資料-4 受領資料

資料-4.1 Streamlining Facility Delivery　Bill East, PhD, PE, F.ASCE

資料-4.2 アランスカンウェイ高架・地下化工事の CIM

資料-4.3 FORUM ON BUILDING AND CIVIL INFORMATION MODELING (BIM/CIM)

資料-4.4 Information Systems for Civil and Environmental Engineering　Joshua Peschel, PhD

資料-4.5 Autonomous Vision-based Condition Assessment of Civil Infrastructure Systems

資料-4.6 Building and Civil Information Modeling & Intelligent, Information-Intensive Systems for Supporting Sustainable Infrastructure Systems　Nora El-Gohary, Ph.D.

資料-4.7 BIM for Infrastructure Finamcial Impact for all stakeholders　Ken Stow

an important note:

The identification of specific products or services noted in this presentation does not constitute an endorsement by the United States Government.

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

ERDC

Engineer Research and Development Center

Streamlining Facility Delivery

Bill East, PhD, PE, F.ASCE

Research Civil Engineer

U.S. Army, Corps of Engineers

bill.east@us.army.mil

real-time visibility of asset/facility network

DoD, OSD-Business Enterprise Integration

effective and efficient operation

TRADOC PAM 525-66

minimize total cost of ownership

Army Strategy for the Environment

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

BUILDING STRONG®

ERDC

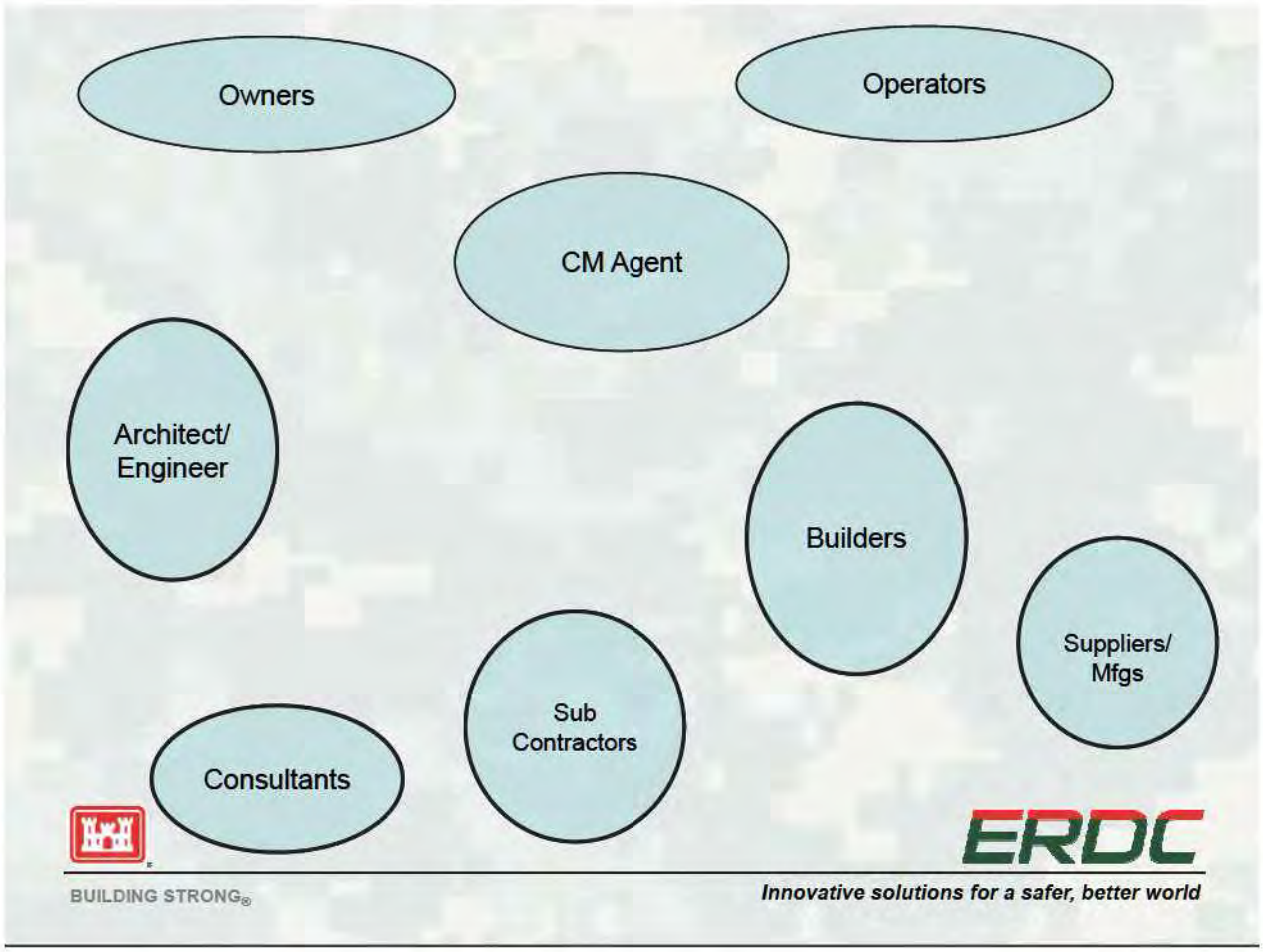
Innovative solutions for a safer, better world

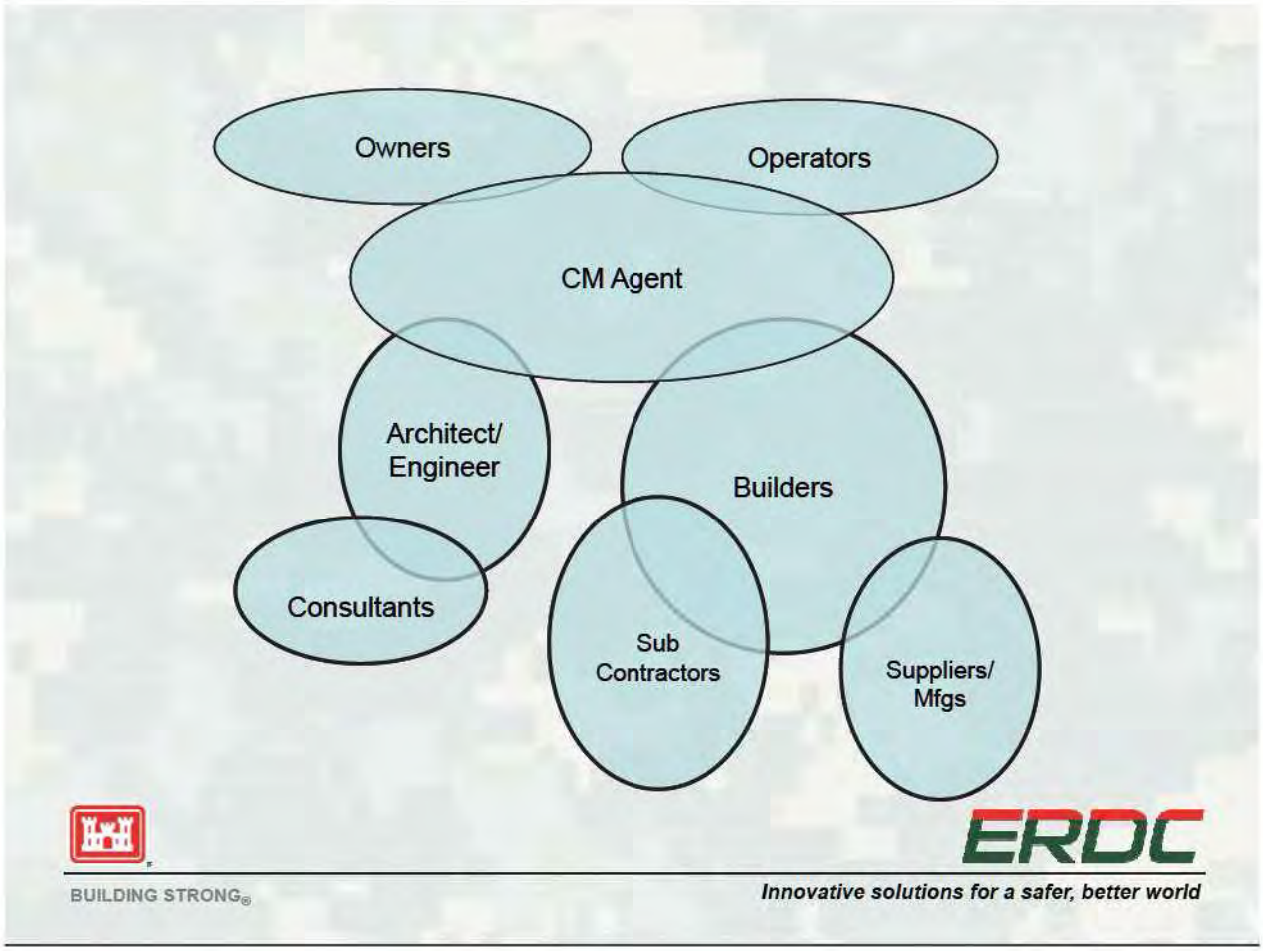
NEVER FORGET

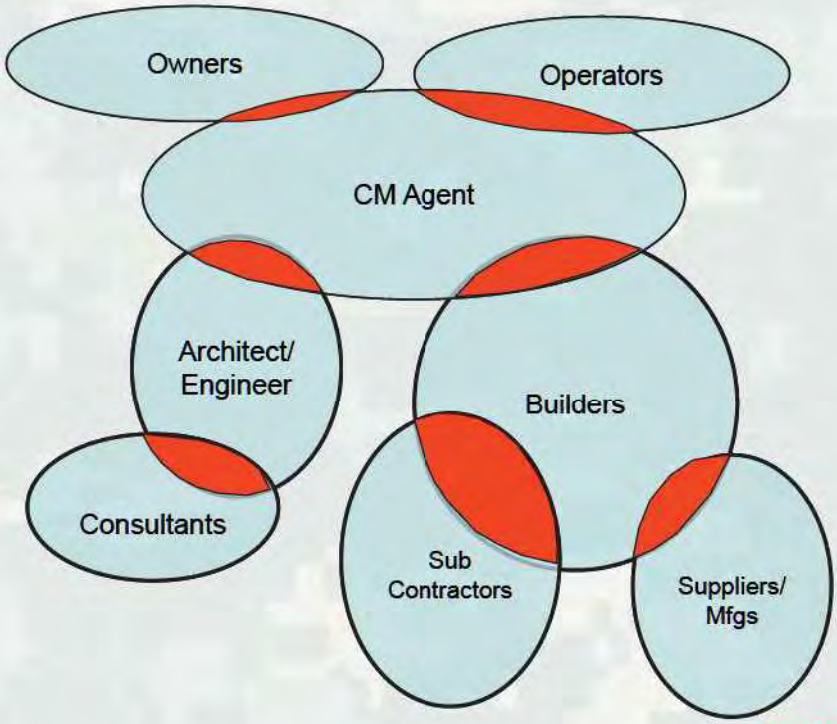
standardize process

unlock content

see what happens…


Owners
Operators
CM Agent
Architect/
Engineer
Builders
Suppliers/
Mfgs
Sub
Contractors
Consultants
ERDC
BUILDING STRONG®
Innovative solutions for a safer, better world

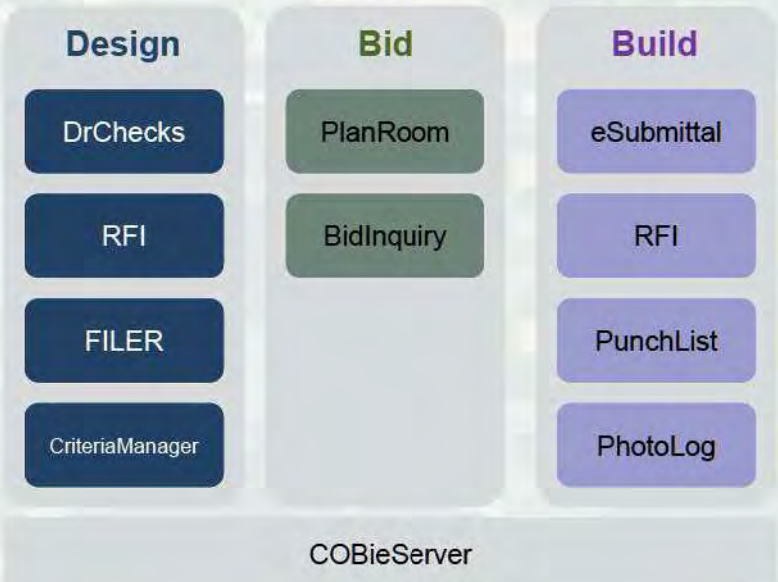

Owners
Operators
CM Agent
Architect/
Engineer
Builders
Consultants
Sub
Contractors
Suppliers/
Mfgs
ERDC
BUILDING STRONG®
Innovative solutions for a safer, better world



BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

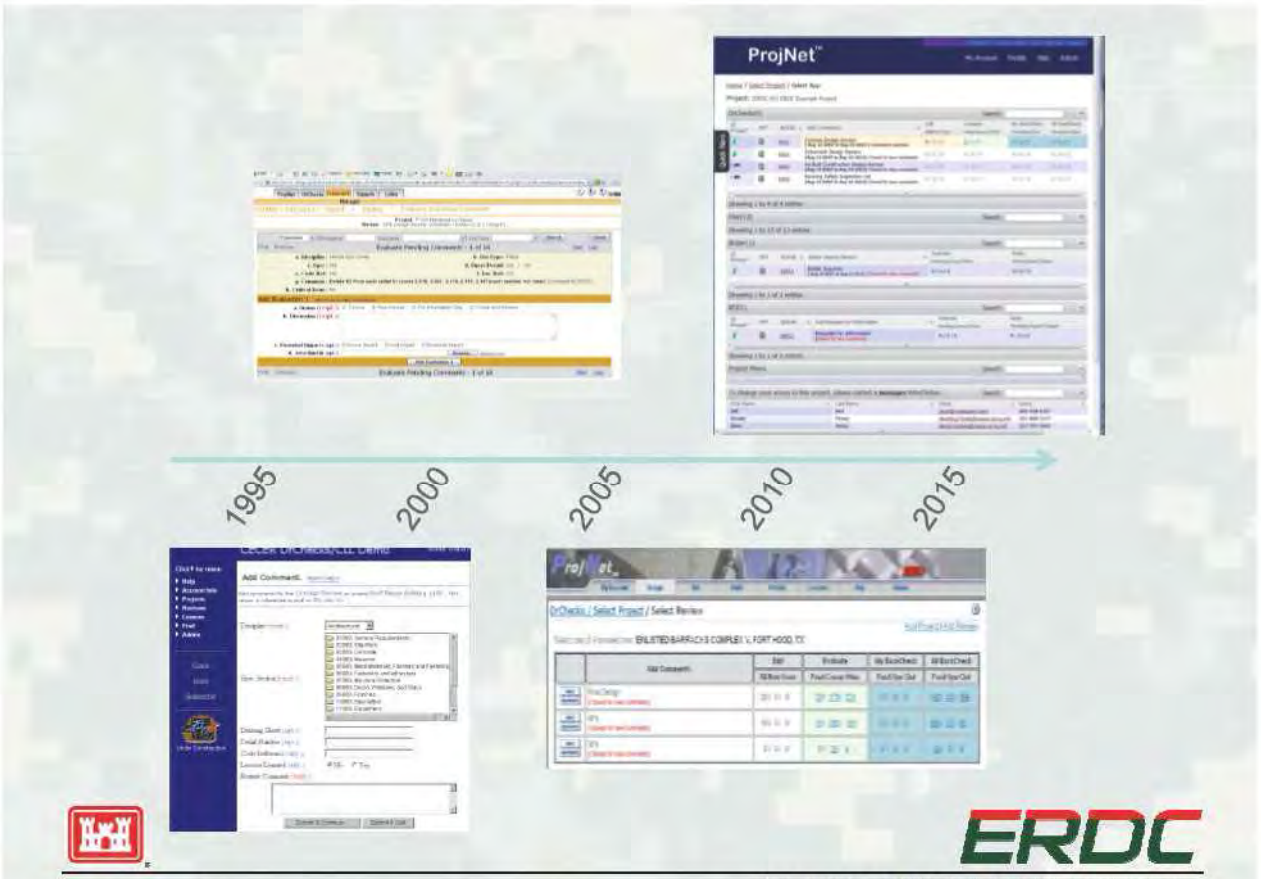


http://www.projnet.com

BUILDING STRONG®

ERDC

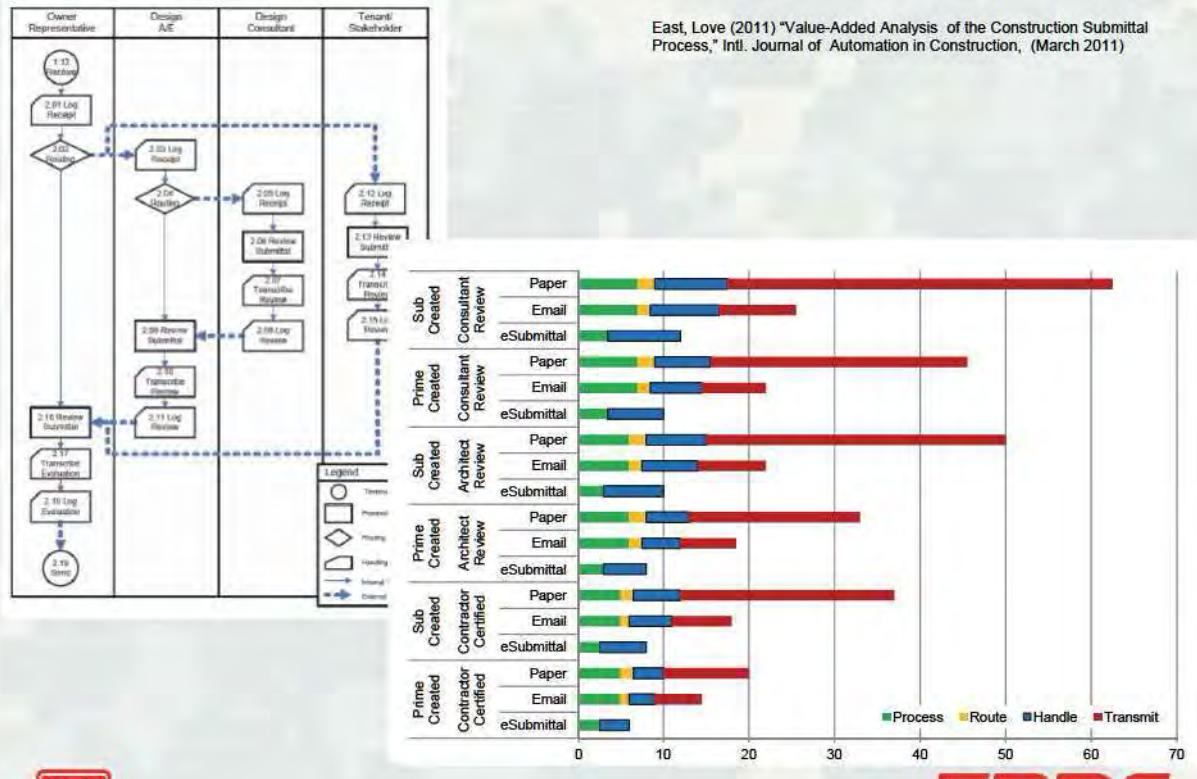
Innovative solutions for a safer, better world



BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world



East, Love (2011) "Value-Added Analysis of the Construction Submittal Process," Intl. Journal of Automation in Construction, (March 2011)

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

standardize process

unlock content

see what happens…

BUILDING STRONG®
ERDC
Innovative solutions for a safer, better world

BUILDING STRONG®

ERDC

*Innovative solutions for a safer, **better world***

"much valuable data associated with the design, construction, and operation of a facility are lost during its life span"

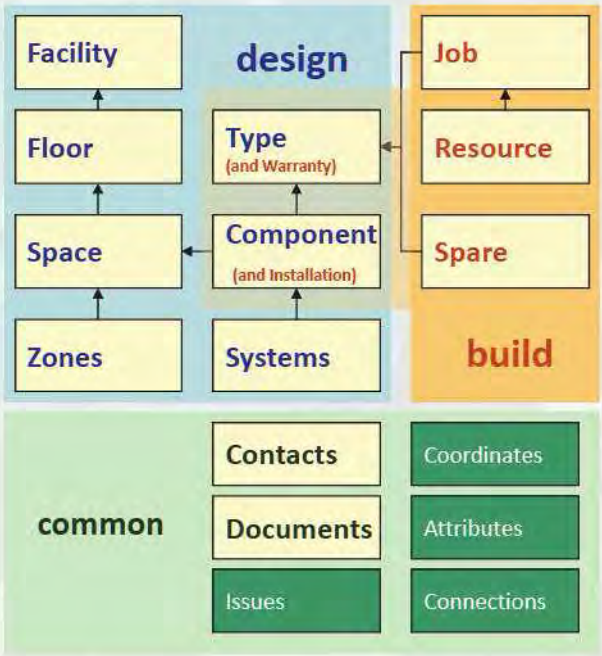
National Research Council (1983) "A Report from the 1983 Workshop on Advanced Technology For Building Design and Engineering, National Academy Press, Washington, DC. 1984.

BUILDING STRONG®

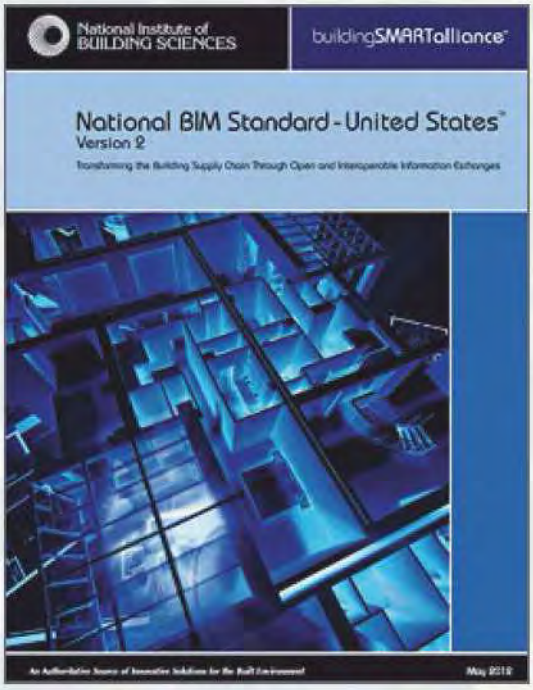
ERDC

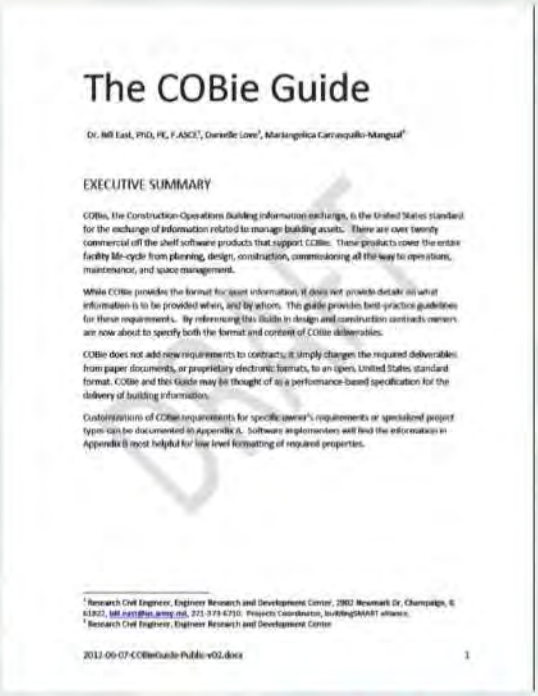
Innovative solutions for a safer, better world

- **programming**
  - spaces
  - zones
- **design**
  - systems
  - components
- **procurement**
  - product information
  - documents
- **commissioning**
  - job plans
  - warranties
  - spares



http://www.wbdg.org/pdfs/erdc_cerl_tr0730.pdf





The COBie Guide

EXECUTIVE SUMMARY

http://www.nationalbimstandard.org/
http://www.wbdg.org/resources/cobie.php

COBie is…

a specification for asset inventory and O&M info

http://www.wbdg.org/resources/cobie.php

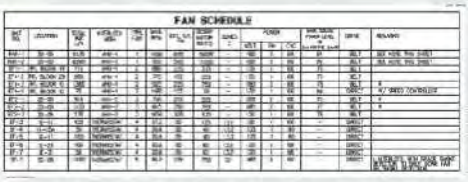
BUILDING STRONG®

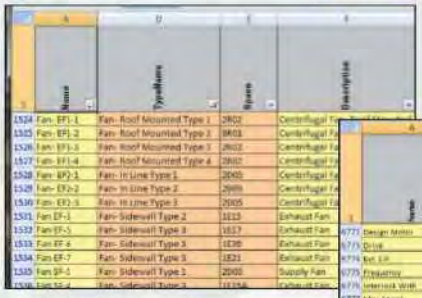
ERDC

Innovative solutions for a safer, better world

COBie.Space Worksheet

COBie.Attribute Worksheet





COBie.Component Worksheet

COBie.Attribute Worksheet

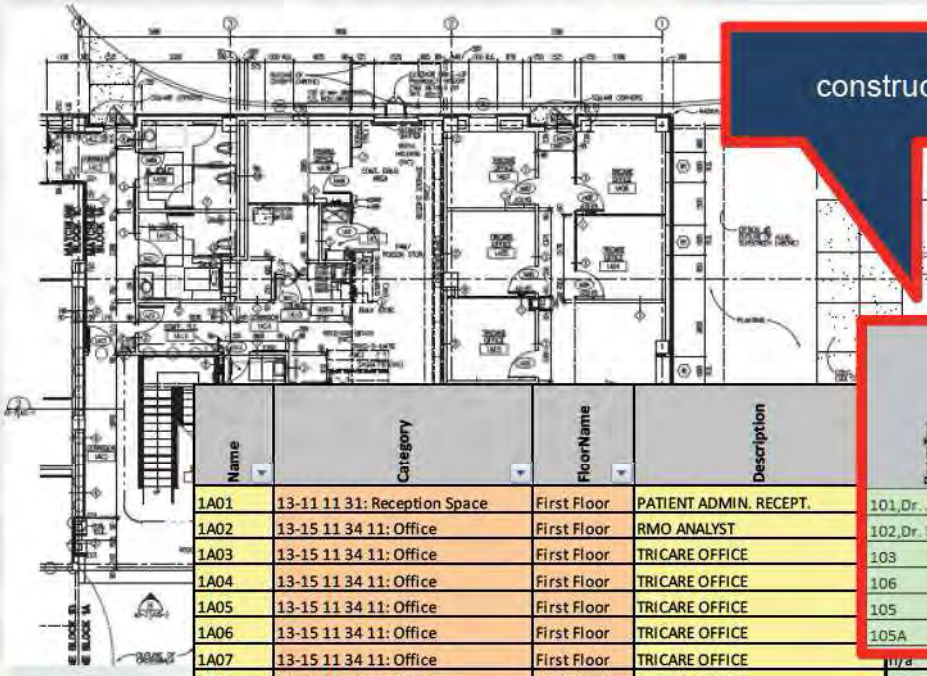
COBie during design

"Does the data match drawing schedules?"

BUILDING STRONG®

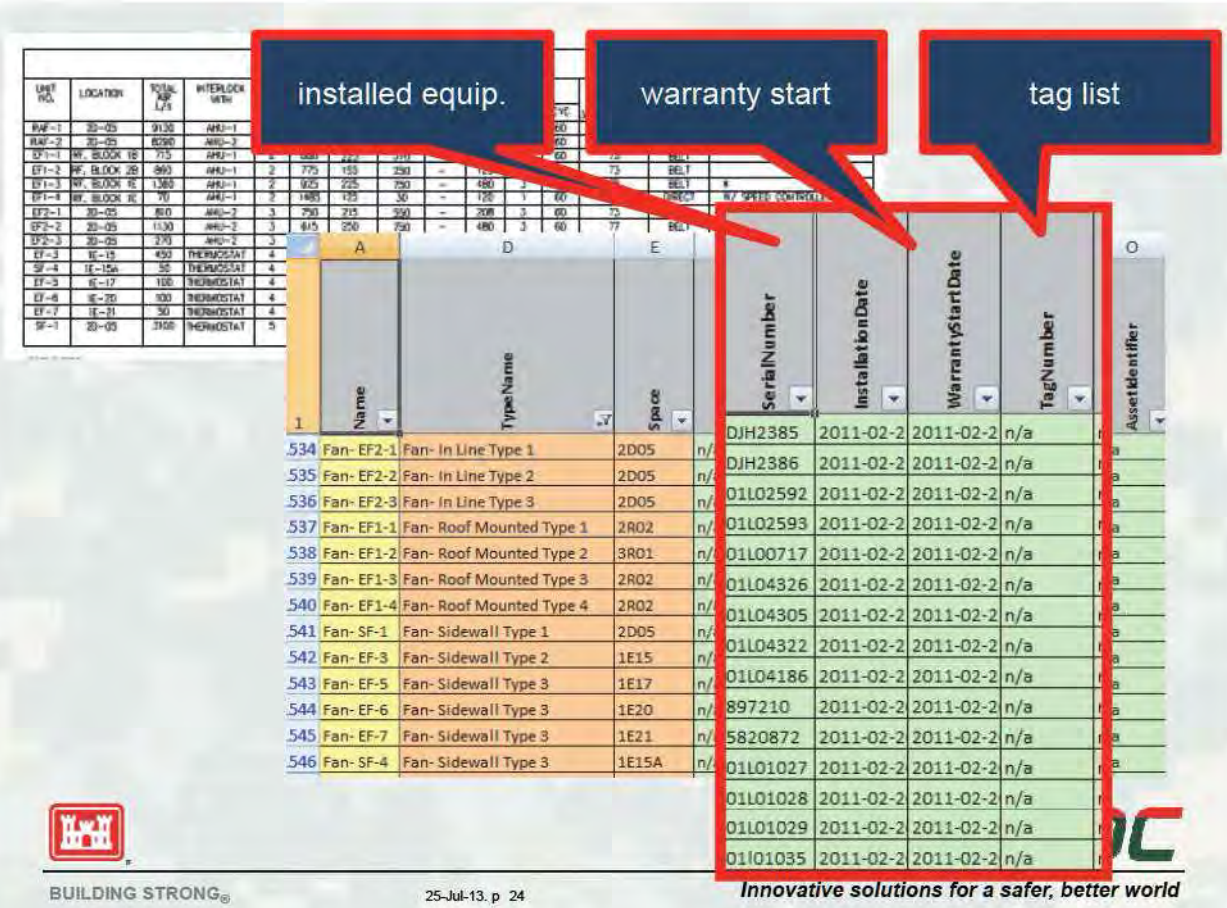
25-Jul-13. p 22

Innovative solutions for a safer, better world



construction signage

Name	Category	FloorName	Description	RoomTag	UsableHeight	GrossArea	NetArea
1A01	13-11 11 31: Reception Space	First Floor	PATIENT ADMIN. RECEPT.	101,Dr. Jones	2700	19.767	19.767
1A02	13-15 11 34 11: Office	First Floor	RMO ANALYST	102,Dr. Smith	2400	27.693	27.693
1A03	13-15 11 34 11: Office	First Floor	TRICARE OFFICE	103	2400	8.874	8.874
1A04	13-15 11 34 11: Office	First Floor	TRICARE OFFICE	106	2400	9.545	9.545
1A05	13-15 11 34 11: Office	First Floor	TRICARE OFFICE	105	2400	8.999	8.999
1A06	13-15 11 34 11: Office	First Floor	TRICARE OFFICE	105A	2400	10.492	10.492
1A07	13-15 11 34 11: Office	First Floor	TRICARE OFFICE	n/a	2400	8.73	8.73
1A08	13-15 11 34 11: Office	First Floor	PHARM. OFFICE	n/a	2400	10.45	10.45
1A09	13-41 11 14 21: Restroom	First Floor	W. TOILET	n/a	2400	10.854	10.854
1A10	13-51 11 21: Break Room	First Floor	LOUNGE	n/a	2400	10.272	10.272
1A11	13-75 11 11: Storage Room	First Floor	JAN.	n/a	2400	2.037	2.037



installed equip.

warranty start

tag list

	Name	TypeName	Space	SerialNumber	InstallationDate	WarrantyStartDate	TagNumber	AssetIdentifier
534	Fan- EF2-1	Fan- In Line Type 1	2D05	DJH2385	2011-02-2	2011-02-2	n/a	
535	Fan- EF2-2	Fan- In Line Type 2	2D05	DJH2386	2011-02-2	2011-02-2	n/a	
536	Fan- EF2-3	Fan- In Line Type 3	2D05	01L02592	2011-02-2	2011-02-2	n/a	
537	Fan- EF1-1	Fan- Roof Mounted Type 1	2R02	01L02593	2011-02-2	2011-02-2	n/a	
538	Fan- EF1-2	Fan- Roof Mounted Type 2	3R01	01L00717	2011-02-2	2011-02-2	n/a	
539	Fan- EF1-3	Fan- Roof Mounted Type 3	2R02	01L04326	2011-02-2	2011-02-2	n/a	
540	Fan- EF1-4	Fan- Roof Mounted Type 4	2R02	01L04305	2011-02-2	2011-02-2	n/a	
541	Fan- SF-1	Fan- Sidewall Type 1	2D05	01L04322	2011-02-2	2011-02-2	n/a	
542	Fan- EF-3	Fan- Sidewall Type 2	1E15	01L04186	2011-02-2	2011-02-2	n/a	
543	Fan- EF-5	Fan- Sidewall Type 3	1E17	897210	2011-02-2	2011-02-2	n/a	
544	Fan- EF-6	Fan- Sidewall Type 3	1E20	5820872	2011-02-2	2011-02-2	n/a	
545	Fan- EF-7	Fan- Sidewall Type 3	1E21	01L01027	2011-02-2	2011-02-2	n/a	
546	Fan- SF-4	Fan- Sidewall Type 3	1E15A	01L01028	2011-02-2	2011-02-2	n/a	
				01L01029	2011-02-2	2011-02-2	n/a	
				01L01035	2011-02-2	2011-02-2	n/a	

http://www.wbdg.org/resources/cobie.php,
http://www.linkedin.com/groups?home=&gid=2638637&trk=anet_ug_hm
http://www.youtube.com/user/BSADemo/videos?view=1

BUILDING STRONG®

ERDC

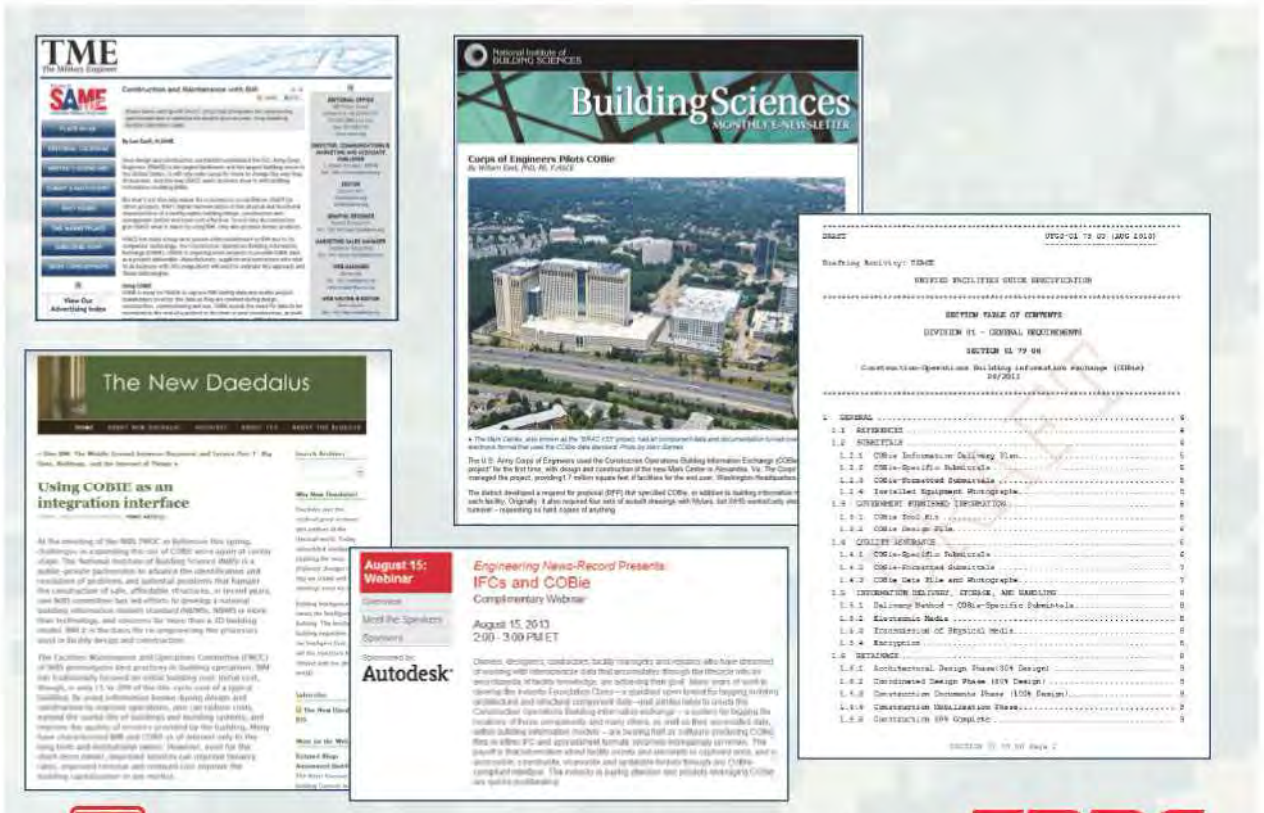
Innovative solutions for a safer, better world

http://www.nibs.org/?page=bsa_cobiemm

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

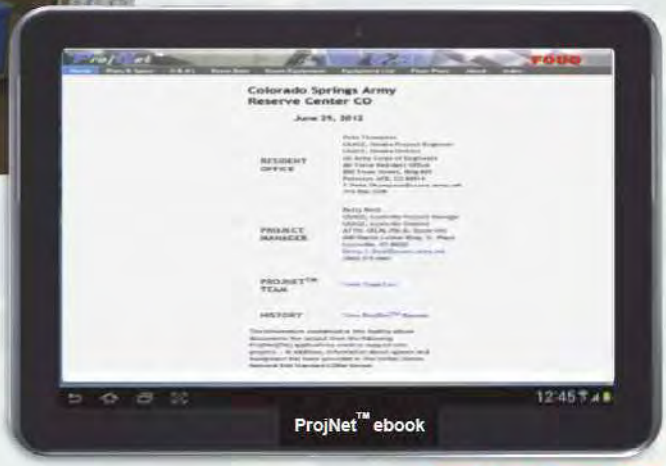


projects.buildingsmartalliance.org/files/?artifact_id=6674

BUILDING STRONG®

Innovative solutions for a safer, better world

or



BUILDING STRONG®

Innovative solutions for a safer, better world

standardize process

unlock content

see what happens… *a new, old paradigm*

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

Ever increasing social demands on our built environment

What is to be done? ignore the alarms

Detailed design analysis (of questionable accuracy)

Unknown as-built, as-operated conditions

Multiple overlapping sensor systems

The New York Times — Science

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

ENVIRONMENT | SPACE & COSMOS

The Nun Who Broke Into the Nuclear Sanctum

Sister Megan Rice, 82, is one of three people arrested in a break-in at a nuclear complex in Oak Ridge, Tenn.

By WILLIAM J. BROAD

She has been arrested 40 or 50 times for acts of civil disobedience and once served six months in prison. In the Nevada desert, she and other peace activists knelt down to block a truck rumbling across the government's nuclear test site, prompting the authorities to take her into custody.

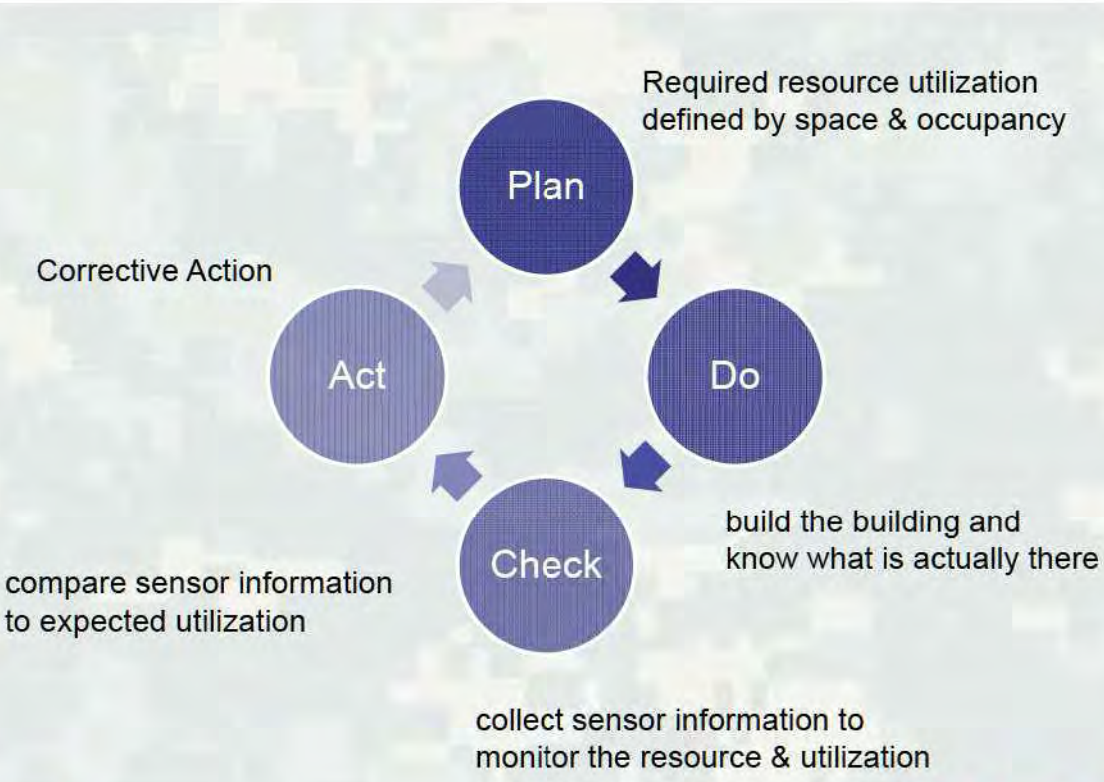
BUILDING STRONG®

ERDC

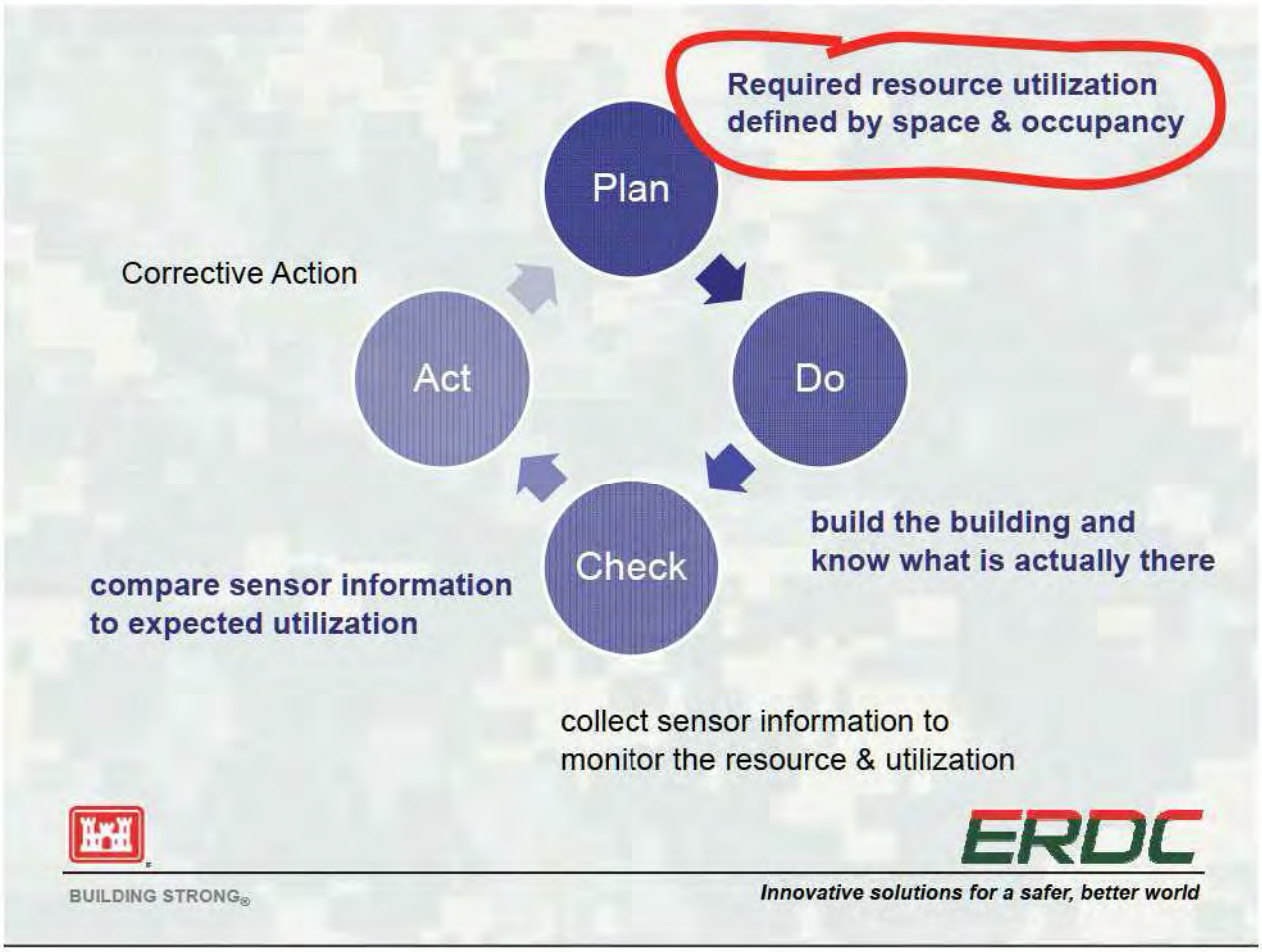
Innovative solutions for a safer, better world

e.g. sustainability…

- checklist don't = benefit
- models don't predict behavior
- control systems don't consider context



BUILDING STRONG®
ERDC
Innovative solutions for a safer, better world



BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

Project Phase	Information Required	Mission	Sustainability	Resource-Based Domain Models			
				HVAC	Electrical	Water	Sensors
Programming/ Design	Requirements (Users)	Building Programming information exchange (BPie)	Sustainability Measurement Guidelines	Resource Requirements Extended Room Data Sheets (BPie)			
	Requirements (Domain)	Technical Design Program and Topology Analysis		Technical Design Program and Topology Analysis			
Design/ Construction	Components	COBie & Life Cycle information exchange (LCie)	Construction-Operations Building information exchange (COBie) Specifier's Properties information exchange (Spie)				Building Automation Management information exchange (BAMie)
	Assemblies	Spatial /Zone Topology Analysis Methods		HVAC information exchange (HVACie)	Electrical System information exchange (Sparkie)	Water System information exchange (WSie)	
	Connections						
Commissioning/ Operations	Behavior (Users)	Emergent Behavior of Building Systems	Sustainability Measurement Guidelines	Emergent Behavior of Building Systems			
	Behavior (Domain)		Sustainability Measurement Guidelines				

http://projects.buildingsmartalliance.org/files/?artifact_id=6040

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

<table>
<tr><th rowspan="2">Project Phase</th><th rowspan="2">Information Required</th><th rowspan="2">Mission</th><th rowspan="2">Sustainability</th><th colspan="4">Resource-Based Domain Models</th></tr>
<tr><th>HVAC</th><th>Electrical</th><th>Water</th><th>Sensors</th></tr>
<tr><td rowspan="2">Programming/ Design</td><td>Requirements (Users)</td><td>Building Programming information exchange (BPie)</td><td rowspan="2">Sustainability Measurement Guidelines</td><td colspan="3">Resource Requirements Extended Room Data Sheets (BPie)</td><td rowspan="2"></td></tr>
<tr><td>Requirements (Domain)</td><td>Technical Design Program and Topology Analysis</td><td colspan="3">Technical Design Program and Topology Analysis</td></tr>
<tr><td rowspan="4">Design/ Construction</td><td>Components</td><td>COBie & Life Cycle information exchange (LCie)</td><td colspan="4">Construction-Operations Building information exchange (COBie)
Specifier's Properties information exchange (Spie)</td><td rowspan="3">Building Automation Management information exchange (BAMie)</td></tr>
<tr><td>Assemblies</td><td rowspan="2">Spatial /Zone Topology Analysis Methods</td><td rowspan="2"></td><td rowspan="2">HVAC information exchange (HVACie)</td><td rowspan="2">Electrical System information exchange (Sparkie)</td><td rowspan="2">Water System information exchange (WSie)</td></tr>
<tr><td>Connections</td></tr>
<tr><td rowspan="2">Commissioning/ Operations</td><td>Behavior (Users)</td><td rowspan="2">Emergent Behavior of Building Systems</td><td>Sustainability Measurement Guidelines</td><td colspan="3" rowspan="2">Emergent Behavior of Building Systems</td><td rowspan="2"></td></tr>
<tr><td>Behavior (Domain)</td><td>Sustainability Measurement Guidelines</td></tr>
</table>

BUILDING STRONG®

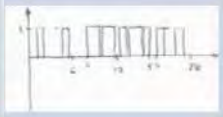
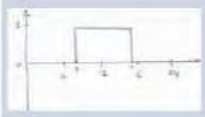
ERDC

Innovative solutions for a safer, better world

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

Daily Waveforms	Short Duration High Frequency (e.g. microwave, water)	Moderate Duration High Frequency (e.g. HVAC)	Long Duration Low Frequency (e.g. lights)
Work Weekday			
Work Weekend			
Home Weekday			
Home Weekend			

BUILDING STRONG®

ERDC

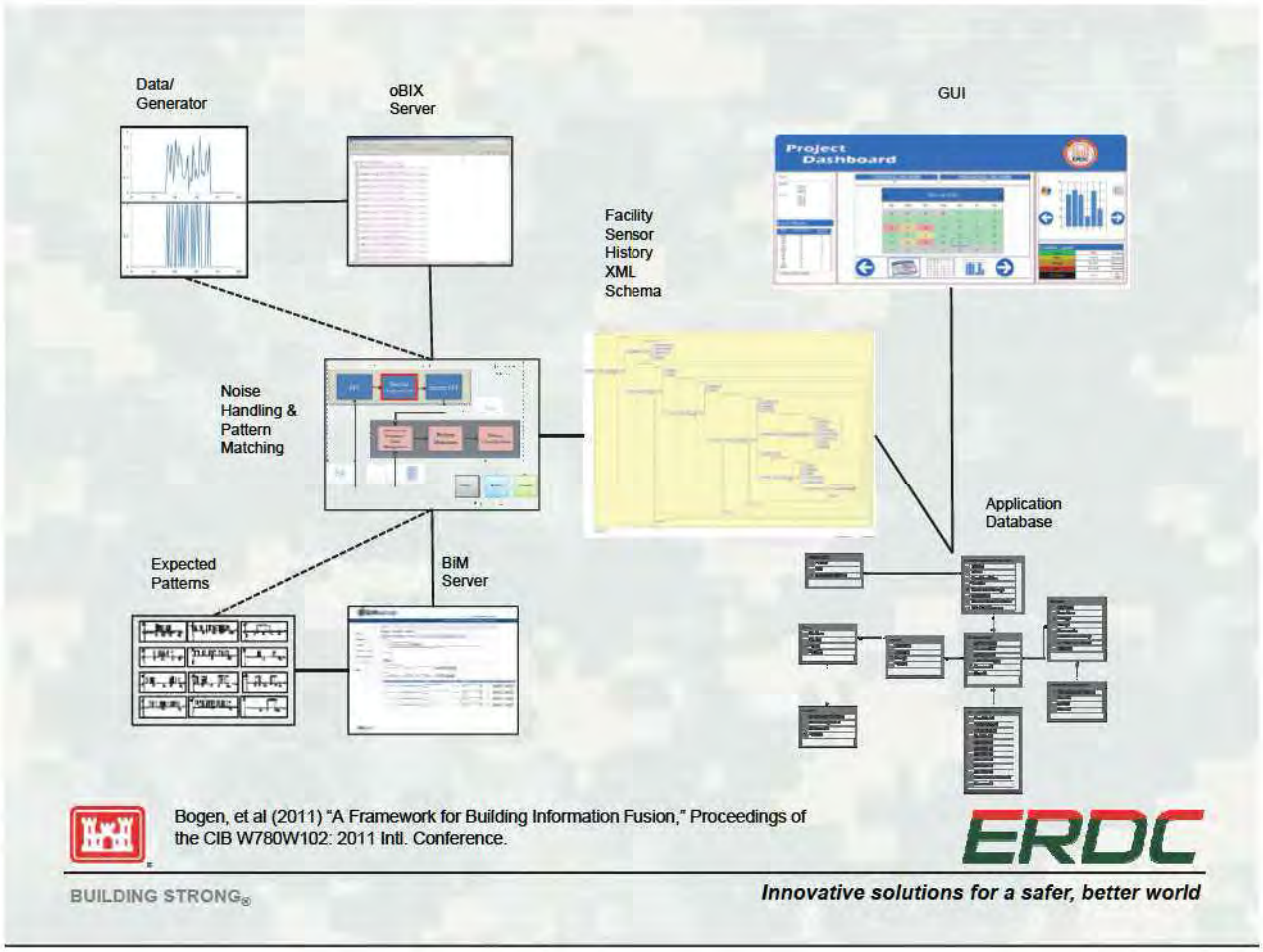
Innovative solutions for a safer, better world

Signal Noise Examples	Intensity Noise	Shift Noise	Frequency Noise
Clean Signal			
Noisy Signal			

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

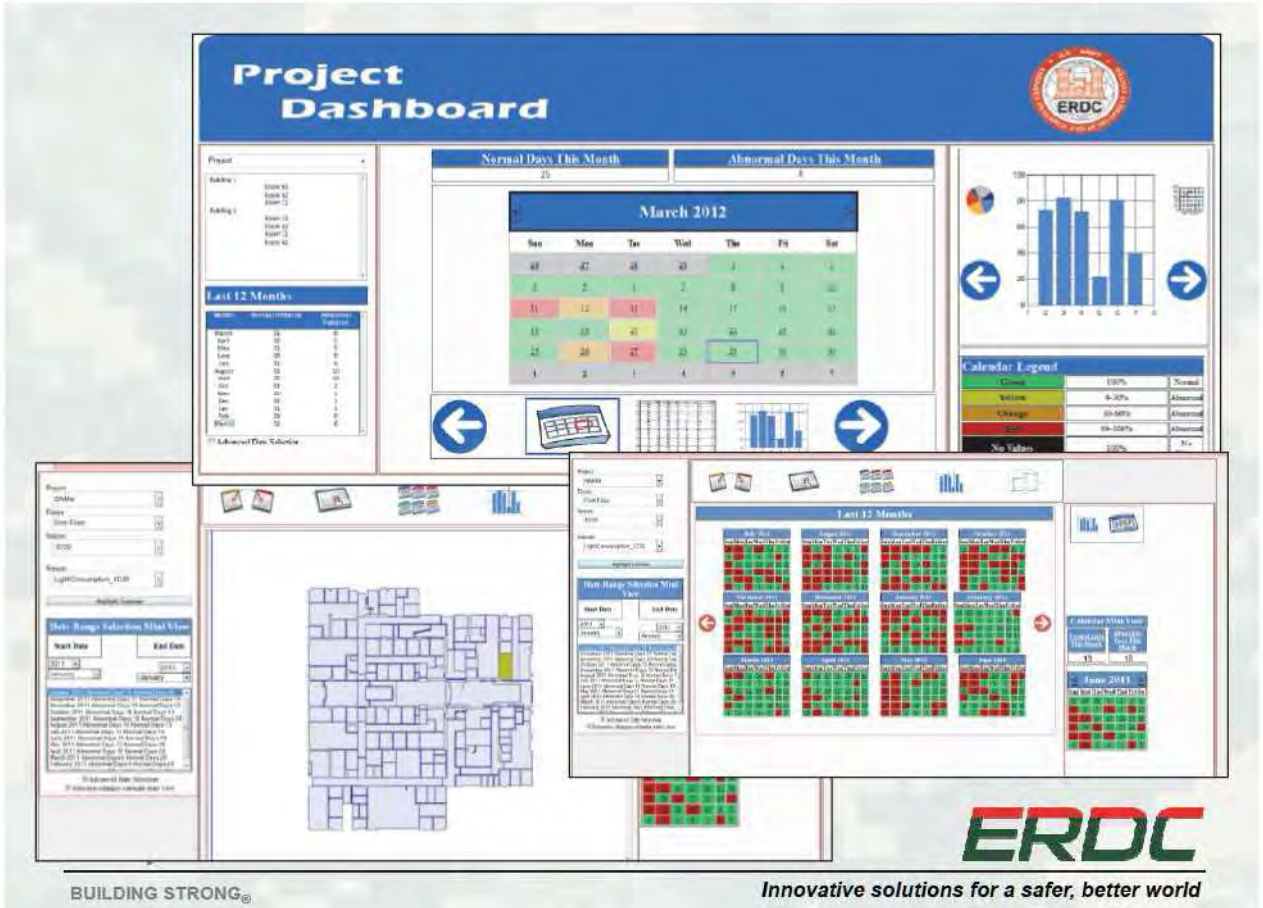


Bogen, et al (2011) "A Framework for Building Information Fusion," Proceedings of the CIB W780W102: 2011 Intl. Conference.

ERDC

BUILDING STRONG®

Innovative solutions for a safer, better world



ERDC

BUILDING STRONG®

Innovative solutions for a safer, better world

what has ERDC done?

- secure cloud-based services 90K users
- created/supported NBIMS-US
- introducing Building Feedback & Learning System

BUILDING STRONG®

ERDC

Innovative solutions for a safer, better world

ERDC

Engineer Research and Development Center

Streamlining Facility Delivery

Bill East PhD, PE, F.ASCE

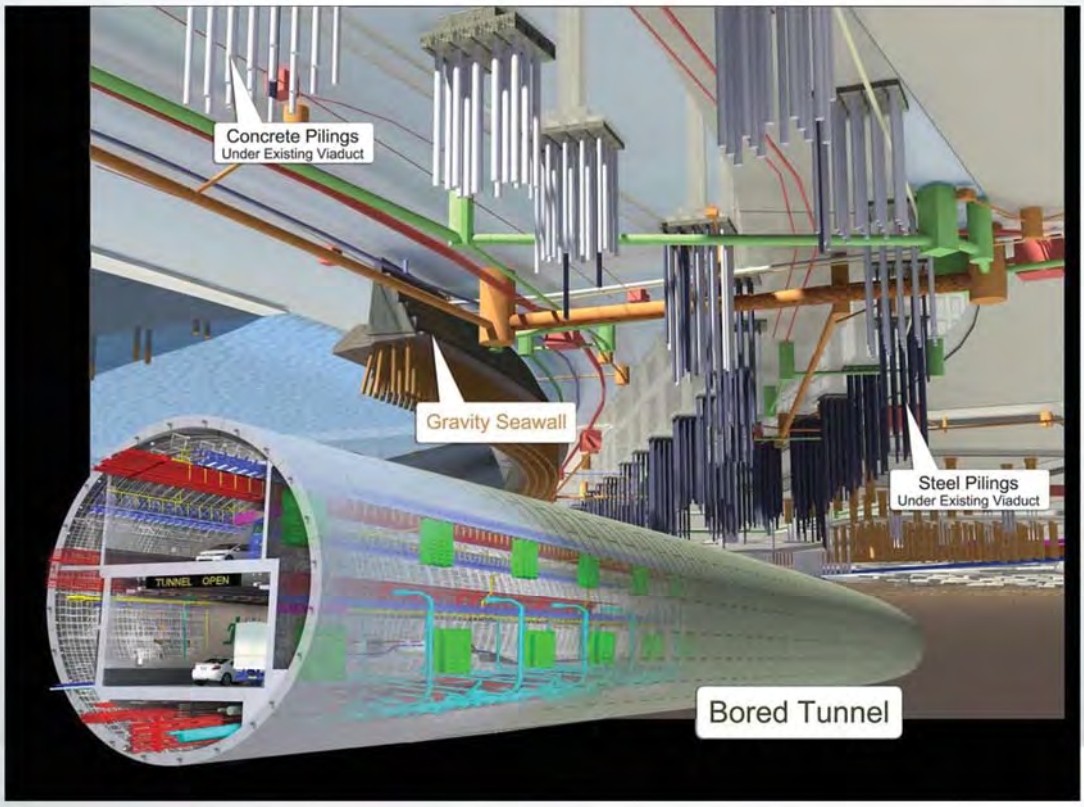
http://www.linkedin.com/in/williameast

bill.east@us.army.mil

アラスカンウェイ高架・地下化工事のCIM

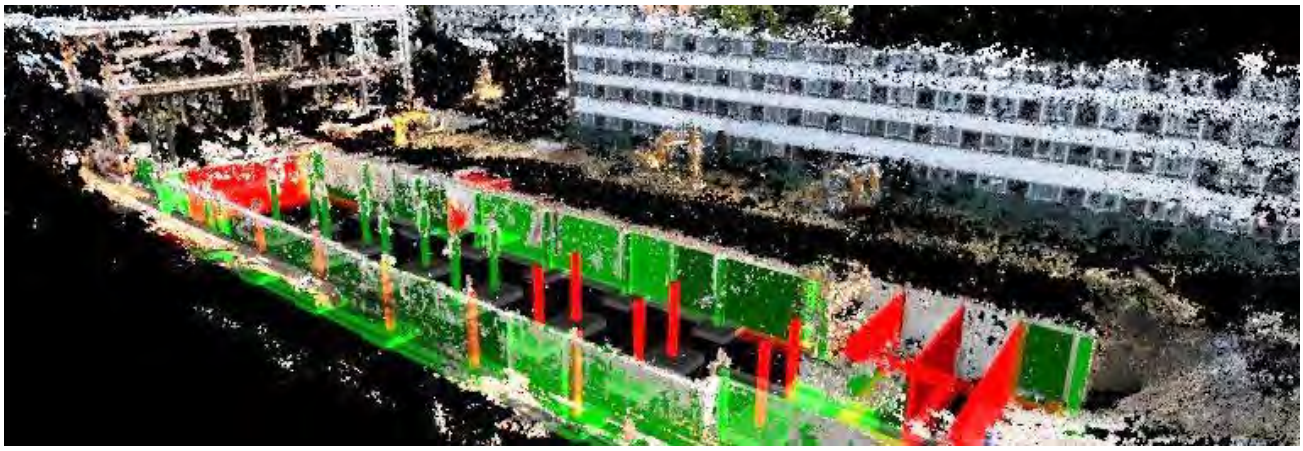
Alaskan Way Viaduct
ワシントン州
USA

Civil 3Dで地下埋設物と道路構造物の設計
ポイントクラウドの現況地形を統合
Navisworksで干渉チェックと工程シミュレーション



AUTODESK.

SEPTEMBER 25, 2013



FORUM ON BUILDING AND CIVIL INFORMATION MODELING (BIM/CIM)

A LIFECYCLE PERSPECTIVE

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Newmark Civil Engineering Lab, 205 N. Mathews Ave., Urbana, IL 61801

CEE at Illinois
September 25, 2013
Forum on Building and Civil Information Modeling (BIM/CIM)

Agenda

Wednesday 9/25/2013		
10:00 - 10:30 a.m.	Arrive Champaign *Professor **Mani Golparvar** will meet to provide parking permits*	
10:30 - 11:00 a.m.	Meeting with Professor **Mani Golparvar**	*3218 Newmark*
11:00 - 12:00 p.m.	Presentation by Dr. **Jan Reinhardt**	*3310 Newmark*
12:00 - 1:30 p.m.	Lunch at the Ballroom, Illini Union, with Professors **Mani Golparvar**, **Liang Liu**, **Khaled El-Rayes, Nora El-Gohary** *Reservation under: **Mani***	*2nd Floor, Illini Union Ballroom*
1:30 - 2:00 p.m.	Presentation by Professor **Mani Golparvar**	*3218 Newmark*
2:30 - 3:00 p.m.	Tour of the Structures Lab *Professor **John Popovics***	*Newmark Civil Engineering Laboratory*
3:00 - 3:30 p.m.	Meeting with Professor **Josh Peschel**	*1302 Siebel Center*
3:30 - 4:30 p.m.	Presentation by Dr. **Bill East**	*1302 Siebel Center*
4:30 - 5:00 p.m.	Follow up Discussion	*1302 Siebel Center*

Participants Group 1- Delegation from Japan

Prof. Nobuyoshi YABUKI
Representation: Japan Society of Civil Engineers
Affiliation: Division of Sustainable Energy and Environmental Engineering
Position: Professor at Osaka University
Interests: To acquire information, knowledge, and documents on how BIM methodology is employed in civil infrastructure projects, particularly, about information sharing among different parties, contractual matters (DB vs. DBB), methods to evaluate the benefits from Infrastructure BIM, dissemination issues (including training), and prospects on Integrated Project Delivery (IPD).

Mr. Shinichiro MOTOMURA
Representation: Ministry of Land, Infrastructure, Transport and Tourism
Affiliation: Construction System Management Office, Minister's Secretariat Engineering Affairs Division, MLIT
Position: Subsection Chief
Interests: Having understood that everything has been set in the US to proceed BIM for Infrastructure initiatives such as organization, human resource, budget and law needed, how and what kind of background did US establish initiatives of BIM for Infrastructure?
What kind of advantage to introduce BIM for Infrastructure at construction sites? Is there any rule or guideline for BIM model submittal to governments and its accuracy or credibility?

Mr. Teruaki KAGEYAMA, P.E.
Representation: Japan Construction Information Center
Affiliation: Research and Development Department, JACIC
Position: Senior Researcher
Interests: Procurement process of BIM
How to manage the outcome of BIM (As Build, Delivery system)

MR. Shigeki HIGASHIDE
Representation: Advanced Construction Technology Center
Affiliation: Research dept.1 and 2, ACTEC
Position: Director
Interests: Progressive means of shift from 2D to BIM and introduction of BIM to industry? BIM introduction to the infrastructure industry requires drastic changes in business rules and legislation, so it looks difficult to immediately proceed and requiring step-by-step process. I would like to know any specific information such as goals, key activities, priorities and roadmaps. Information exchange and sharing means?
I would like to know rules and systems as well as how to manage the systems among multiple organizations such as public sector owners, contractors and local stake holders.

Dr. Takashi FUJISHIMA
Representation: Japan Construction Machinery and Construction Association
Affiliation: Third Research Division, Construction Method and Machinery Research Institute (CMI)
Position: Manager
Interests: Assuming that overall lifecycle productivity is improved with BIM introduction: which business process is reduced; is any work hour reduction expected; and which business process is improved? On the other hand, which business process is increased; is any work hour increase expected; and is any cost increased? Specifically in terms of increased cost, who is going to consume the cost increase and how if the owner wants the contractor to execute the project with BIM.

Mr. Yasuo FUJISAWA
Representation: Japan Civil Engineering Consultants Association
Affiliation: Information Technology Department, Yachiyo Engineering Co., Ltd.
Position: Department Manager
Interests: Any advice to Japan that decided to promote BIM for Infrastructure from now would be appreciated.

Mr. Shinya SUGIURA
Representation: Japan Federation of Construction Contractors
Affiliation: Civil Division General Manager room, Obayashi Corporation
Position: Manager, Information Planning Division
Interests: What is the motivation for small and medium sized contractors to positively implemented BIM for Infrastructure?
When you decide to implement BIM for Infrastructure to a construction project, is there any specific industry-wide rule for the decision or individual firm has its own? The cost required to implement BIM for Infrastructure is too high for smaller firms, specifically smaller construction firms.
Who creates BIM model? The employee or is it outsourced?

Dr. Yoshihiko FUKUCHI
Representation: WW ENI Sales Development, Autodesk Inc
Affiliation: APAC ENI Sales Development Executive
Interests: Any success case or unsuccessful case of BIM for operation and maintenance in infrastructure?

Mr. Kazuhito NISHIHARA
Representation: The Kensetsutsushin Shimbun Corporation

N/A

Mr. Seiji YAMAMOTO
Representation: Autodesk JAPAN

N/A

Mr. Tomoharu YAMANE
Representation: Autodesk JAPAN

Participants Group 2- U.S. Partners

Dr. Bill EAST, P.E.
Representation: CERL – R&D Center
Position: Research Civil Engineer

Dr. Jan REINHARDT
Representation: ADEPT Project Delivery Ltd.
Position: Founder/Principal – Former Program Manager for Virtual Design and Construction for Turner Construction Company

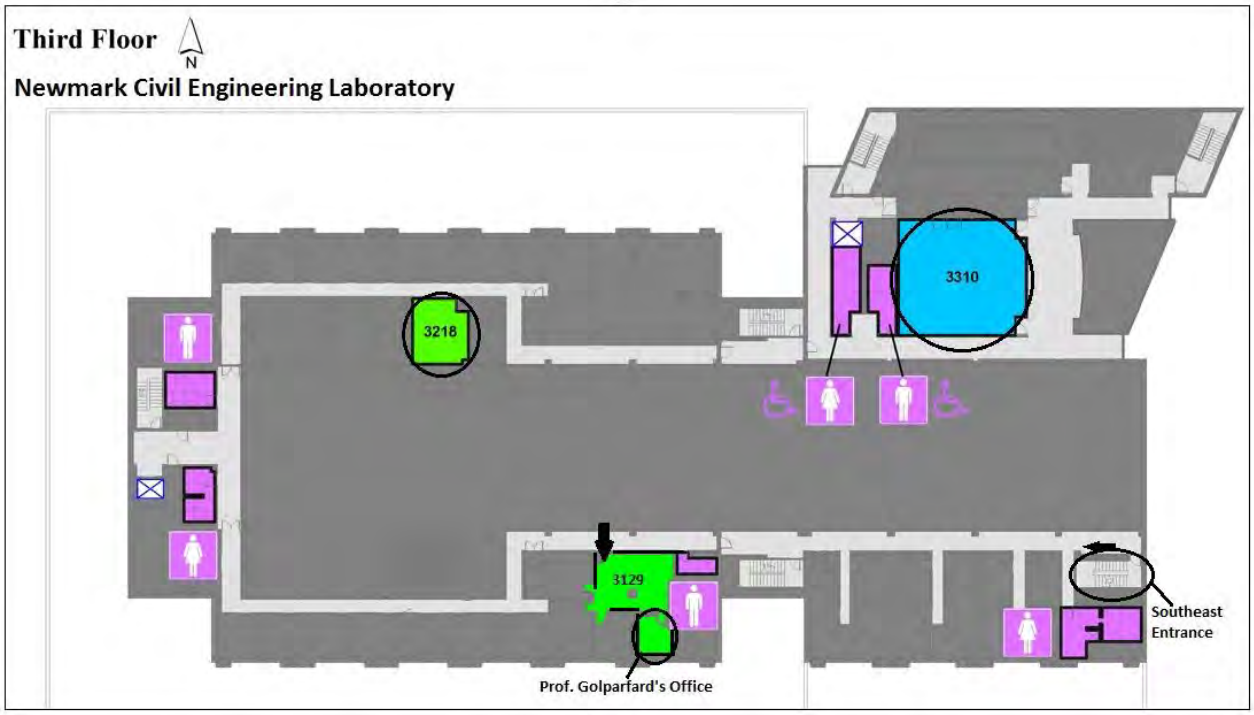
Mr. Doug EBERHARD
Representation: Autodesk US, formerly Parsons Brinckerhoff
Position: Sr. Director – Infrastructure Project Development

Directions to Newmark Civil Engineering Laboratory:

Address: 205 N. Mathews, Urbana, IL 61801

Please make your way to the southeast entrance of the building (black arrow) and take the stairway (first door on your left upon entering the building) up to the 3rd floor.

Once on the 3rd floor of Newmark, please walk north to room 3129 (on the left) where you will find Professor **Mani Golparvar-Fard's** office (**3129d**).



Feel free to email (fellis@illinois.edu) or call (#217-300-3646) with any questions.

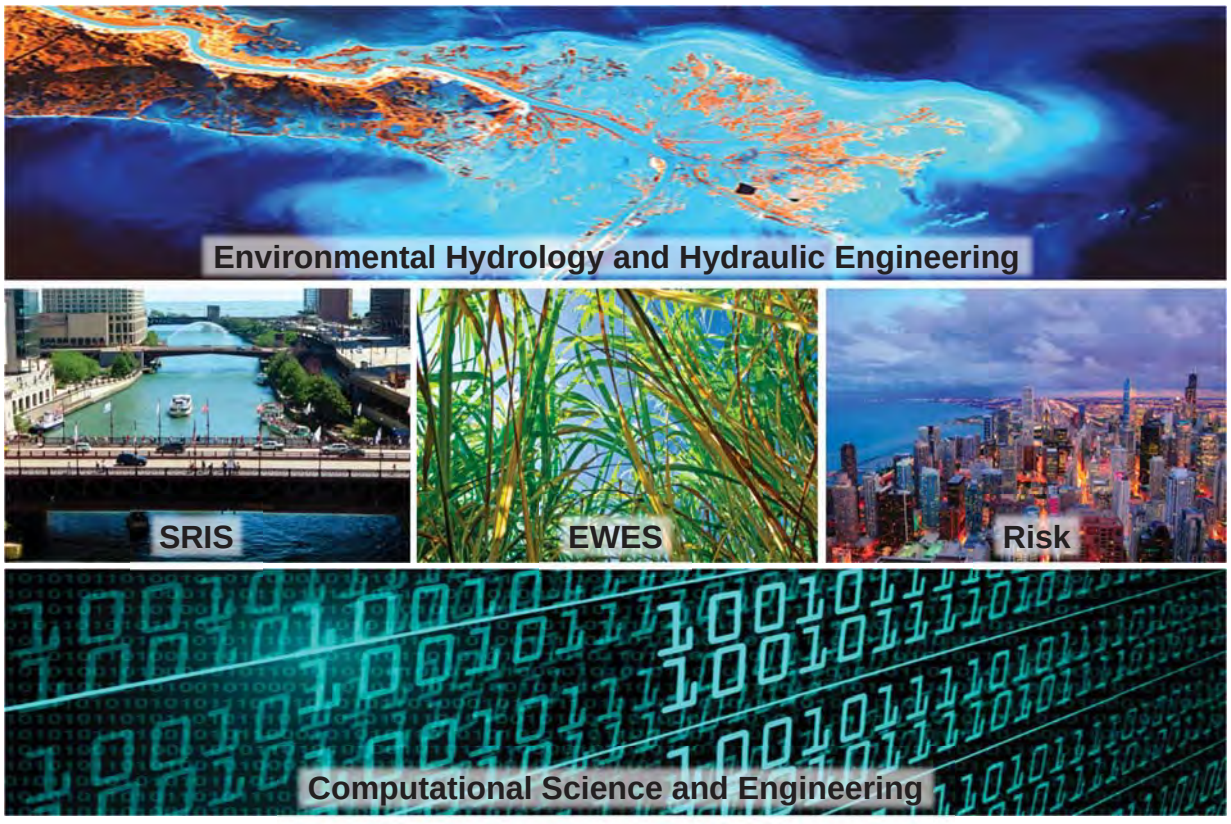
Information Systems for Civil and Environmental Engineering

Presented by:

Joshua Peschel, PhD
Civil and Environmental Engineering

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

About Prof. Joshua Peschel, PhD



Prof. Joshua Peschel Current Research

Post-Disaster Response[1-3]

- small UAVs used for inspection
- response teams are *ad hoc*
- human-robot interfaces are key

Rainforest Hydrology[4]

- energy-water measurements lacking
- several barriers to measurement
- physical object interaction necessary

Transportation Monitoring

- errors in traffic system estimation
- problem streets/roads not known
- robot acts as traffic state filter

[1] **J.M. Peschel** and R.R Murphy (2013). On the Human-Machine Interaction of Unmanned Aerial System Mission Specialists. *IEEE Transactions on Human-Machine Systems,* in press.

[2] **J.M. Peschel**, B.A. Duncan and R.R. Murphy (2013). A Mission Specialist Interface for Small Unmanned Aerial Systems. *IEEE Transactions on Human-Machine Systems,* in review.

[3] R.R. Murphy, **J.M. Peschel**, C. Arnett and D. Martin (2012). Projected Needs for Robot-Assisted Chemical, Biological, Radiological, or Nuclear (CBRN) Incidents. In *Proceedings of the 10th IEEE International Symposium on Safety, Security, and Rescue Robotics* (SSRR '12) (*Nominated for Best Paper Award*).

[4] **J.M. Peschel** (2012). Towards Physical Object Manipulation by Small Unmanned Aerial Systems. In *Proceedings of the 10th IEEE International Symposium on Safety, Security, and Rescue Robotics* (SSRR '12) (*Invited Paper*).

Prof. Joshua Peschel Current Research (2)

Computational Geometry

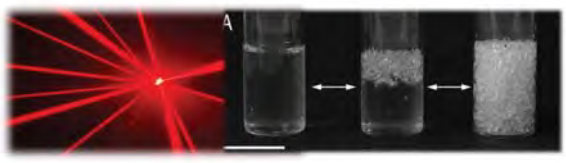
- fair partitioning of polygons
- approximation algorithms
- wide applications

Sketch Recognition[1-4]

- computers learn what we draw
- algorithms and systems
- engineering education applications

Computer Vision

- soil-structure interaction
- looking inside soils
- shear strength of the material



[1] Hammond, T., D. Logsdon, **J.M. Peschel**, J. Johnston, P. Taele, A. Wolin and B. Paulson. 2010. A Sketch Recognition System for Recognizing Free-Hand Course-of-Action Diagrams. *In Proceedings of the 22nd Conference on Innovative Applications of Artificial Intelligence* (IAAI 2010), Atlanta, Georgia. (Acceptance Rate: 39%).

[2] **J.M. Peschel** and T. Hammond. (2010). A Pen-Based Approach for Water Resources Model User Interfacing. AWRA GIS and Water Resources VI, Orlando, Florida.

[3] **J.M. Peschel**, B. Paulson and T. Hammond. (2009). A Surfaceless Pen-Based Interface. In *Proceedings of the 7th ACM SIGCHI Annual Conference on Creativity and Cognition*, Berkeley, California.

[4] **J.M. Peschel** and T. Hammond. (2008). STRAT: A Sketched-Truss Recognition and Analysis Tool. In *Proceedings of the Visual Languages and Computing (VLC) Special Session on Sketch Computing*, Boston, Massachusetts.

Learn Civil Engineering Design in the New Cyberinfrastructure

GIS for civil engineers

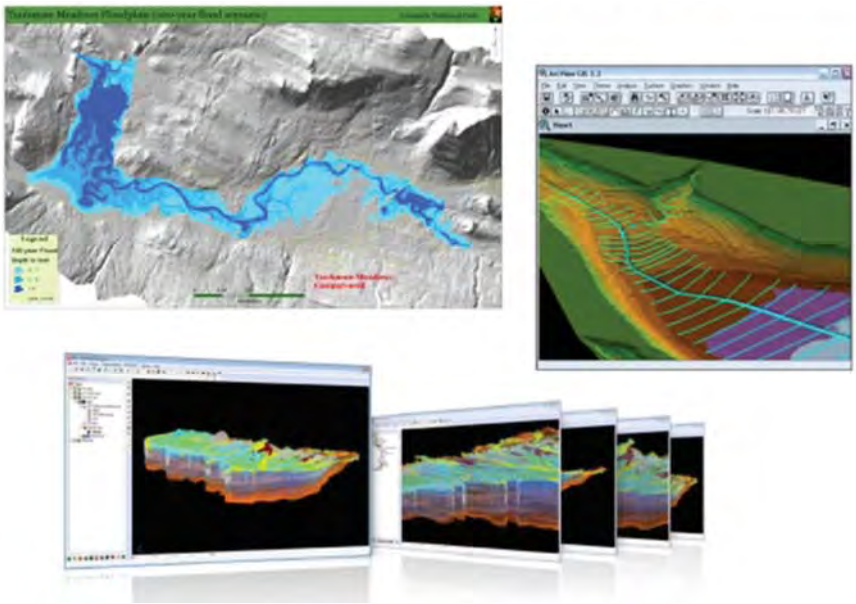
CEE 498 GIS is a 3-hour design course by Prof. Joshua Peschel to be offered in Fall 2013. This course will provide students with a working knowledge of modern geographical information systems (GIS) applied to all areas of the civil and environmental infrastructure. The focus will be on developing sustainable and resilient GIS-based solutions to open-ended design problems; example topics include:

- **Public Transportation Networks**
- **Hydro and Wind Power**
- **Building Information Models (BIMs)**
- **Hazardous Materials Spills**
- **Flooding After Hurricanes**
- **Bridge Scour Susceptibility**
- **Decentralized Wastewater Treatment**

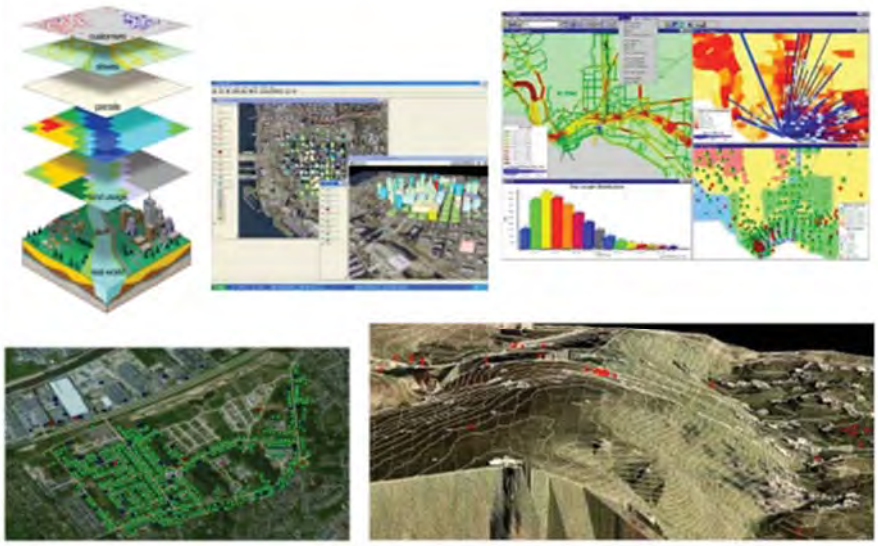
CEE 498 GIS is open to all students that have a science or engineering background with at least junior-level standing – contact Prof. Peschel for more information (peschel@illinois.edu).

CEE 498 GIS
Fall 2013

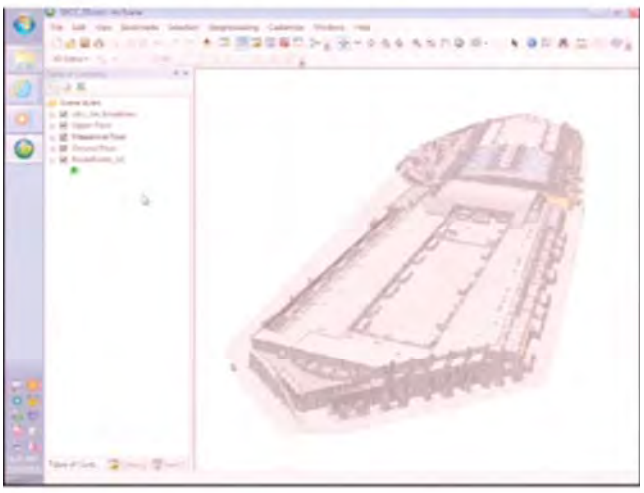
Applications in Environmental Hydrology and Hydraulic Engineering



Other Applications in Civil and Environmental Engineering



Other Applications in Civil and Environmental Engineering (2)



Status of Information Systems

We do these things very well

- represent large and complex infrastructure systems
- model changes in space and time
- provide two-dimensional representations of these systems

We do not do these things very well

- three-dimensional representations of infrastructure systems
- high resolution features at points and in three dimensions
- data interoperability and HCI are limiting factors

My Biggest Problem

Big Data

Information Systems for Civil and Environmental Engineering

Presented by:

Joshua Peschel, PhD
Civil and Environmental Engineering

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Autonomous Vision-based Condition Assessment of Civil Infrastructure Systems

February 8, 2013

Mani Golparvar, Ph.D.
Assistant Professor
Real-time & Automated Monitoring & Control Lab
Department of Civil and Environmental Eng.
E-mail: mgolpar@illinois.edu

Derek Hoiem, Ph.D.
Assistant Professor
Computer Vision Lab
Department of Computer Science
E-mail: dhoiem@illinois.edu

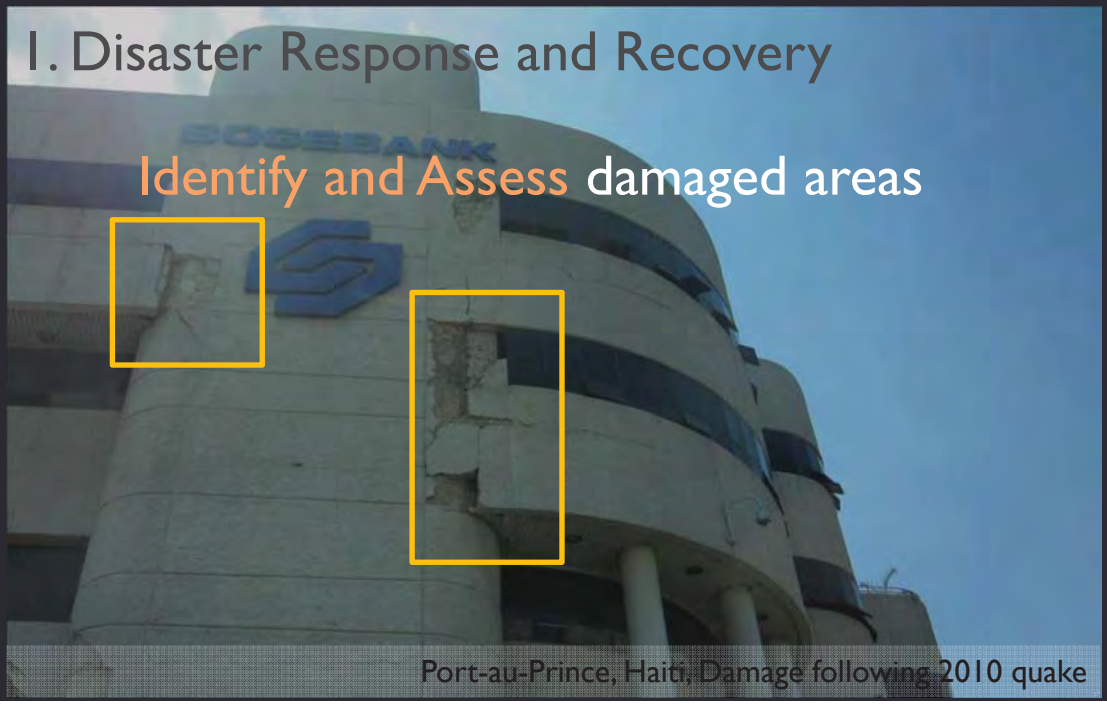
Timothy Bretl, Ph.D.
Assistant Professor
Coordinated Science Laboratory
Department of Aerospace Eng.
E-mail: tbretl@illinois.edu

Yoshihiko Fukuchi, Ph.D.
Business Program Director
Asia and South Pacific Division
Autodesk Co.
E-mail: yfukuchi@alum.mit.edu

UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN

Civil Infrastructure Condition Assessment

- Aerial robots to collect visual data (images and videos) for stability analysis



Civil Infrastructure Condition Assessment

- Aerial robots to collect visual data (images and videos) for damage assessment

II. Health Monitoring in Contaminated Sites

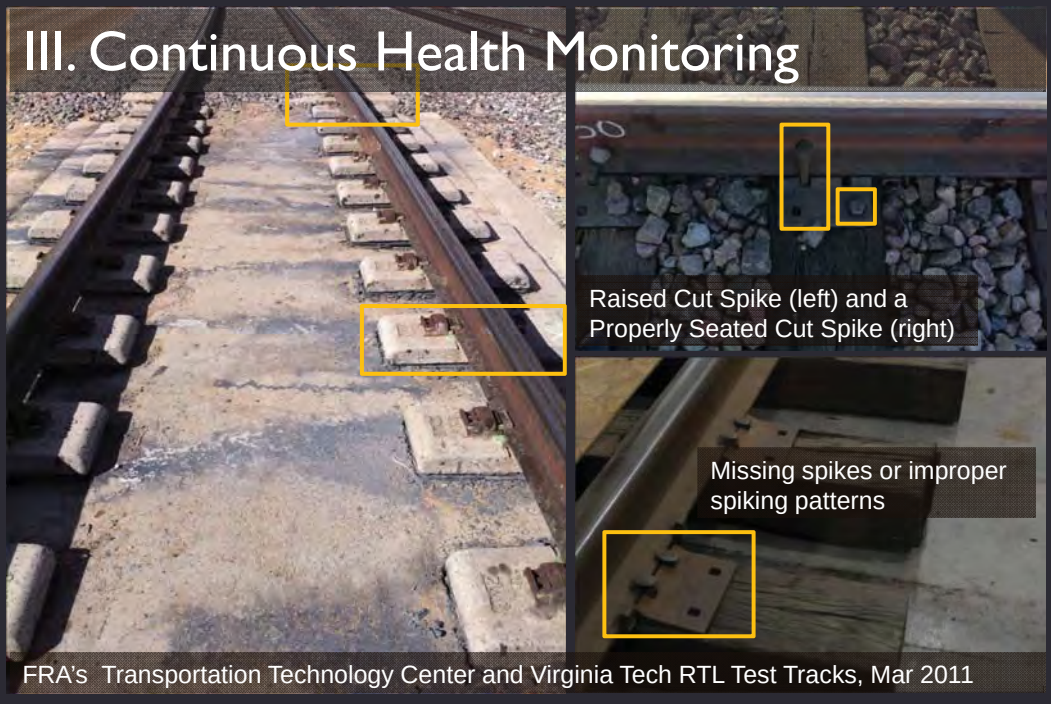
- Autonomous collection of visual data

Fukushima Daiichi Nuclear Power plant I disaster, 2011

Civil Infrastructure Condition Assessment

- Robotic Platforms to collect visual data (images and videos) for condition assessment

III. Continuous Health Monitoring



FRA's Transportation Technology Center and Virginia Tech RTL Test Tracks, Mar 2011

Civil Infrastructure Condition Assessment

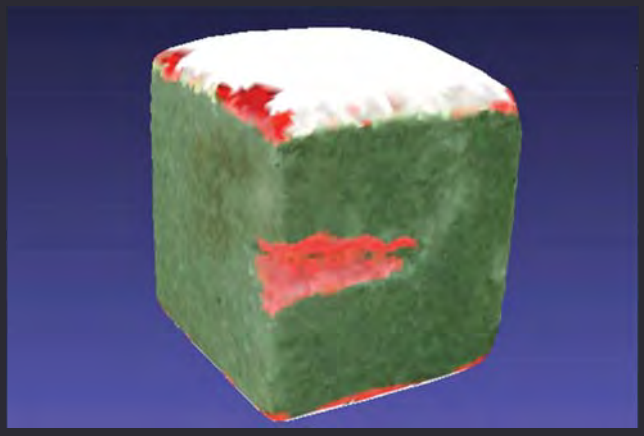
- Aerial robots to collect visual data (images and videos) to assist with condition assessment

IV. Bridge Condition Assessment

Overview of Proposed Methodology

Autonomous Collection of Digital Images

Structure from Motion → Dense 3D Reconstruction → Mesh Modeling → Detection of Surface Anomalies → Color-coded Mesh



Preliminary Case Study I

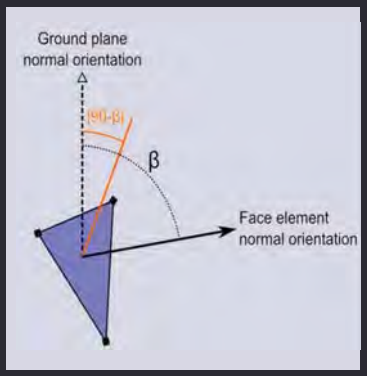
- 48, 7MP photos taken in circle at 2.4 m from column
  - Approximately equal spacing between photos (30 cm)
  - Column dimensions: 140x53x23 cm
- 5 min to gather images, 4 min computation to process
  (GPU and Multi-core CPU implementation)

2D images

Textured 3D mesh model

Preliminary Case Study (continued)

- Mark hard-to-identify cracks using 3D geometrical and appearance-based detection



Criterion: Is |90-β| > threshold angle?
Yes (cracked) → tint red,
No (uncracked) → tint green

Preliminary Case Study II

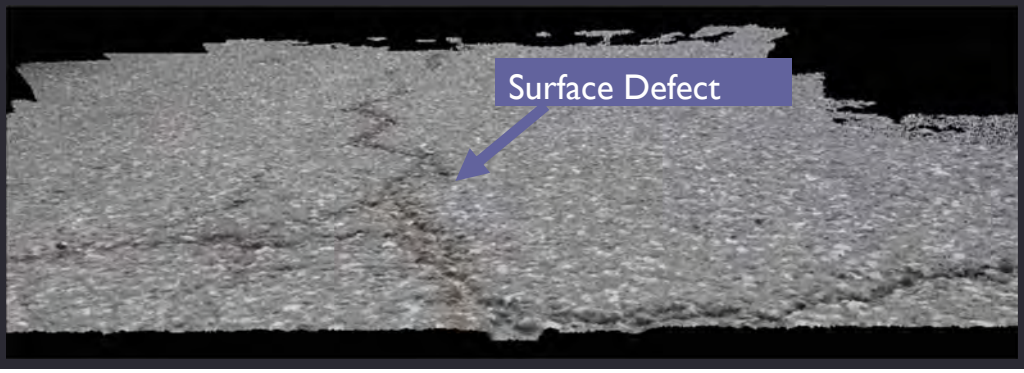
- 3D reconstruction of Rail track geometry for the purpose of detecting anomalies on track itself and supporting system

100 <2144x1244 px> images; ~4sec of camera movement

Preliminary Case Study III

Detecting cracks on surface of asphalt

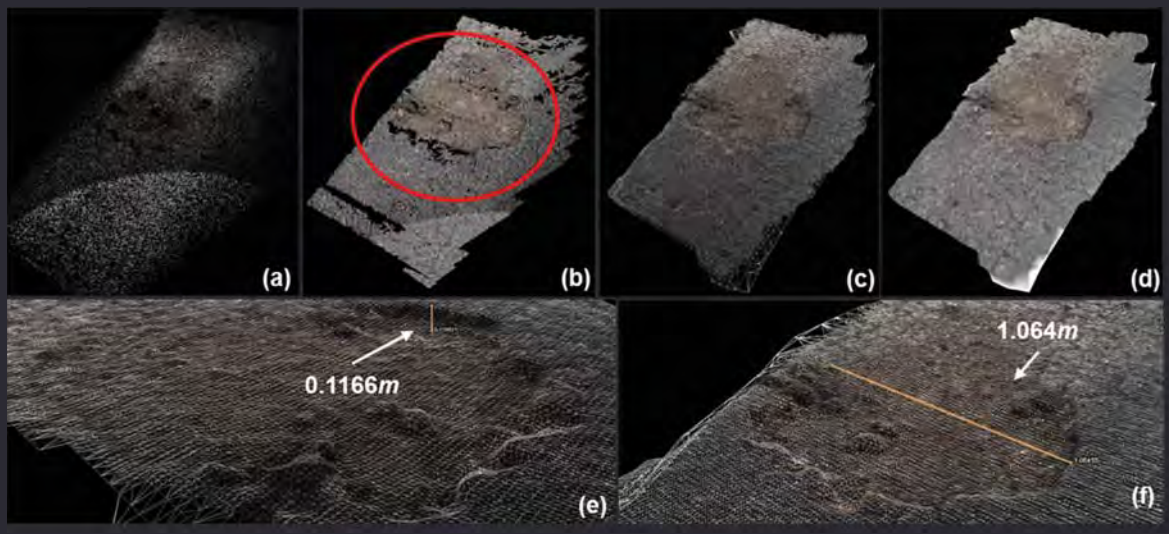
(1)	(2)	(3)	(4)	(5)
(6)	(7)	(8)	(9)	(10)
(11)	(12)	(13)	(14)	(15)
(16)	(17)	(18)	(19)	(20)



Preliminary Case Study III (continued)

Detecting cracks and potholes on surface of asphalt

- 3D reconstruction
- mesh modeling
- detection and assessment of defect

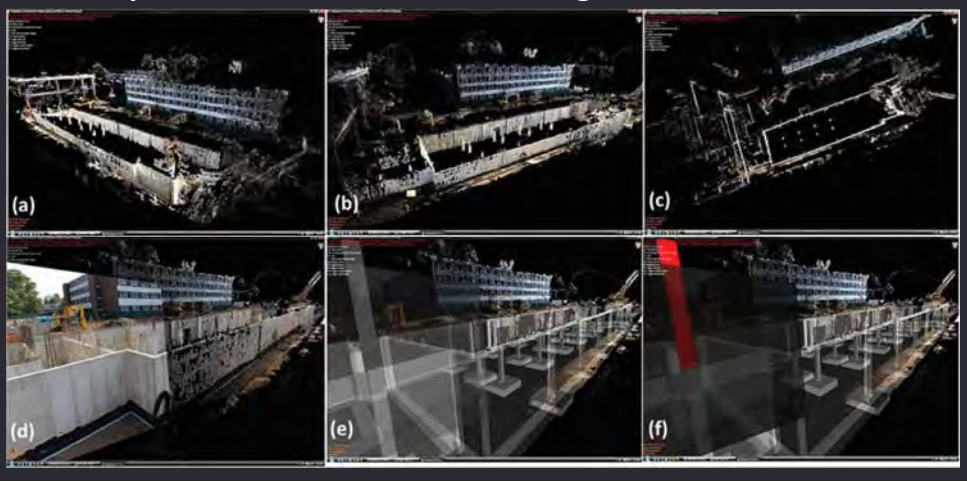


Preliminary Case Study IV

Preliminary Case Study IV (cont.)

Autonomous data collection and 3D reconstruction

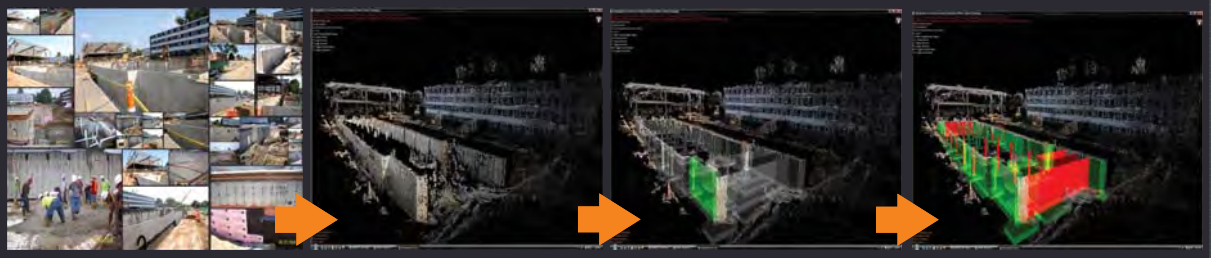
Integrated as-planned / as-built modeling and assessment of changes



Ongoing Work

1. Joint visualization of vision-based as-built models and BIM-based as-planned models
2. Automated as-built 3D modeling

Overview of the D⁴AR modeling pipeline



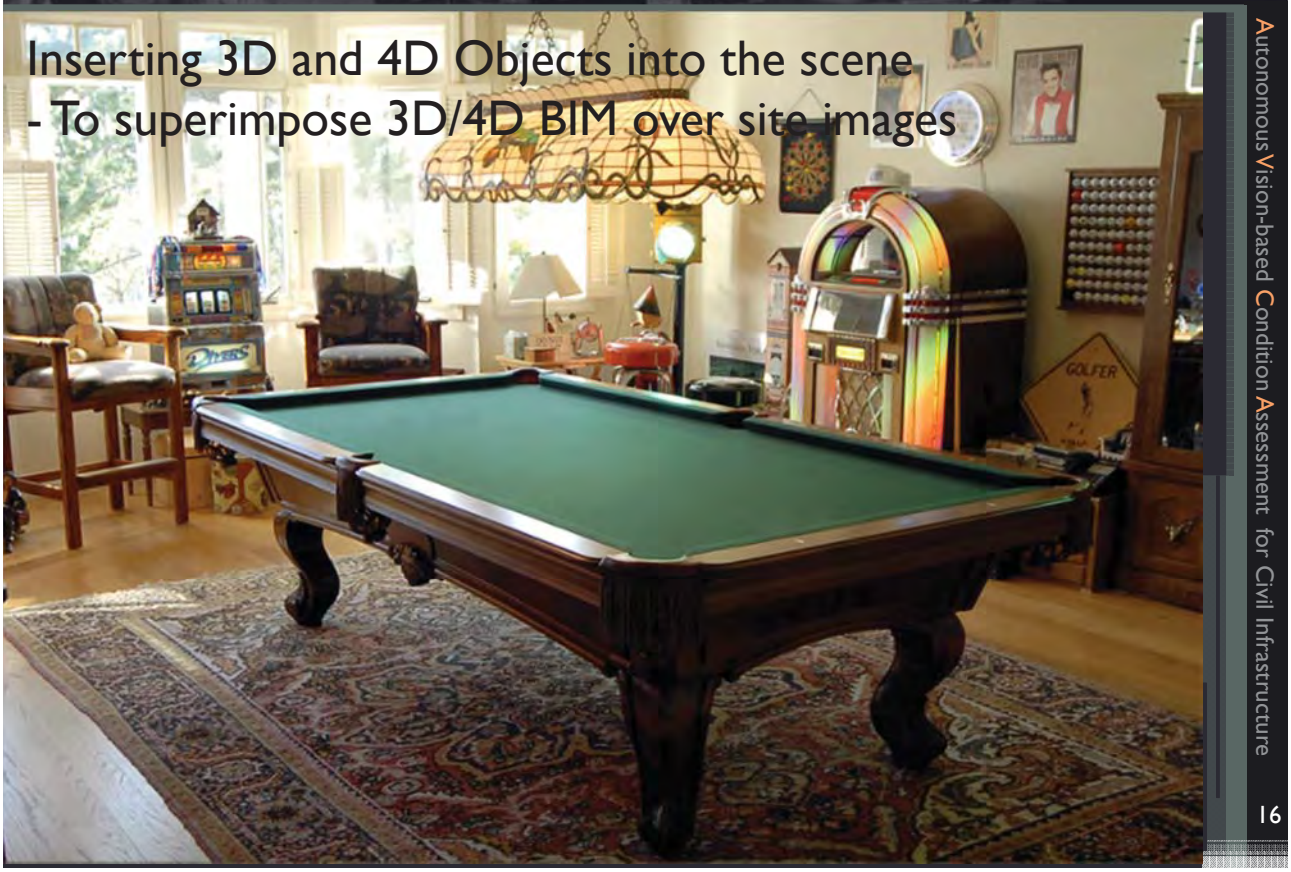
D4AR Modeling Process

1. Collect Images and Videos Using Consumer-Level Digital Cameras (no control or pre-calibration required)
2. Reconstruct 3D as-built point clouds
3. Develop 4D point clouds
4. Superimpose 4D BIM + 4D point clouds
5. Analyze progress deviations

Overview of data and processes
In the D⁴AR reconstruction, automated progress monitoring engine and visualization system

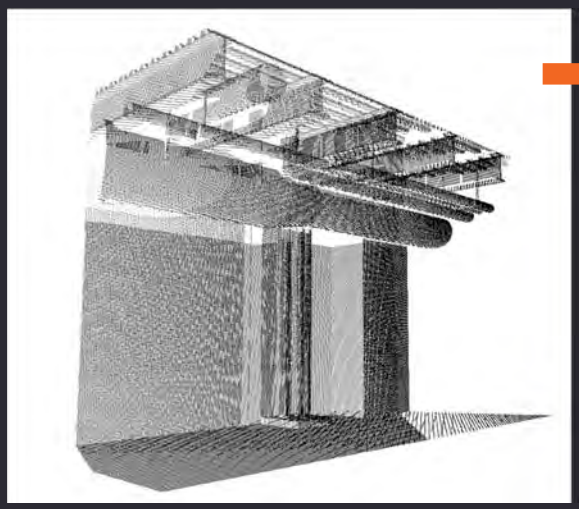
Demo: https://vimeo.com/24146527

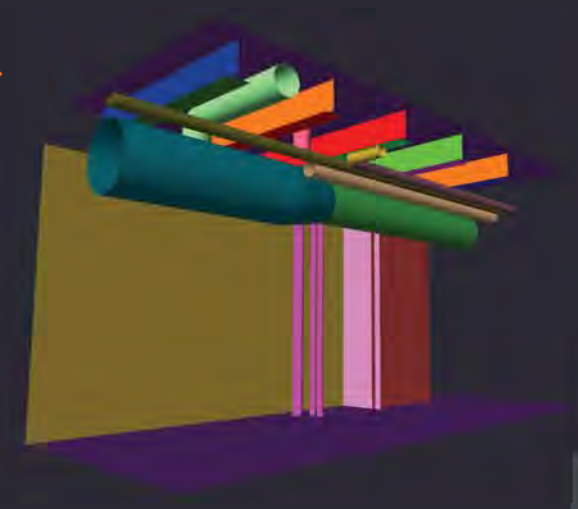
Preliminary Case Study V - Rendering



Preliminary Case Study V (Cont'd)

Automated 3D As-built Modeling



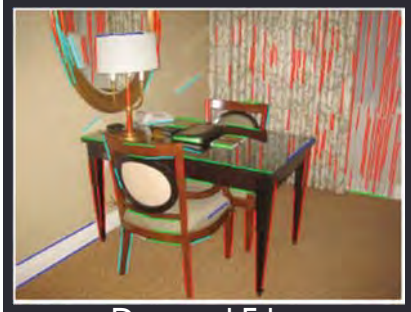


Automated 3D As-built Modeling

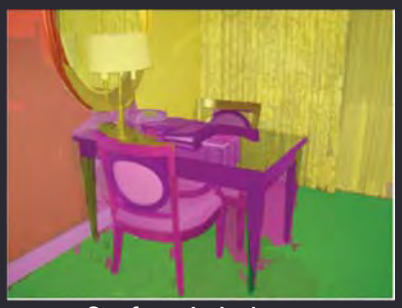
1. Reconstruct 3D Geometry in form of a Pointcloud Model
2. Reason about Scene Layout (next slide)
3. Segment point cloud into parts
4. Perform Model (Primitive and NURBS) fitting

Automated Reasoning of Room Layout

Automated Extraction of Room Layout for As-built Modeling



Detected Edges



Surface Labels

Box Layout

Detected Edges

Surface Labels

Box Layout

How to Approach Infrastructure Renewal?

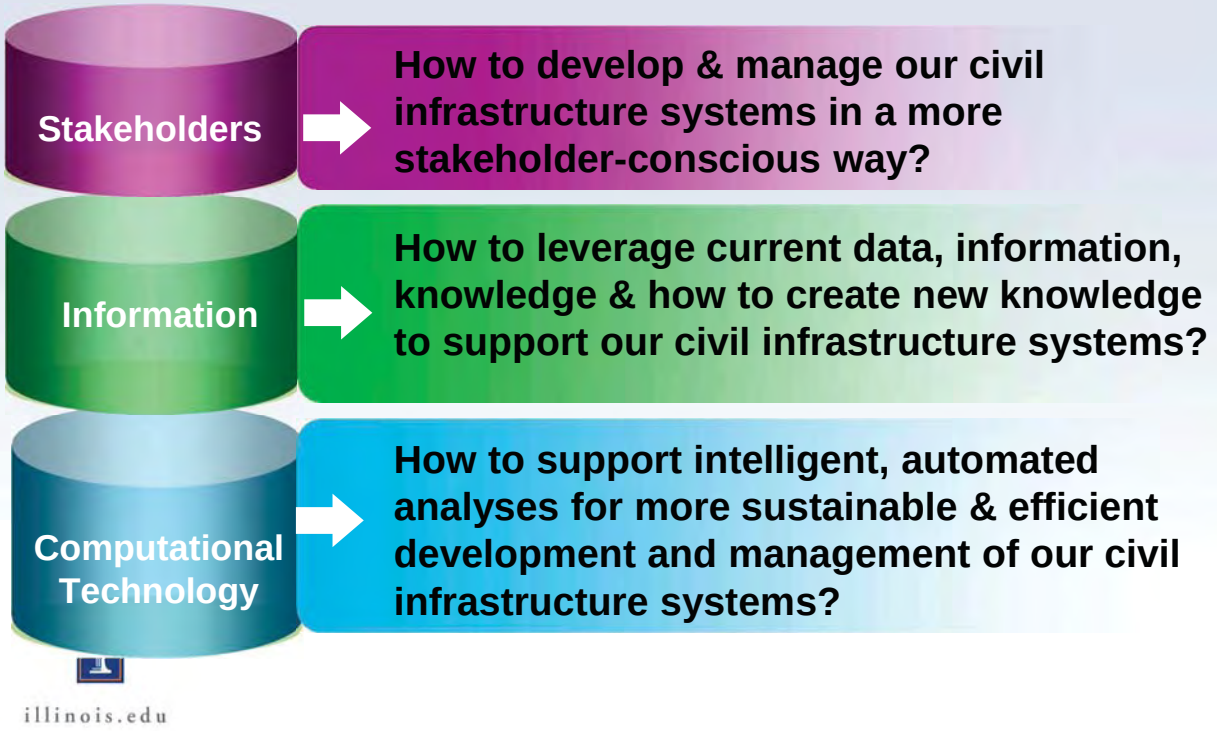
Infrastructure systems in the U.S. are deteriorating & require major rehabilitation & significant reinvestment

"However, approaching infrastructure renewal by continuing to use the same processes, practices, technologies, and materials that were developed in the 20th century will likely yield the same results" (NRC 2009)

In moving toward physically, socially, economically & environmentally sustainable infrastructure systems, we need "a paradigm shift in how the nation thinks about, builds, operates, and invests in critical infrastructure systems" (NRC 2009): paradigm that "brings more information and more stakeholders to the table" and makes use of new technologies.

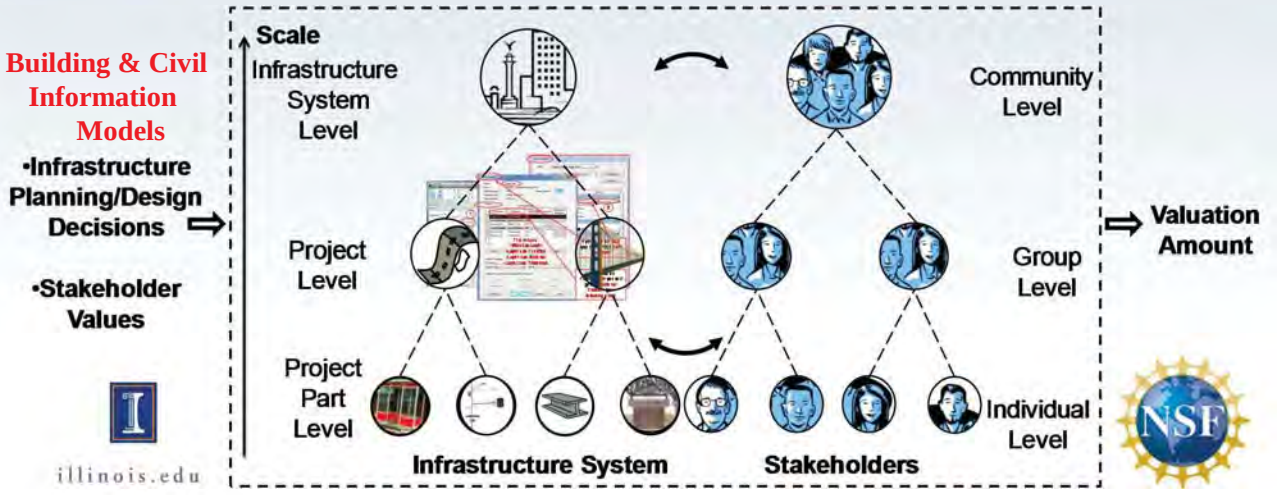
illinois.edu

Fundamental Questions



Stakeholder-Conscious & Value-Sensitive Project Planning & Design

- How to plan, design, construct & operate our civil infrastructure systems in a way that maximizes its collective life cycle value?

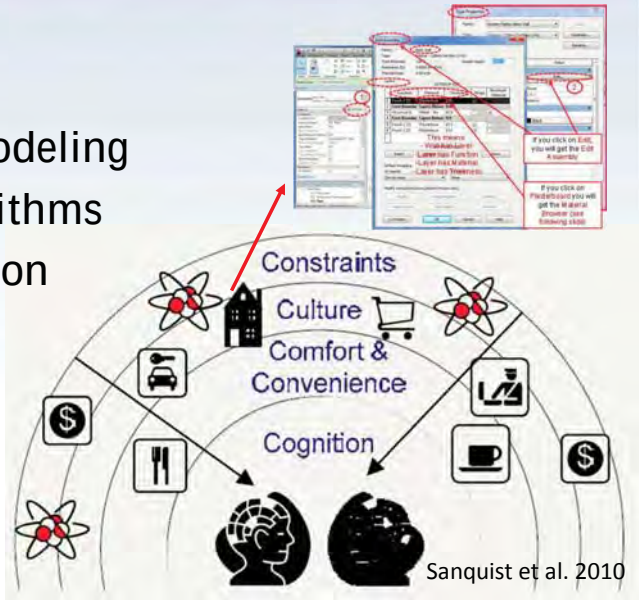


Automated Environmental Compliance Checking

- Cost of compliance checking: over $2 billion per year (AGC 2010)
- Cost of non-compliance: violators spent $12.1 billion during fiscal year 2010 to achieve environmental compliance (US EPA 2011)

Human-Centered & Value-Sensitive Improvement of Building Energy Efficiency

- How to improve building energy efficiency by reducing energy consumption while maintaining user (occupant) values?
  - Empirical Studies
  - Building Information Modeling
  - Machine Learning Algorithms
  - BIM-integrated Simulation



Sanquist et al. 2010

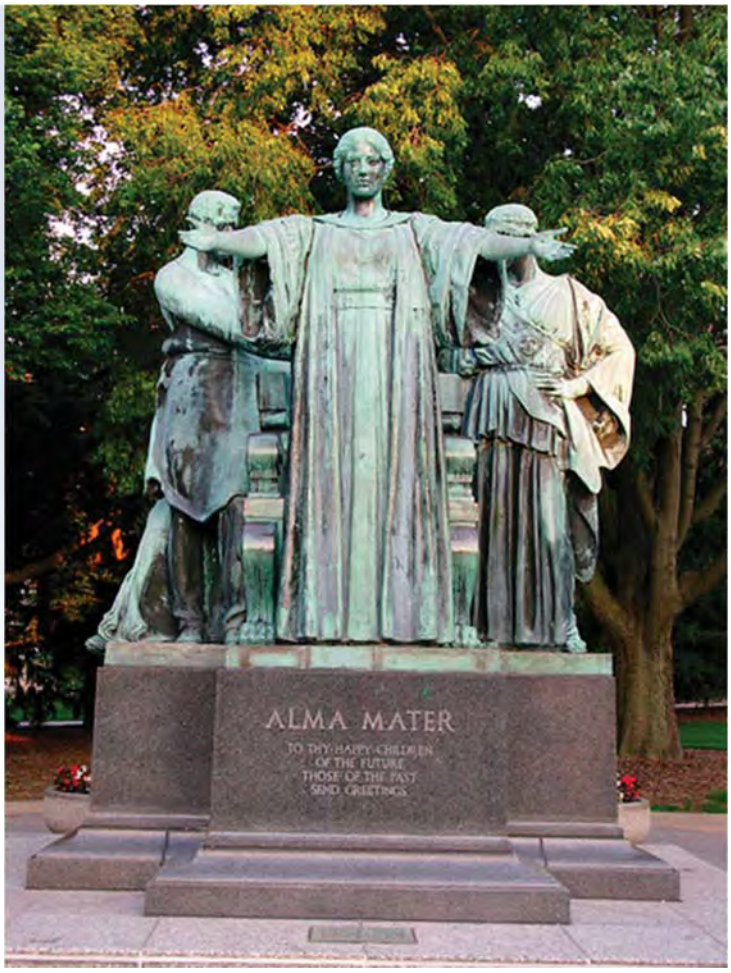
illinois.edu

Qatar Foundation

Thanks!

Questions?

illinois.edu

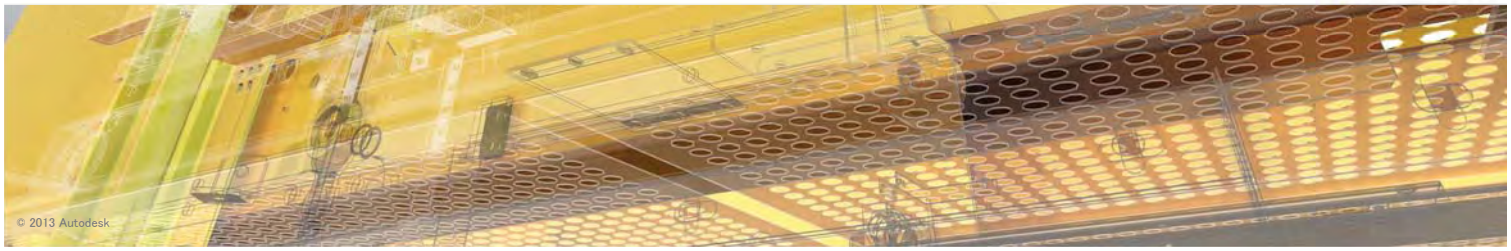


Autodesk 2013

BIM for Infrastructure
Financial Impact for all Stakeholders

Autodesk
Ken Stowe

AUTODESK.



Agenda

- Global Experiences and Observations
- Opportunities – Lean Philosophy –
- 6 years of Collecting Research
- 5 years of ROI Workshop
- Results of Workshop Forecast
- Implementing High Performance Initiative

AUTODESK.

Global Experiences and Observations

- 1970 – Layout and Control – Manual
- 1980 – Estimating – Bridge
- 1983 – Steel Penstock – Field Engineer
- 1985 – Scheduling Manager – Wastewater
- 1988 – First 3D in AutoCAD – Hydroelectric Power
- 1991 – EuroDisney – 4D by Hand
- 1992 – Lean Workflow for Rockwork – EuroDisney
- 1994 – First 4D in AutoCAD – Hewlett Packard Manufacturing
- 1997 – Sharing 3D CAD Files – New England Aquarium – finding Clashes
- 1998 – First Revit 4D with Safety and Security – Boston Museum of Fine Arts

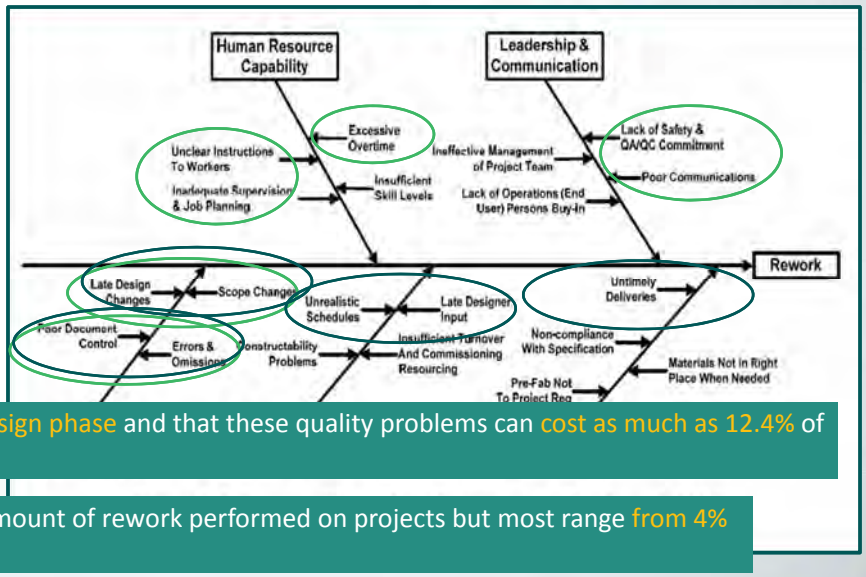
AUTODESK.

Global Experiences and Observations

AUTODESK.

Opportunities – Lean Philosophy

- Rework
  - Rework–the enemy of Productivity
  - Quality Problems and Rework



- …79% of the problems originate in the design phase and that these quality problems can cost as much as 12.4% of the contract amount (Burati, 1992).
- "…studies have been conducted on the amount of rework performed on projects but most range from 4% (direct cost) to 14%." Chelson (2010)

AUTODESK.

Measuring and Classifying Construction Field Rework: A Pilot Study

Rework

Aminah Robinson Fayek, Ph.D., P.Eng.
Manjula Dissanayake, Provisional Ph.D. Candidate
Oswaldo Campero, M.Eng.

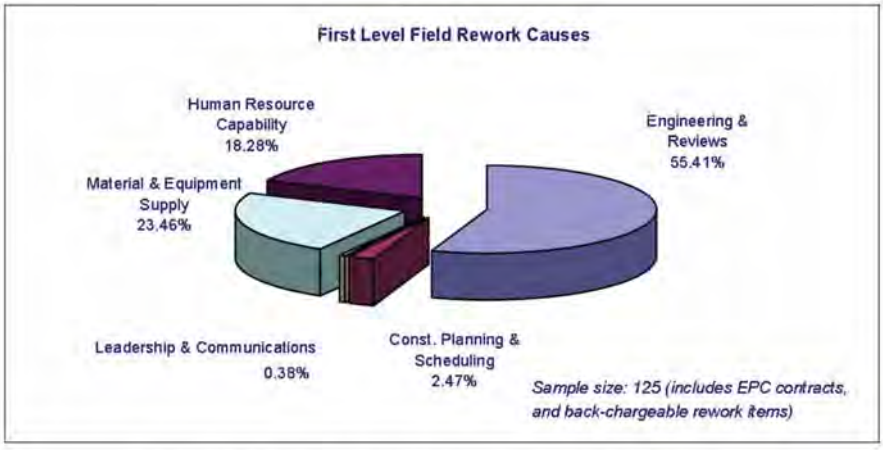


Figure 5.2. First Level Field Rework Classification Causes

"Engineering & Reviews" and "Material & Equipment Supply" were the factors that most significantly contributed to rework, with 55.41% and 23.46% respectively. "Human Resource Capability", "Construction Planning & Scheduling", and "Leadership & Communications" made relatively low contributions to rework, accounting for 18.28%, 2.47%, and 0.38% of the rework causes, respectively.

AUTODESK.

The Cost of Rework – ENR Magazine quoting CII

- Rework costs—including labor, materials, equipment and subcontractors—can run from 2% to 20% of a project's total contract amount. That equates to an estimated total of $15 billion a year, according to CII. Breaking that down further, the institute found the direct cost of rework averaged 2.4% of total contract value for standard industrial construction projects and **12.4% for civil and heavy industrial projects.**

- http://enr.construction.com/business_management/project_delivery/2012/1203-contractors-confront-the-growing-costs-of-rework.asp

Construction Industry Institute®

AUTODESK.

Opportunities – Strategy
Aim to Fix the Dominos of Rework

- Document Existing in 2D
- Design/Communicate in 2D
- Clashes, Inconsistencies, Illogical Design
- Lack of User Buy-in
- Bid with Flawed Design
- Requests for Information
- Low Confidence/Prefabrication
- Change Orders
- Rework
- Field Inefficiency
- Delays, Overtime
- Low Quality
- Late Completion

These become your PREDICTIVE Key Performance Indicators

AUTODESK.

7 years of Collecting Research
Research – 45 sources

- Center for Integrated Facilities Engineering (CIFE) – Stanford CA US
- University of Seoul – Ghang Lee – Korea
- Construction Industry Institute – Auburn TX US
- University of Salford– Koskela – UK
- Israel Institute of Technology – Sacks – Israel
- University of Maryland – Chelson – MD US
- University of Michigan – US
- University of Southern California – Becerik–Gerber – US
- Lean Construction Institute – International Org.
- University of Alberta – Fayek – Canada
- University of British Columbia – Staub–French – Canada
- Delft University– Moran – Netherlands
- Australian Journal of Construction Economics – Azhar– Australia

Plus Publicly available case studies with evidence of measuring performance

AUTODESK.

AUTODESK.

Research – What are the Financial Impacts of BIM on Project Performance?

- These studies also report very few or no RFIs, COs due to conflicts, and incredibly reduced plan conflicts and rework. (Chelson 2010)
- Reduction of rework and idle time due to site conflicts savings for trade contractors are on the order of 9% of project costs. (Chelson 2010)
- …construction concerns were evaluated by the CII which determined that direct rework costs were 5% of project costs (CII, 2005).
- …a typical firm that experienced rework costs estimated at 5% of their contract value. Once a quality assurance …program was implemented, rework was reduced to less than 1% of the contract value in most of its projects" (Lomas).

Financial Impact of Investing in BIM/Productivity Initiatives

Labor Productivity

STANFORD UNIVERSITY

- "labor productivity 15% to 30% better than industry standards (Khanzode, 2007)"
- "engineers had 47% decrease in labor hours needed to design and manage projects (Kaner, 2008)"

UK Government Mandates and Performance Results

- The government has championed the use of building information modeling (BIM) after it was announced that **£1.7 billion has been saved** on major projects over the past year.

  Ministers had been full of praise for the technology and were impressed by the way it can make the construction phase a much more efficient process. Stephen Kelly, chief operating officer at the Cabinet Office, explained to Construction News that **66 per cent of the £400 billion Major Project Authority portfolio is now being delivered on time and within budget, a substantial improvement on the 33 per cent seen in 2010.**

- http://www.jacksons-security.co.uk/News/building-development/bim-praised-after-govt-saves-1.7bn-on-major-projects-2659.aspx

AUTODESK.

Benefits to the Industry as a whole (UK reference NIBS)

··· And the Costs of BIM

Benefits to the Industry as a whole In the US NIBS study analysts reviewed the performance of projects in the context of information management, its flows and reuse between businesses and the costs of not enabling these processes through the use of tools such as BIM.

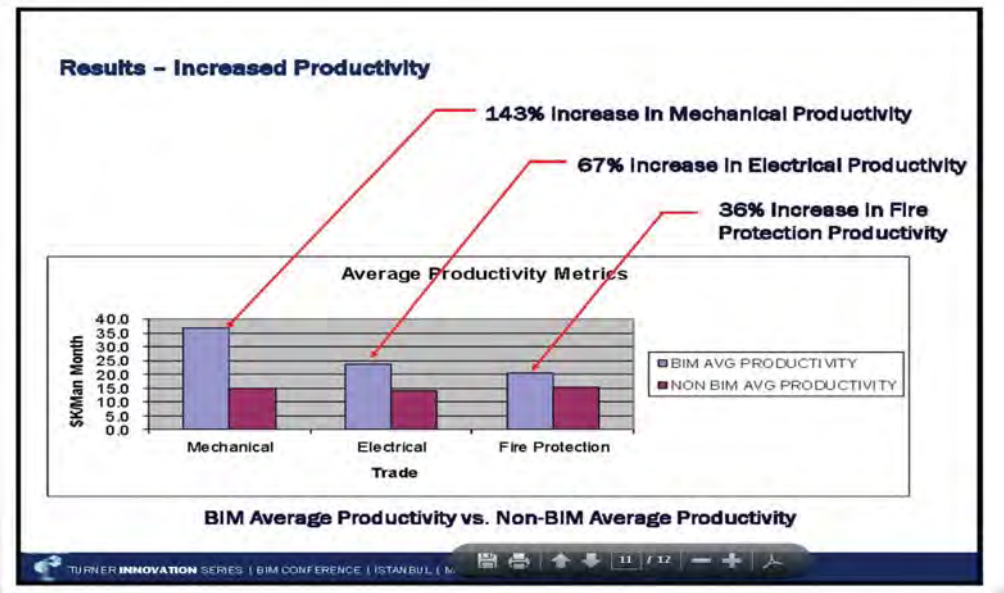
Their analysis indicated that the net-savings offsetting set up costs to be **5%** on the construction of **new-build** projects and **1.5%** in **refurbishments**. The study did not go on to analyse the savings derived from the operational or facilities management during the post occupancy stages.

Will BIM adoption involve a cost premium? Details are yet to emerge, but costs are estimated to **increase by 1% overall**, but **net savings of 5%** on construction cost should be achieved as a minimum. Improved base design information should reduce modelling costs of other team members.

Strategy Paper for the Government Construction Client Group - From the BIM Industry Working Group – March 2011 http://www.bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf

AUTODESK.

Turner Construction – Labor Productivity



AUTODESK.

US DOE – Industrial BIM – 10% Overall Savings

- The U.S. Department of Energy's Natinal Nuclear Security Administration processes nuclear and high-explosive materials at its Pantex complex in Amarillo, Texas. CH2M-Hill is providing full design services for a new $100 million, 45,000-sq-ft high-explosives pressing facility there.
- When conventional CAD construction documents were 95% complete, the project went on hold for funding and scope Taking advantage of this hiatus, Forman modified CH2MHill's contract, giving it four months to convert the CAD design into BIM.
- The modeling proved highly valuable. **Clash-detection software identified thousands of collisions,** but, more importantly, virtually "walking through" every room with the operations staff, the software uncovered **more than 500 serious problems.**
- **Independent cost estimators calculated a $10-million savings generated by the modeling effort.**

- http://california.construction.com/features/archive/2009/1109_F2_BIMSpecialReport.asp

AUTODESK.

Overall Savings vs Modeling Effort

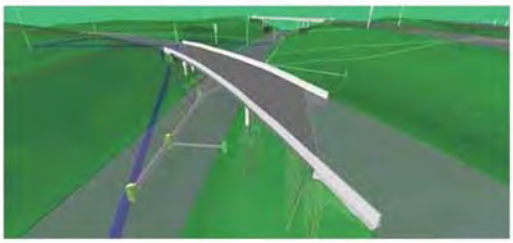
- *Festival Place, Basingstoke*
- Opened in 2002, Festival Place is a large regional shopping centre in Hampshire, redeveloped at a cost of £110 million. New buildings had to be fitted around existing shops in a complex jigsaw, so a 3D model was used to simplify the process, enable spatial co-ordination and clash detection, and help sequence the construction programme.
- **Costs**: The initial model took two modelers **three months to complete.**
- **Benefits**: Savings of **around 9% (est) realized** in the construction phase.

Constructing the business case – British Standards Institution

AUTODESK.

Cost avoidance and savings for Wisconsin's Mitchell Interchange Project

- "The successful use of BIM as a proof-of-concept for construction of the Mitchell Interchange has encouraged WisDOT to move forward with deploying BIM in the design and construction phases of the $1.7 billion reconstruction and capacity expansion of the Zoo interchange in Milwaukee – Wisconsin's busiest interchange," concluded Bob Gutierrez, WisDOT SE Freeways design chief.
- Model-based visualizations and construction simulations proved helpful for all project stakeholders – designers, contractors, and owner as well as for other stakeholders and the public. "The construction team met regularly …using Navisworks to visualize and evaluate construction issues and trade-offs in real time, streamlining decision-making," explained Oldenburg. The 3D model and 4D simulations were used prior to construction to fine-tune construction planning and to **evaluate design impacts on construction-related traffic delays and life-cycle operations and maintenance activities such as snow removal, upkeep of roadside landscaping, and access for both routine maintenance and emergencies.**

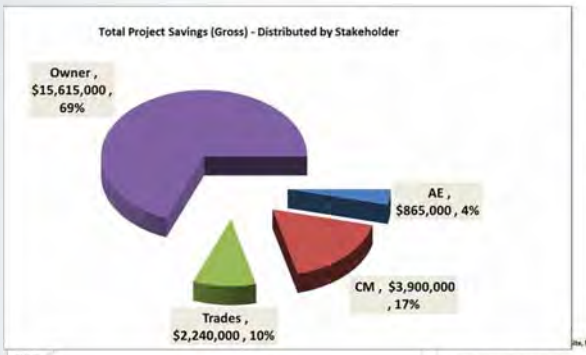


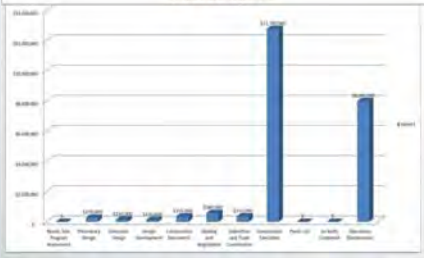
BIM benefits project stakeholders by improving collaboration and providing an environment where everyone understands what they are seeing and can look at the project as a whole.

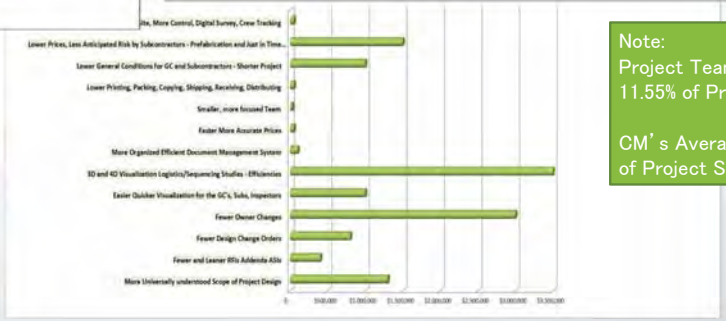
 http://www.rebuildingamericasinfrastructure.com/magazine-article-rai-10-2012-redesigning_a_complex__critical_freeway-9018.html

AUTODESK.

Financial Impact Workshop







Note:
Project Team Savings Average 11.55% of Project Budget

CM's Average Savings is 17% of Project Savings

AUTODESK.

AutoCAD® Civil 3D®
Autodesk® 3ds Max® Design

BIM for Infrastructure solutions to help increase efficiency on infrastructure projects.

We are experiencing a 30 percent schedule reduction by using BIM workflows on our infrastructure projects... and those savings jump to almost 45 percent on our race track projects. Numbers like these speak for themselves.

—Jack Lashenik, P.E.
Vice President
American Structurepoint, Inc.

Completed $70-million Iowa Speedway. Image courtesy of American Structurepoint, Inc.

AUTODESK.

Skanska – JFK Airport

- At JFK airport, using 3-D modeling to develop solutions
- July 19, 2013 by Alex Filotti New York City's John F. Kennedy International Airport in New York is one of the busiest airports in the world, with more than 45 million passengers streaming through its terminals. It's very challenging to work amidst all of those people and the planes that carry them about without disturbing any aspects of this mini-city – not impacting ongoing operations is an essential part of airport construction.
- Building information modeling (BIM) helped us successfully navigate this complex environment while doing the foundation work as part of the team for the JFK's Checked Baggage Inspection System project. **With BIM, we provided the owner with a 21 percent savings from the original design cost, shortened the schedule by three weeks and provided a safe job site in which there were no lost-time accidents.**
- Skanska's work included driving 152 foundation piles. Our use of BIM stemmed from a vexing challenge: 42 of the 152 piles required for this project needed to be driven underneath and just six inches from the tapered cantilever glass wall of the existing, operating terminal. Additionally, airplane wings would be just feet from Skanska's pile driving rigs as the jets taxied about. We needed a smart solution to help us successfully and safely deliver our portion of the project.

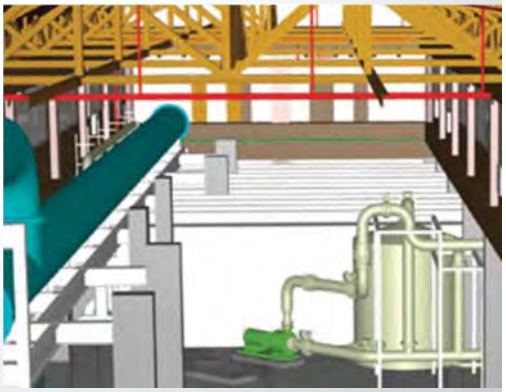
Source: http://blog.usa.skanska.com/category/construct/

AUTODESK.

Water Treatment Plant Clashes, RFI's, Schedule

WALSH CONSTRUCTION ARCHER WESTERN

- Archer Western of Atlanta, a subsidiary of Walsh, used BIM on the $76-million Central Arizona Project water treatment plant expansion, building models from 2D drawings created by the project engineers. Klancnik says the company spent **$40,000 to create the models, but identified more than $150,000** in system clashes. **Requests for information were also reduced by an estimated 75%,** with zero change orders. Klancnik says that the 12 people who worked on the model during preconstruction saved the work of dozens in the field later, helping **shave the 28-month schedule by five weeks.**



AUTODESK.

Industrial BIM –Barton Malow

- Barton Malow was selected as the General Contractor for SeverStal's Pickle Line Tandem Cold Mill (PLTCM) and Hot Dip Coating Line (HDCL) projects. The 320,000 SF (plus 180,000 band staging area) PLTCM incorporates two separate steel-making processes …**Accelerated 10 weeks during construction**, the $150 million project will be completed in just 14 months…the model verified quantities… Another benefit from the model included tracking process equipment through Vela Systems to provide an electronic turnover package to SeverStal. The package includes a database of all equipment and its installation and maintenance history. SeverStal realized a **$900,000 savings in quantity verification as bid process** and a **$10 million savings in interference resolution**

- http://www.bartonmalow.com/projects/severstal

AUTODESK.

PARKING GARAGE – Change Orders and Delays

Case Study 2:
The methodology used in Case study 1 was also used in Case study 2 also projects C and D; projects C and D are comparable. Please see the table below. Also, note here that in addition to project C's associated multiple BIM preventable direct cost, its schedule was delayed by a total of 426 days past its original 601 day duration. The data also revealed that project C's predicted BIM ROI would have been around 1654%, and project D's ROI was estimated at roughly 300%.

Project C And D Results

	Project C (Pre-BIM)	Project D (BIM-Assisted)
Contract Value:	$41,757,618.00	$44,400,000.00
Cost Of Change Orders:	$5,097,222.00	$513,632.00
Original Schedule Duration:	601 Days	652 Days
Schedule Delay:	426 Days	0 *(60 Days Early)*
Contract Type:	GMP	GMP
Delivery Method:	Negotiated Bid	Negotiated Bid
Square Footage:	439,760 SF	456,594 SF
Use:	Mixed use- res. condo/ garage	Mixed use- res. condo/garage
Number of Stories (Towers):	14 Stories	7 Stories
Number of Units:	311	218
Type of Construction (Towers):	Conv. formwork w. Conv. Reinf.	Conv. formwork w. cast in place tables
Type of Construction (Garage):	Post- tens. conc. w. conc. cols.	(DB) post tens. conc. w. steel cols.
Scope:	CM - all conc. self- performed	CM - all conc. self- performed

Table 6: Cost comparisons with and without BIM usage in case study2 [Source: B Giel et al - Ref: 8]

AUTODESK.

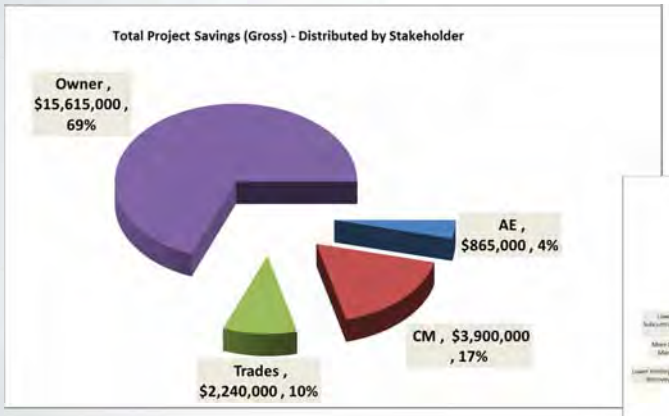
Specifying Information Requirements for Operations and Maintenance

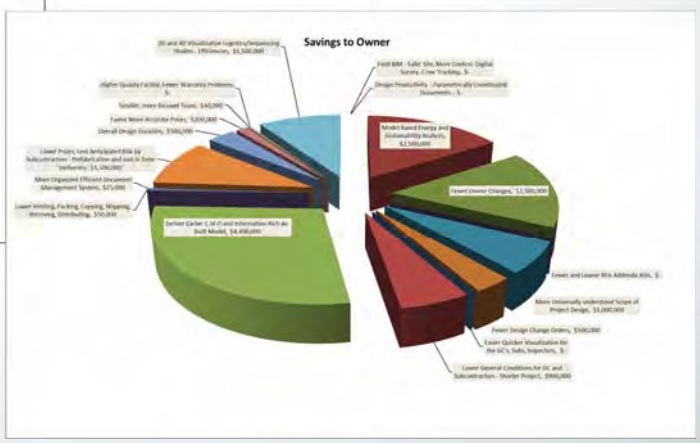
- The **Unified Facilities Guide Specifications (UFGS), a joint effort of several US federal government agencies,** are construction guide specifications used in facility construction projects of the participating agencies. The guide includes this list (see Appendix B for a more detailed version) of the types of information required in operations & maintenance data package:

- Spatial Assets
- Equipment Assets
- Parts and Warranty Contacts
- Warranty Information
- Replacement Parts
- Operating Plans
- Preventive Maintenance
- Emergency Operations
- Troubleshooting Instructions
- Safety Instructions
- Coordinates
- Products and Equipment Attributes

AUTODESK.

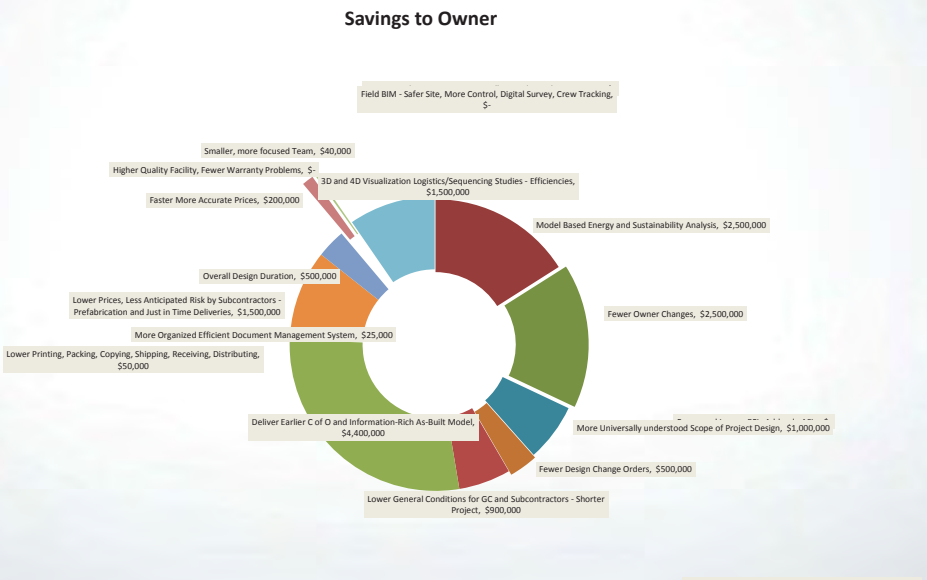
Results of Workshop Forecast (Sample Project $200M)





AUTODESK.

Implementing High Performance Initiative



AUTODESK.

Gatwick Airport
£1.172bn spend between 2008 and 2014

- Data on its assets is key to a client like Gatwick, and one of the first things the Bechtel/Gatwick team did was develop a standard form for all works information with a BIM model at its heart. This was back in 2010, some nine months before the government placed BIM models at the heart of its Construction Strategy.

BIM at the heart

- "Driving its development at Gatwick has been engineering manager Eli Walter. "In the past people were doing BIM but in a haphazard manner. Probably nine months before the government's announcement, we had decided the same thing; that **BIM was going to be key."**
- **And data is the key**. "BIM for us is not for all the pretty pictures, but because it is a smarter way of working; for us it is a data set to be used by everyone – technicians, asset managers and the engineering team," he says. …
- …The prospect BIM holds is that we can get all that information in a model, so that 25 years down the line we will be able to peer in and see our archive.
- Gatwick's BIM model is built primarily around Autodesk and Revit, but other platforms could use it if required – for example Civil 3D for highways work.
- Phillpot is also confident that **contractors see the benefit of BIM**. "Contractors can get a huge advantage if they use the BIM model. Modelling in 4D can absolutely help with project planning. …
- And pretty **pictures do play a part, particularly in winning over airlines when planning works.** "You can provide assurance to airlines whose chief concern is their daily operation," says Phillpot.

- http://www.nce.co.uk/gatwick-airport-ready-for-take-off/8635328.article

AUTODESK.

Winning Owner and Public Support for the Design
HNTB – San Diego Airport

- **AHEAD OF SCHEDULE, UNDER BUDGET**
- From the Beginning "It has created incredible gains"
  - Clash detection
  - **Explaining to the owner and other interested parties**

San Diego Airport Green Build

- Quotes start from 40 seconds and from 4:50 in the video

http://www.youtube.com/watch?v=kMZTtsbPgQk

http://www.youtube.com/watch?v=377fUFfV08U

AUTODESK.

土木学会　土木情報学委員会
米国 CIM 技術調査団
国土基盤モデル小委員会
ICT 施工研究小委員会

発行：2014 年 1 月 20 日