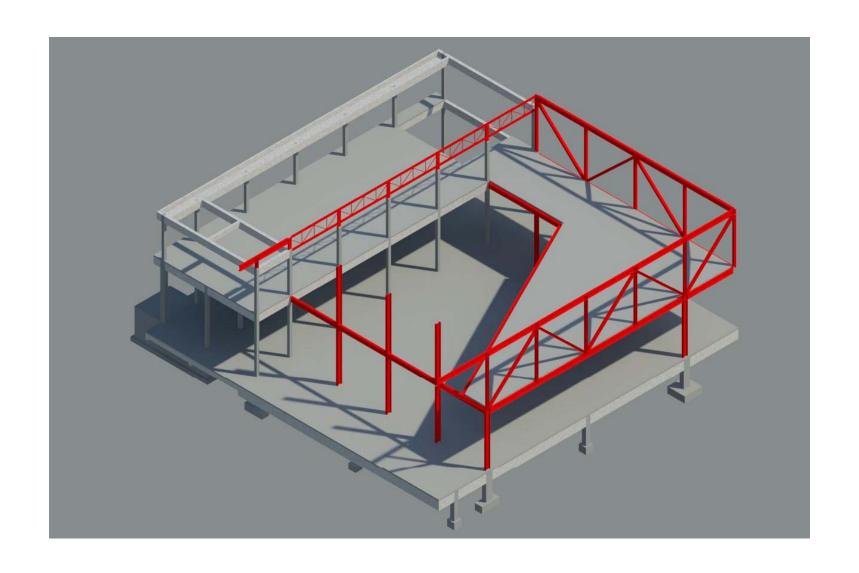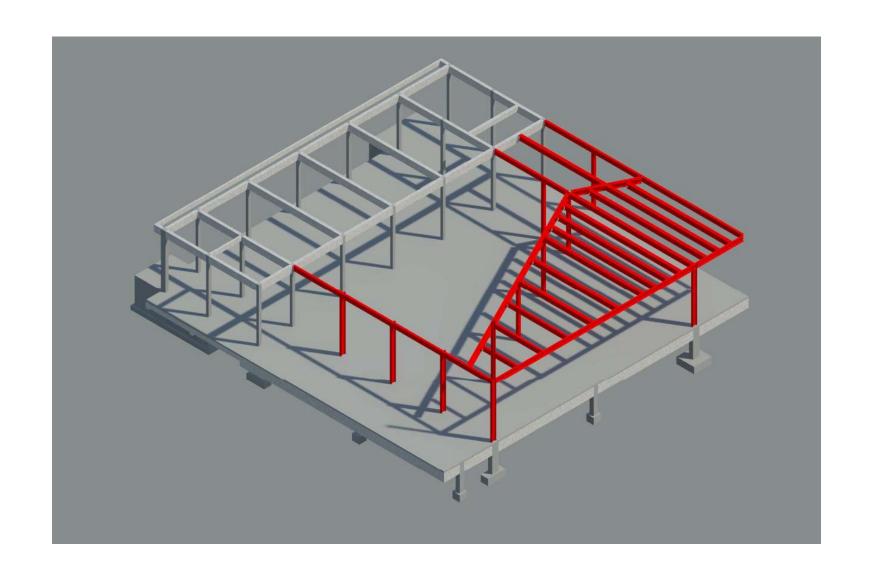
BIM for Structural Steel Design and Construction
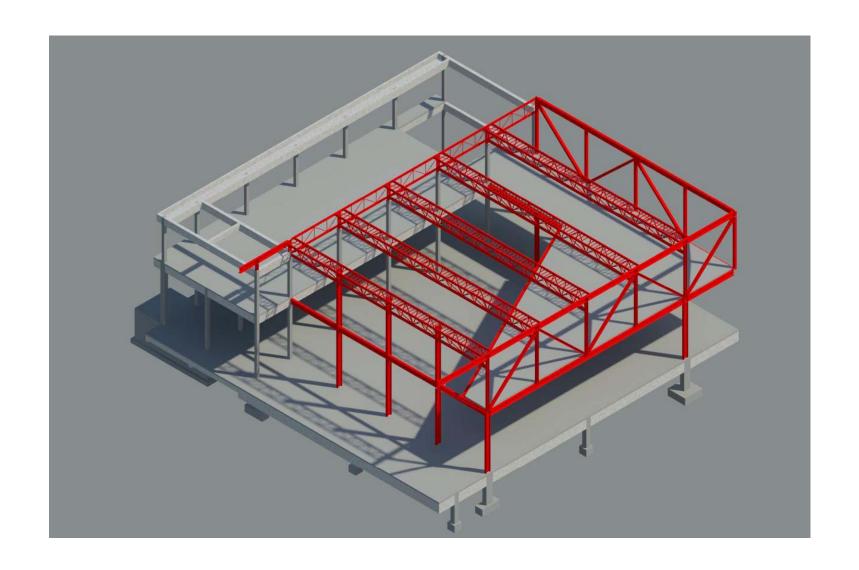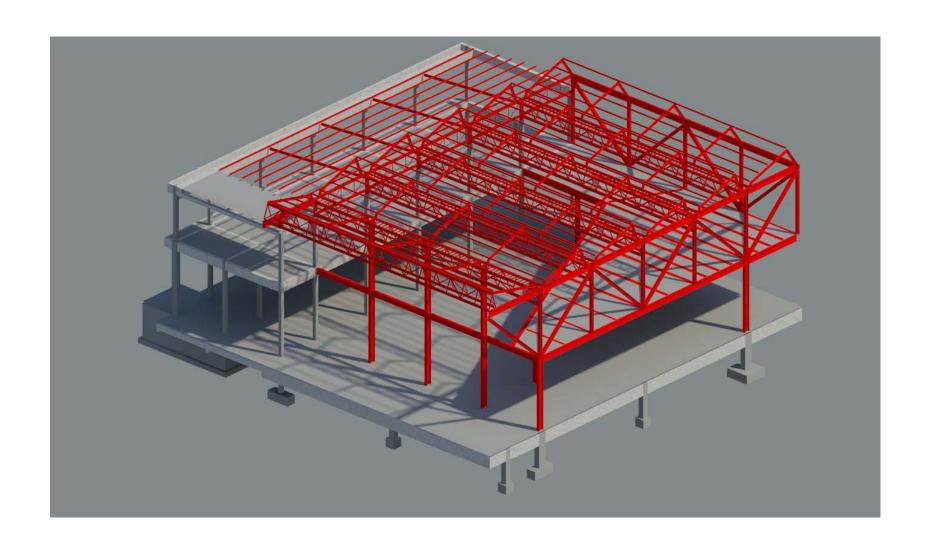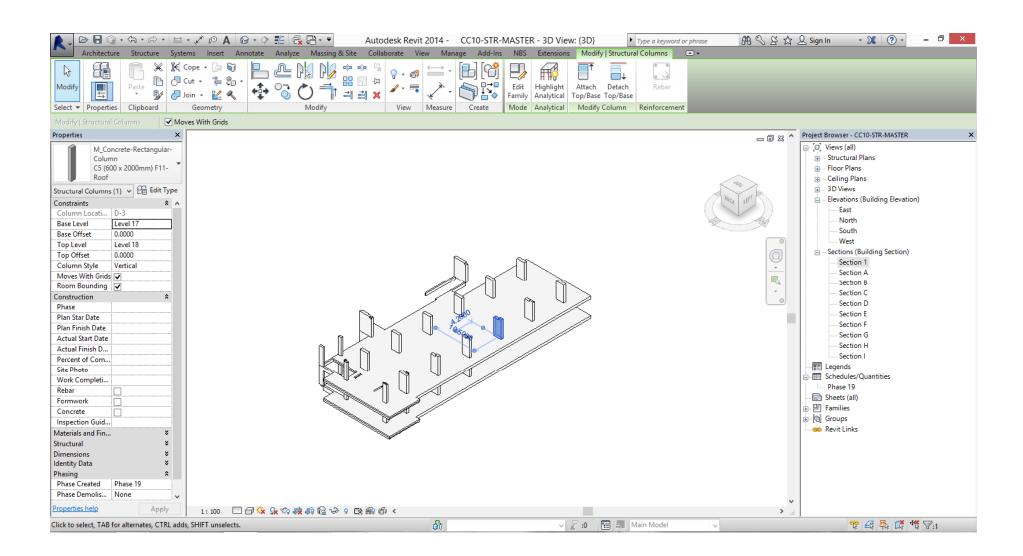
4D – Time Management

5D – Cost Management
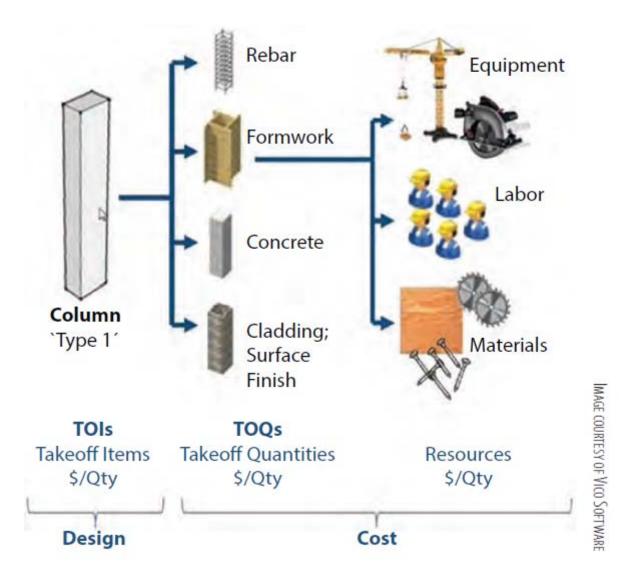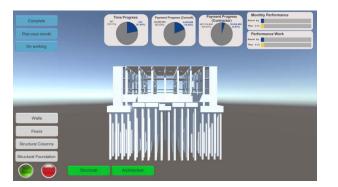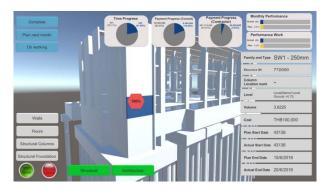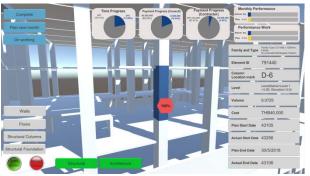
Figure 1.12   5D data flow

Hardin and McCool (2015)
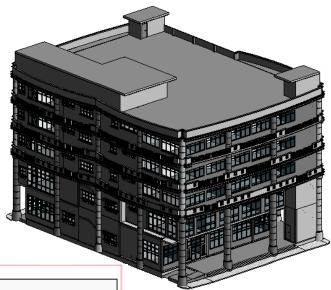
BIM-Enabled Dashboard System

6D – Sustainable Management
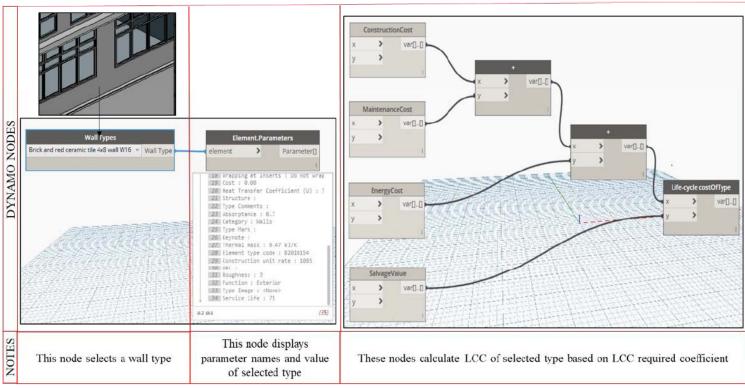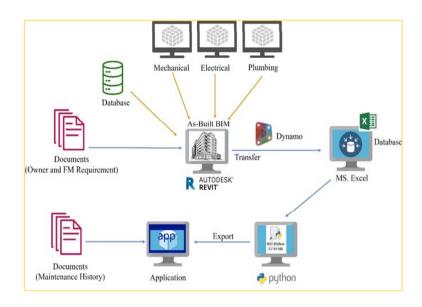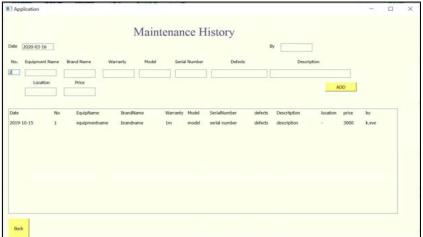
Figure 2. An example for applying the proposed system to a typical external wall type.

31

7D – Facility Management

War Room for Construction Projects

Immersive Virtual Reality (VR) System

USB-Control Receiver

Control Unit
(Using synchronization technology)

Front

Tracking camera (6 units)

Projector (3 units)

Rear

VR System Accessories

Controller & Position Tracker

USB-Mouse

Position Tracker

X-Box joystick

Visualization

Polarization Glasses

Polarization Glasses with Tracker

VR System Accessories

Head-Mounted Display (HMD)

Gloves

Immersive Virtual Reality (VR) System

Heritage BIM

4
BIM for Infrastructure Projects

Monday, 3rd February

| 15.00 | Excursions |
| 19.00–21.00 | Get together |

Tuesday, 4th February

| 10:00 | Opening session |

Chaired by and Opening: Tommi Arola - buildingSMART Finland
Venue: Park Hall

10:00 Keynote
How do we Fundamentally Change the Perception of Construction on Planet Earth?
Fred Mills - The B1m

10:30 CLIENT'S VIEW FOR OPEN BIM - CASE FINNISH TRANSPORT INFRASTRUCTURE AGENCY
Terno Seedainen - Finnish Transport Infrastructure Agency, Juha Liukas - Sitowise

11:00 DISFRAGMENTING THE CONSTRUCTION INDUSTRY USING A DIGITAL PLATFORM
Jaan Saar - Ministry of Economic Affairs and Communications

11:30 CLIMBING THE BIM STAIR STEP BY STEP – SWEDISH TRANSPORT ADMINISTRATION IS ON THE MOVE
Peter Axelsson - The Swedish Transport Administration, Karin Anderson - The Swedish Transport Administration

12:00 HOW TO EVALUATE 100+ BIM USE CASES FOR AN INFRASTRUCTURE OPERATOR?
Odilo Schoch - SchochArch Services LLC, Billal Mahsoub - SBB Swiss Rail

| 12:30 | Lunch, Exhibition and Networking |

13:30	Session 2 Railways and Tramlines 1	Session 3 Technical Solutions 1	Session 4 Roads and streets 1	Session 5 Utilities and distribution network
Chaired by:			Dominique Chevillard - Fédération Nationale des Travaux Publics	Tomi Henttinen - buildingSMART Finland
Venue:	Park Hall	Duetto 1	Duetto 2	Sopraano
13:30	UTILIZATION OF BIM IN THE EARLY DESIGN PHASE, CASE ESPOO-SALO DIRECT RAILWAY CONNECTION Ms. Annemari Naaranla - Welado Oy, Valtteri Brofman - WSP Finland Oy	OPEN AND REAL TIME COST MANAGEMENT DATA TO INFRA SECTOR Jami Mykkänen - Civilpoint Oy	ASSET INFORMATION MODEL FOR NYE VEIER - TRONDELAG Leni Veström - Trimra AS	PARAMETRIC AS BUILT INFORMATION MODELLING FOR JET FUEL PIPELINES IN LATVIA Janis Berks - ITX1, Igors Ackenbergs - ITXD
14:00	BIM IMPLEMENTATION FOR THE RAIL BALTICA GLOBAL PROJECT – PHASE 1 Raitis Bušmanis - RB Rail AS	BE READY FOR THE UPCOMING DIGITAL DATA DELIVERY STANDARD IC0D Peter Imbrechts - Nearus Technologies	SHARING RELATIVE CUT AND FILL INFORMATION TO WORKGROUPS AND SUPERVISORS IN 3D MACHINE CONTROL WORKSITES Manu Marttinen - NCC Industry, Petri Niemi - Finnmap Infra Oy, Lauri Hartikainen - Pointscene.com	BIM IMPLEMENTATION IN ELECTRICAL ENGINEERING SECTOR BY PROJEKTAI IR CO Tomas Cudarkis - "Projektai ir Co", UAB, Vaidotas Sarka - InnoBIM, UAB
14:30	IFC RAIL – ON TRACK AND WITH END STATION IN SIGHT Peter Axelsson - The Swedish Transport Administration, Marion Schenkwein - NRC Group Finland Oy	SUSTAINABILITY ASSESSMENT OF CONSTRUCTION PROJECTS USING EPD AND THE INDATA NETWORK Oliver Kusche - cloudEPD AS	SPONSOR PRESENTATION BY HEXAGON	BIM STANDARD FOR POWER INFRASTRUCTURE AT PSE S.A. - POLISH NATIONAL TRANSMISSION SYSTEM OPERATOR Jerry Rusin - BIM Point
14:45			SPONSOR PRESENTATION BY INFRAKIT	

| 15:00 | Coffee, Exhibition and Networking |

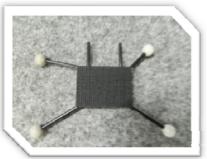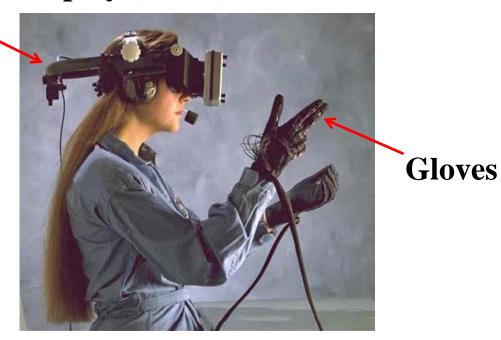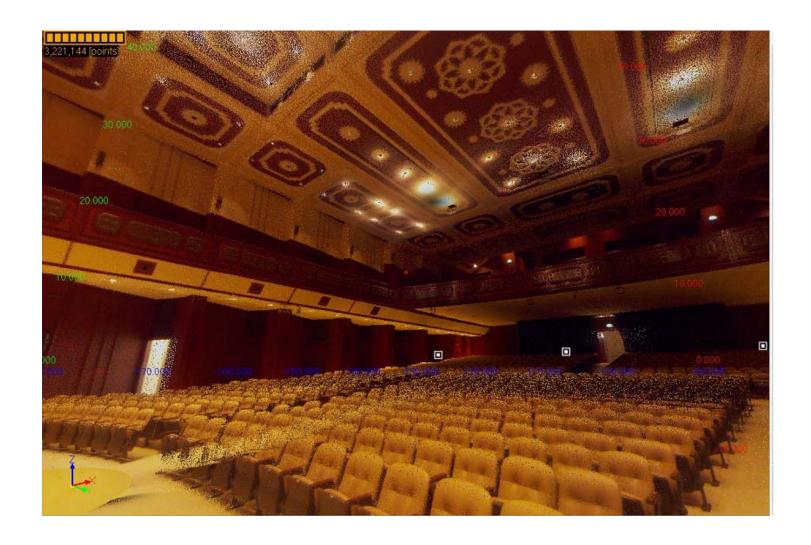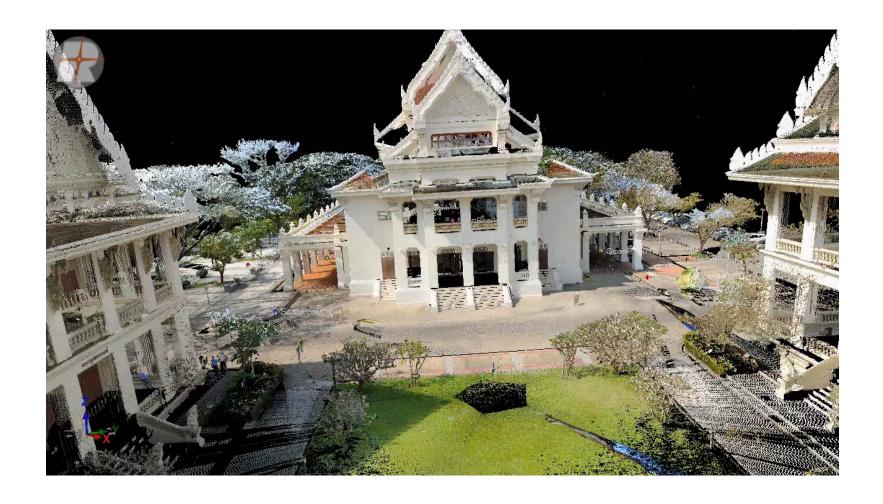| 15:45	Session 6 Roads and streets 2	Session 7 Bridges, tunnels and structures 1	Session 8 Geotechnic	Session 9 Ports and Waterways
Chaired by:	Petteri Palvalainen - Novatron Oy	Christophe Castaing - Egis	Juha Liukas - Sitowise	Tommi Arola - buildingSMART Finland
Venue:	Park Hall	Duetto 1	Duetto 2	Sopraano
15:45	RECENT DEVELOPMENTS OF IFC ROADS Karin Anderson - The Swedish Transport Administration	BIM FOR BRIDGES & STRUCTURES - CREATING IFC-BASED LIFECYCLE DATA MANAGEMENT STANDARDS FOR THE U.S.A. Jeffrey Ouellette - jo consulting	GEOLOGICAL AND GEOTECHNICAL MODEL IN BIM Ric Kudoh - CYO Corporation	INTEROPERABILITY IN PORTS BIDDING Stefania Correa - Andrade Gutierrez Engenharia
16:15	BIM MODEL AS A BRAIN FOR INFRASTRUCTURE CONSTRUCTION PROCESSES – PROJECT A5 – BYPASS OF DRASENHOFEN Martin Kriz - Strabag AG	CLASSIFICATION OF BRIDGES BASED ON LINKED DATA AND SEMANTIC WEB TECHNOLOGY Jan-Erik Hoel - Trimble Solutions Sandvika	IDBE GEOTECH: THE BSI AND OGC COLLABORATION FOR GEOTECHNICAL DATA STANDARDIZATION Michael Beaufils - French Geological Survey BRGM	BIM FOR MAINTENANCE AND OPERATION OF WATERWAY INFRASTRUCTURE - THE PROJECT 'NEW LOCK TRIER' Ralf Becker - RWTH Aachen University, Sigfrid Knapp - Federal Waterways Engineering and Research Institute
16:45	CASE SIENIKJA STREET IMPROVEMENT IN CITY OF OULU ASSET OWNER USING OPENBIM PLATFORM IN INFRA DESIGN AND CONSTRUCTION PHASE Ilkka Tieaho - Infrakit Group Oy	BIM INFRASTRUCTURE: IMPLEMENTING BIM FUNCTIONS AND SCAN-TO-MODELLING REQUIREMENTS FOR THE MANAGEMENT OF BRIDGE STRUCTURES Fabrizio Banfi - Politecnico di Milano	COCLASS FOR GEOTECHNICAL OBJECTS - 5 GEOBIM PILOT PROJECTS IN SWEDEN Mats Svensson - Tyréns AB	LENGTHENING OF THE SAIMAA CANAL LOCKS, A BIM LEARNING EXPERIENCE FROM THE DESIGNER'S PERSPECTIVE Mikael Sieimy - FCG Design and Engineering Ltd
17:15	IMPLEMENTATION OF OPEN BIM IN CITIES Timo Perttula - Ramboll Finland Oy	PAVING THE WAY FOR A MAJOR PROJECT IN LITHUANIA WITH OPENBIM Domas Dzina - TEC Infrastructure	UTILIZING INFRA BIM FOR EMBANKMENT SETTLEMENT ANALYSIS Aatu Etelänuori - Sitowise Oy	OPEN BIM TOOL TO RAILWAY AND HARBOR CONSTRUCTION PROJECTS – CASE: DEEPENING KOKKOLA FAIRWAY AND HARBOR PROJECT Eero Jyväkimäen - Civilpoint Oy

| 18.30–20.00 | City reception at Tampere City Hall |

National BIM Guidelines and
Case Studies for Infrastructure

SBEnrc Project 3.28

Sustainable
Built Environment
National Research Centre

April 2017
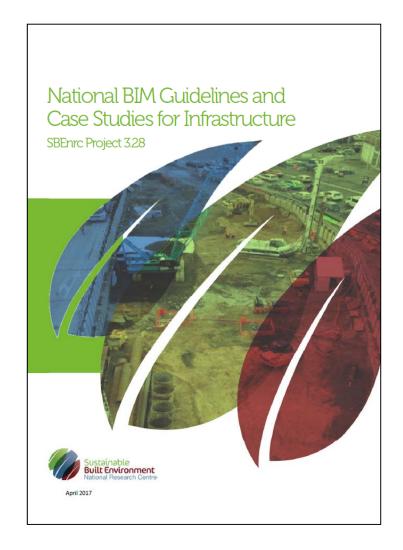
Executive Summary

To date, the level of BIM implementation in the transport infrastructure sector is a few years behind that for vertical building construction. Compared with the building sector, the provision of infrastructure usually involves physical and organisational structures addressing society needs which are mainly owned and managed by governments. Almost all published BIM guidelines/standards are targeted to the building sector. The purpose of this BIM

2 BIM uses in infrastructure

Fig. 1: BIM uses in infrastructure
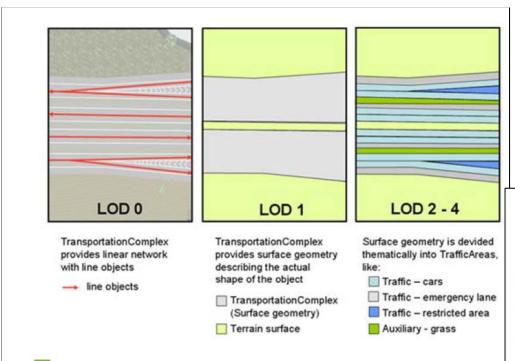
Fig. 4: *TransportationComplex* in LOD0, 1, and 2-4 (example shows part of a motorway) (source: Rheinmetall Defence Electronics).
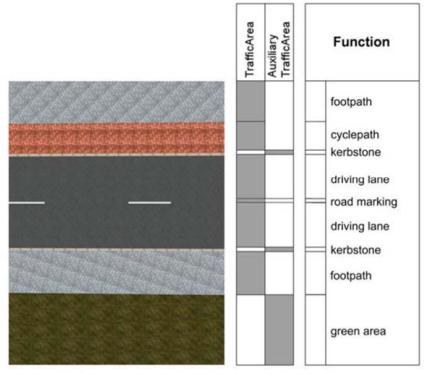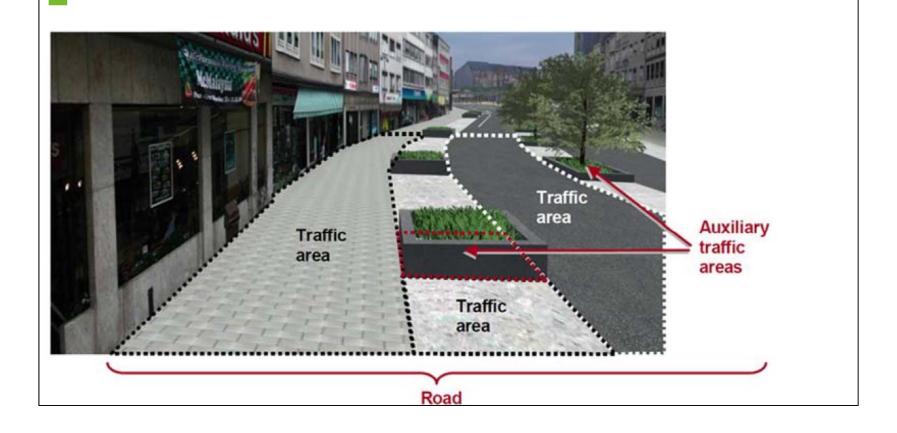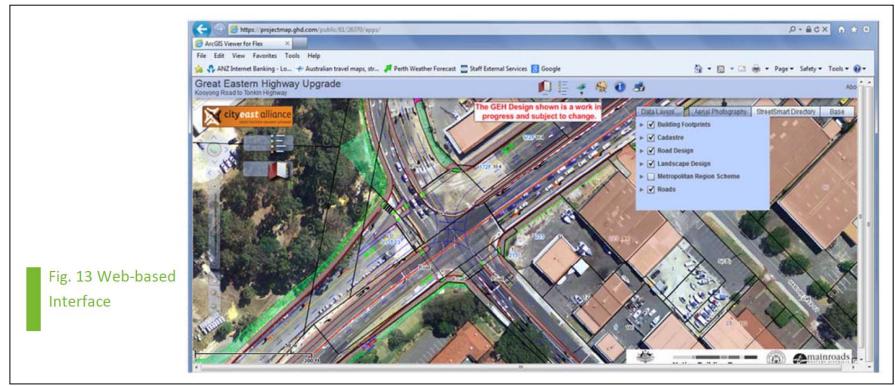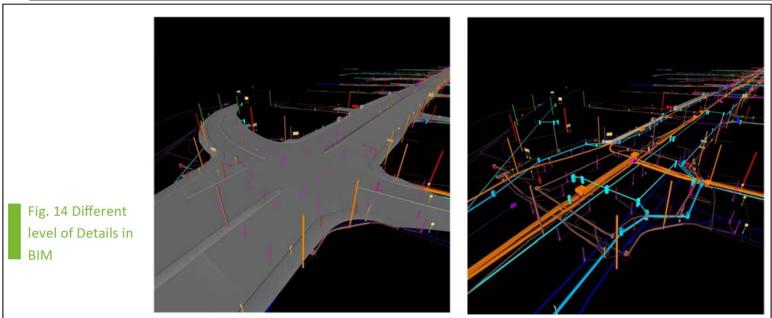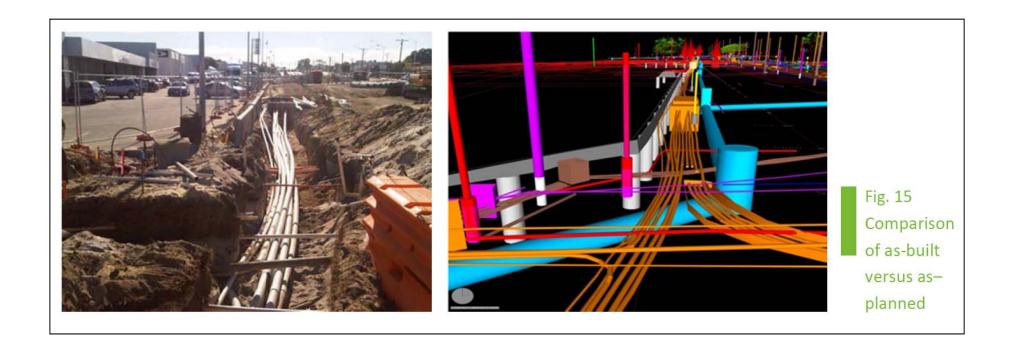

Fig. 5: *TransportationComplex* in LOD 2-4: representation of a road with a complex cross-section profile (example shows urban road) (source: Rheinmetall Defence Electronics).

Fig. 3: Example for the representation of a *TransportationComplex* in LOD2 in CityGML: a road, which is the aggregation of *TrafficAreas* and *AuxiliaryTrafficAreas* (source: City of Solingen, IGG Uni Bonn).

Fig. 13 Web-based Interface

Fig. 14 Different level of Details in BIM
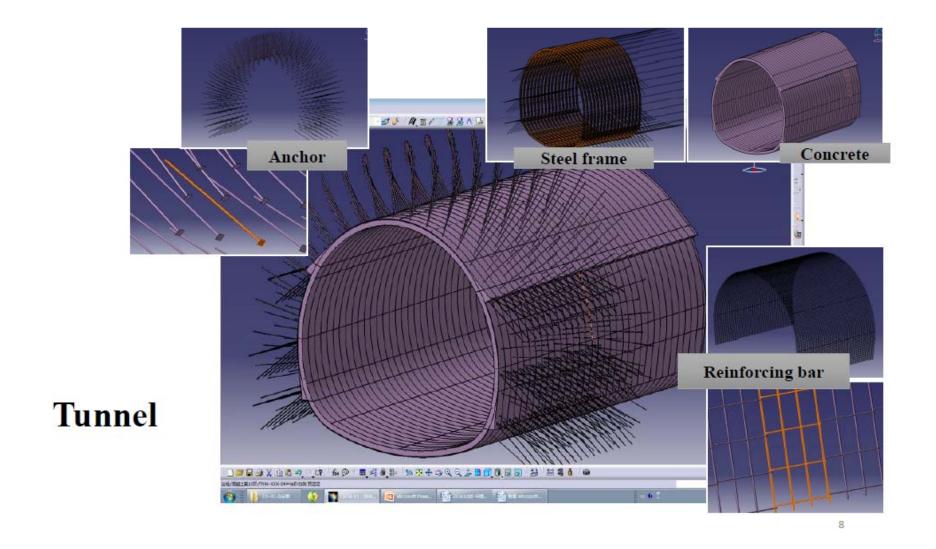
Fig. 15 Comparison of as-built versus as–planned

China Railway BIM (CRBIM) Alliance

- The CRBIM was established in December 2013.
- Its purpose is to promote the application of BIM technology in the China railway field.
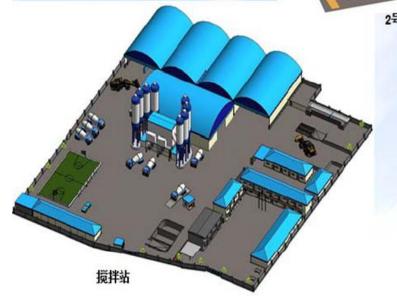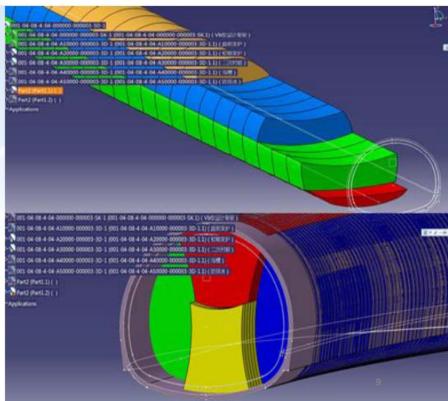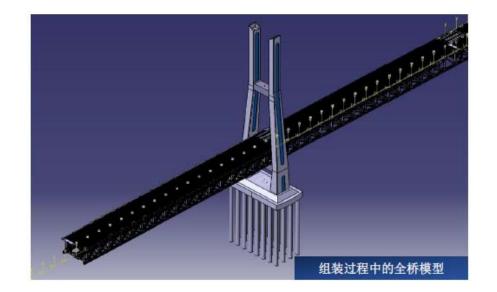- Members:

Tunnel

Anchor

Steel frame

Concrete

Reinforcing bar

Tunnel excavation process simulation

2号斜井

攪拌站

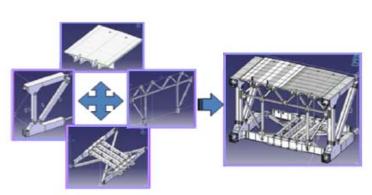**Tunnel temporary works**

52

Steel Bridge

- **Digital pre-assembly construction**
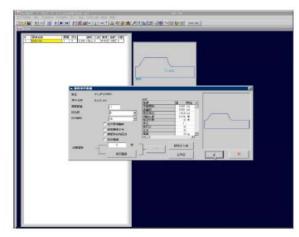- **Construction management based on BIM 4D**

组装过程中的全桥模型

10

Steel Bridge

- Integrated manufacturing of steel beam
- Data exchange between BIM models and CNC
- Automation and accuracy using BIM

Subgrade

- Digital construction for subgrade using BIM

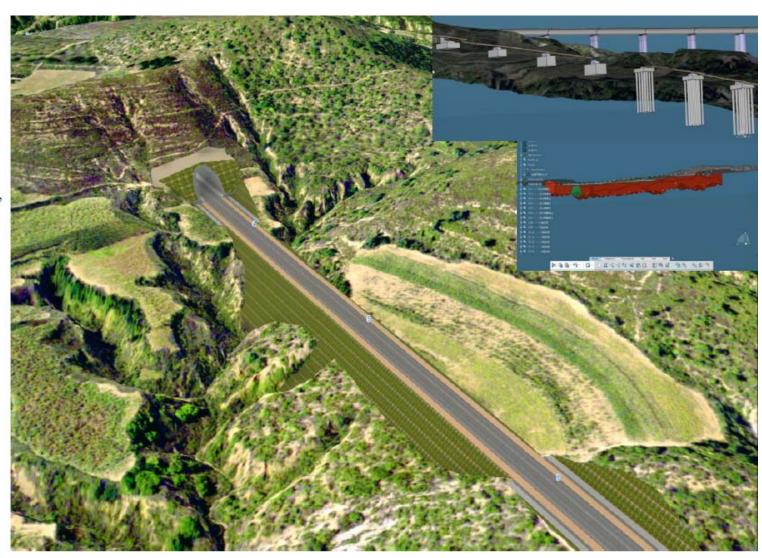- Data exchange between BIM models and construction machinery

Design Coordination

- Terrain, alignment, subgrade, track, bridge, tunnel, station model
- Design check
- Quantity take off (QTO)
- Drawing output
- Construction simulation
- Finite element analysis

China Railway BIM Standard

- China Railway BIM Standard is composed of three parts:
- Part 1: Railway BIM Classification Standard
  - Refer to ISO 12006-2
  - Was completed in December 2014.
- Part 2: Railway BIM Data Standard
  - Based on ISO 16739:2013
  - A draft version was accomplished in June 2015.
  - The public version was expected to be available in December 2015.
- Part 3: Railway BIM Delivery Standard
  - Based on ISO 29481, started in July 2015
- Led by the Third Railway Survey and Design Institute Group Corporation & Tsinghua University, all direct members involved.
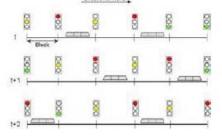
18

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Spatial structure

Assembly

System

Physical element

Data standard Architecture

Property

Component

19

58

Tunnel

Station

Bridge

Alignment

Discipline modules

Subgrage

Track

Drainage

Here's how smart construction could transform home-building after COVID-19

The pandemic is forcing us to find new ways of building homes and offices.

Image: REUTERS/Pascal Rossignol

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Digital Transformation of Home-building

Digital Collaborative Platforms

Digital platforms such as cloud based Building-Information-Modelling (BIM) is essential in the workflow to enable the industry-wide shift into remote ways of collaboration, and to better manage risk, enable collaborative workflow globally, plan for sustainability.

Artificial Intelligence

Artificial Intelligence can speed up and automate elements of design and construction. Algorithms can be developed to automate the assembly of prefabricated building components to form varying massing and layouts which directly respond to define physical and environmental conditions, using GIS-data, to optimize volumes to achieve the highest yield of units and drive value, and possibly learning from occupants' changing living behavior to define next generation homes for future of living.

Internet-of-Things & Robotics

The Internet-of-Things (IoT) is a vital interface in connecting the physical and digital operations. Industrialization of connected buildings will likely become mainstream, because successful integration of sensors, antennas, control systems and other components into the building envelop is best managed in a factory scale setting. Construction robotics for use in factory settings have entered the market. On-site applications including autonomous excavating equipment, surveying drones, painting machines, worker exoskeletons, will also continue to proliferate.

Smarter planning and design

The construction sector is already using Building Information Modelling (BIM), a first step in the digital transformation of the sector. During the COVID-19 lockdown, BIM was more widely adopted in the industry. It enabled projects to continue in a digital and virtual environment even when participants were unable to meet in person. This collaborative approach allows data to be shared across professional disciplines and businesses, and facilitates smarter construction. In the prefab industry, the data can then be fed into manufacturing processes for components and modules that are later put together to form finishing buildings.

Homes Made In Factory
80% reduction on site based labor; **25%** overall reduction in labor.

Less Labor

Amount of labor on site significantly reduced assisting with social distancing and productivity on site. Prefabricated systems typically have 80% less labor on site compared to traditional construction. The amount of activities that require working in groups is also reduced.

Shorter Programs

Providing shorter programs with more surety on program with little disruption around future waves where traditional construction sites may close again.

Early data provides evidence to support this where prefabricated based projects have not closed and not seen any impact on progress, productivity or program.

Cost Certainty

Mitigating cost increases due to longer programs and reduced productivity. Future project costing is likely to include known and unknown risk associated with program, labor, supply chain fragility and material shortages. Prefabrication does not suffer these risks to the extent of traditional construction.

Faster Delivery

Numbers of deliveries to site required significantly reduced. Prefabricated solutions deliver near finished elements to site. Most of the trade and supply chain management is carried out in the factory reducing material deliveries to site and the need to distribute at scale.

Greener Construction **90%** reduction in construction waste; **70%** saving in CO_2 emissions.

Reduced Energy Use On-site

Research shows gross savings of around 80% and net savings of around 30% for off-site manufactured buildings.

This takes into account worker access, movement and accommodation – services, lighting and equipment/plant, including site-wide lighting.
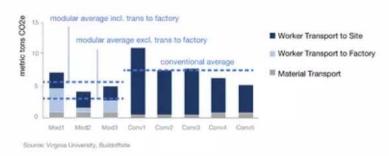
Less Waste

Traditional construction suffers from up to 30% wastage – in terms of time, where work needs to be repeated, and materials, where up to 30% can end up in landfill. The comparators figures factory-controlled conditions is 1-3%.

Less Traffic

A comparative study of the total CO_2 emissions associated with onsite and offsite manufacturing was completed by Virginia University. In terms of metric tons of CO_2 associated with transport this study shows site-based reductions in the order of 60%.

Onsite-Offsite comparison of CO_2 emmissions due to transport

Legend:
- Worker Transport to Site
- Worker Transport to Factory
- Material Transport

modular average incl. trans to factory
modular average excl. trans to factory
conventional average

metric tons CO2e

Mod1 Mod2 Mod3 Conv1 Conv2 Conv3 Conv4 Conv5

Source: Virginia University, Buildoffsite

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Q&A