Big Data for Big Projects:
Using Information for any Scale of Design

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Chicago Build Expo 2019

CHICAGO BUILD 2019 EXPO
SEPTEMBER 19 - 20
McCORMICK PLACE

"Without data
you're just another person
with an opinion."

W. Edwards Deming

LET’S BEGIN

TADEH HAKOPIAN

BIM Coordinator at HKS

Eight years of experience in AEC industry with focus on Design Technologies including

- Estimating and Planning
- Concept design
- Construction Documents
- Field Operations,
- Research and Staff Training

OBJECTIVES

1. Relevance of big data in the AEC industry.

2. Data analysis standards and how they apply towards project lifecycles

3. Sources of data in our projects from models to operations data and how that can be translated to usable information to gain valuable insights.

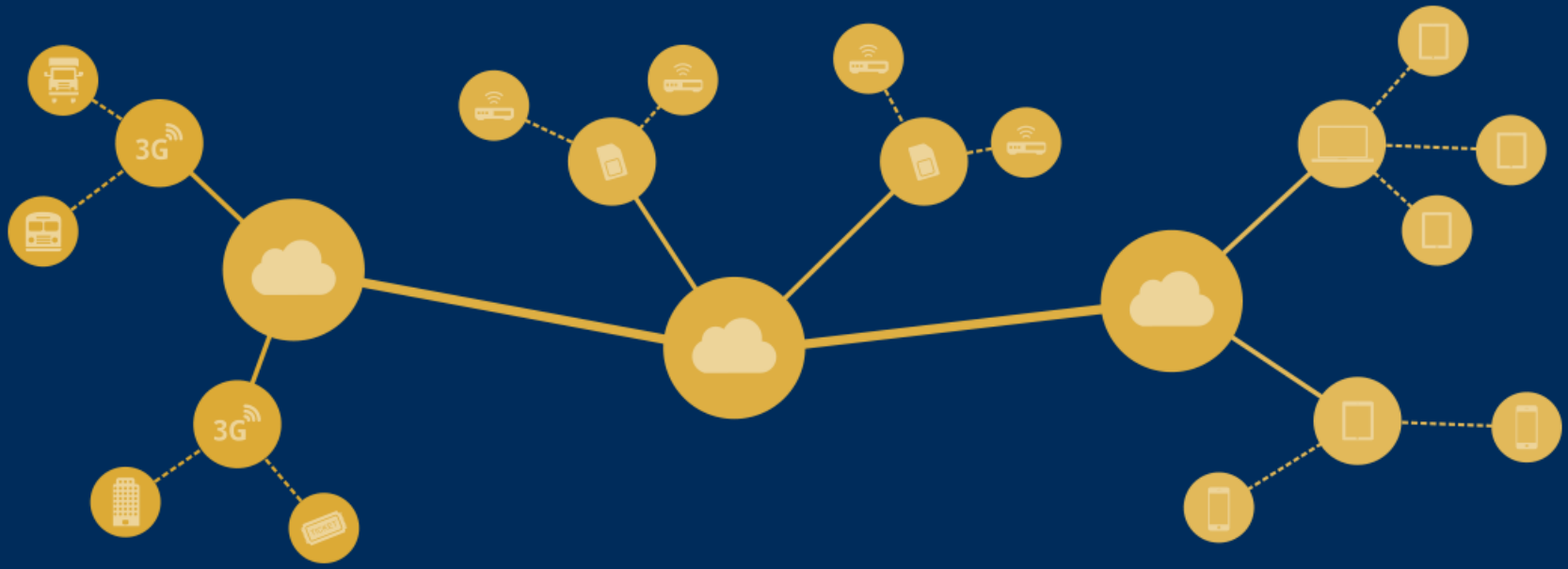
DISCLAIMERS

1. Not an endorsement of any product

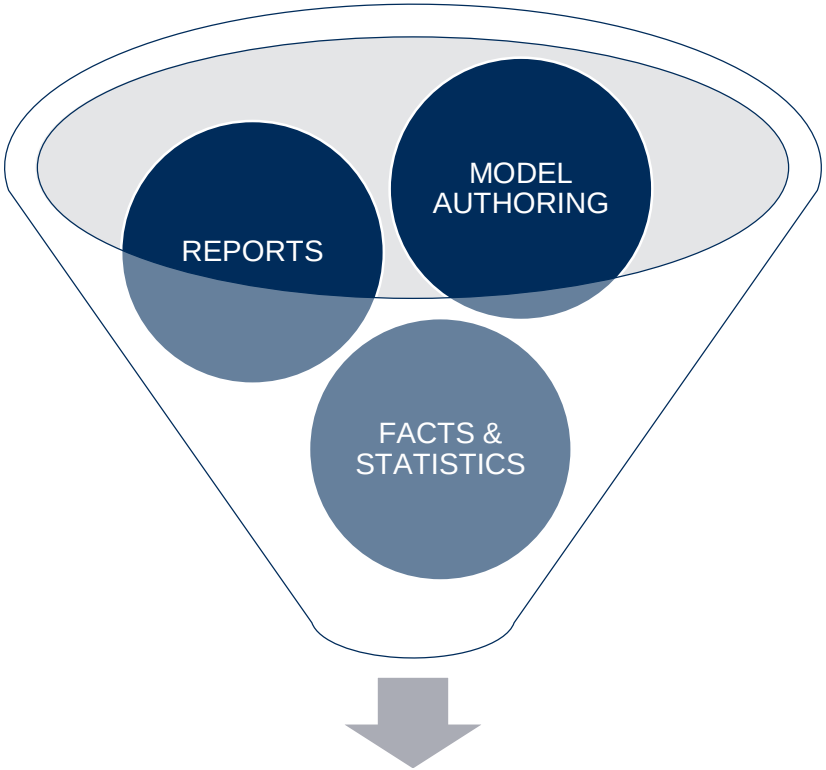
2. Key theme is the sharing and collaborating of information

3. Not an exhaustive description of all standards but we will go over the important stuff

DATA DRIVEN DECISIONS



COLLECTION



DATA

DATA IN AEC

Good Data

Good (Reliable) Information

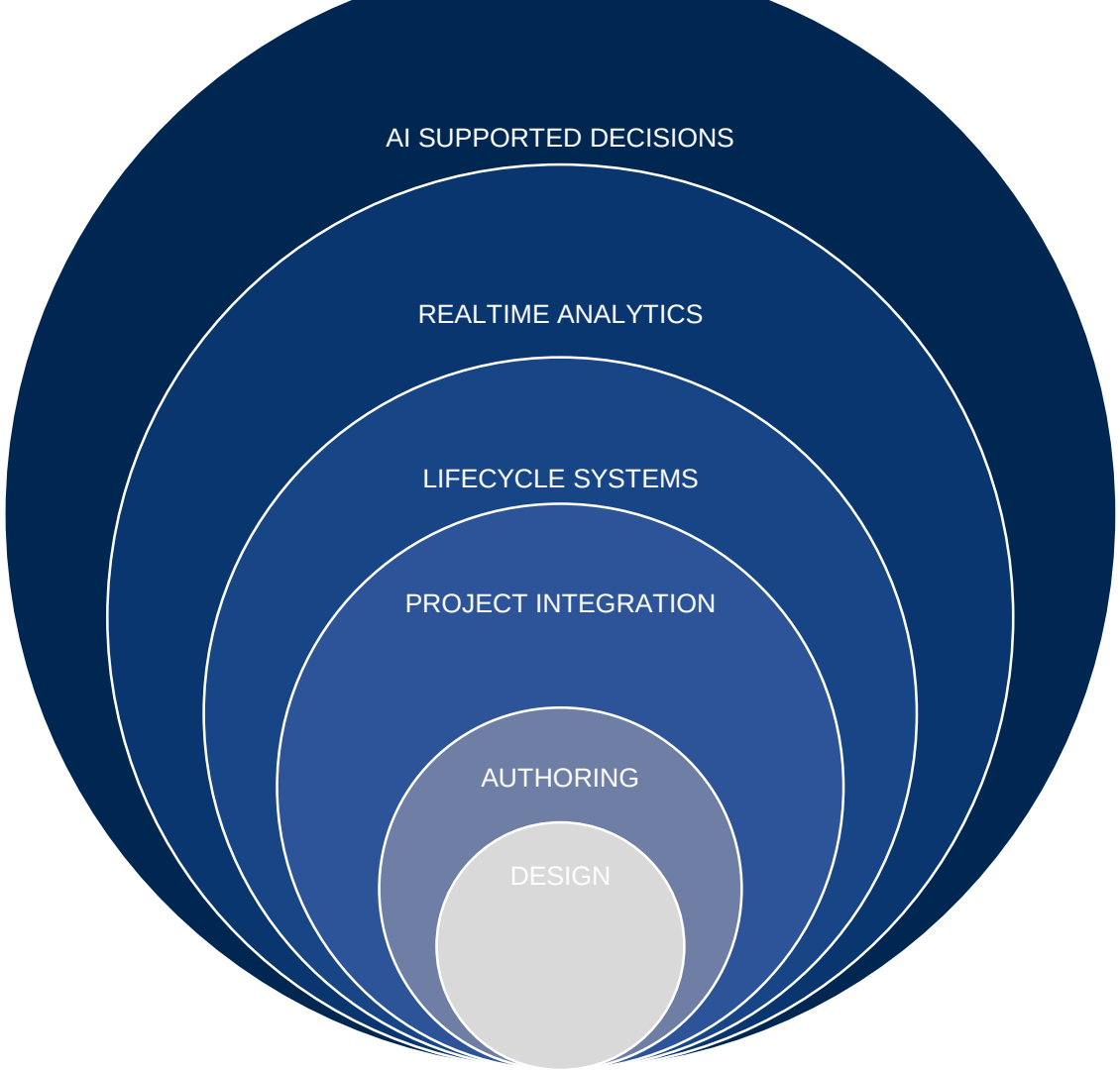
Good (Useful) Decisions

Data → Information → Decisions

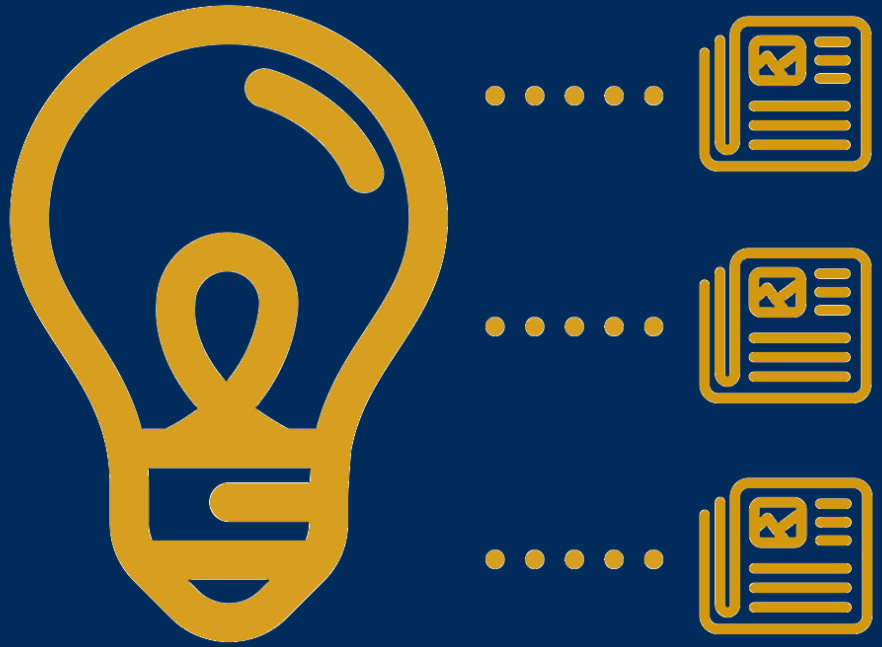
Bad Data

Bad (Unreliable) Information

Bad (Poor) Decisions

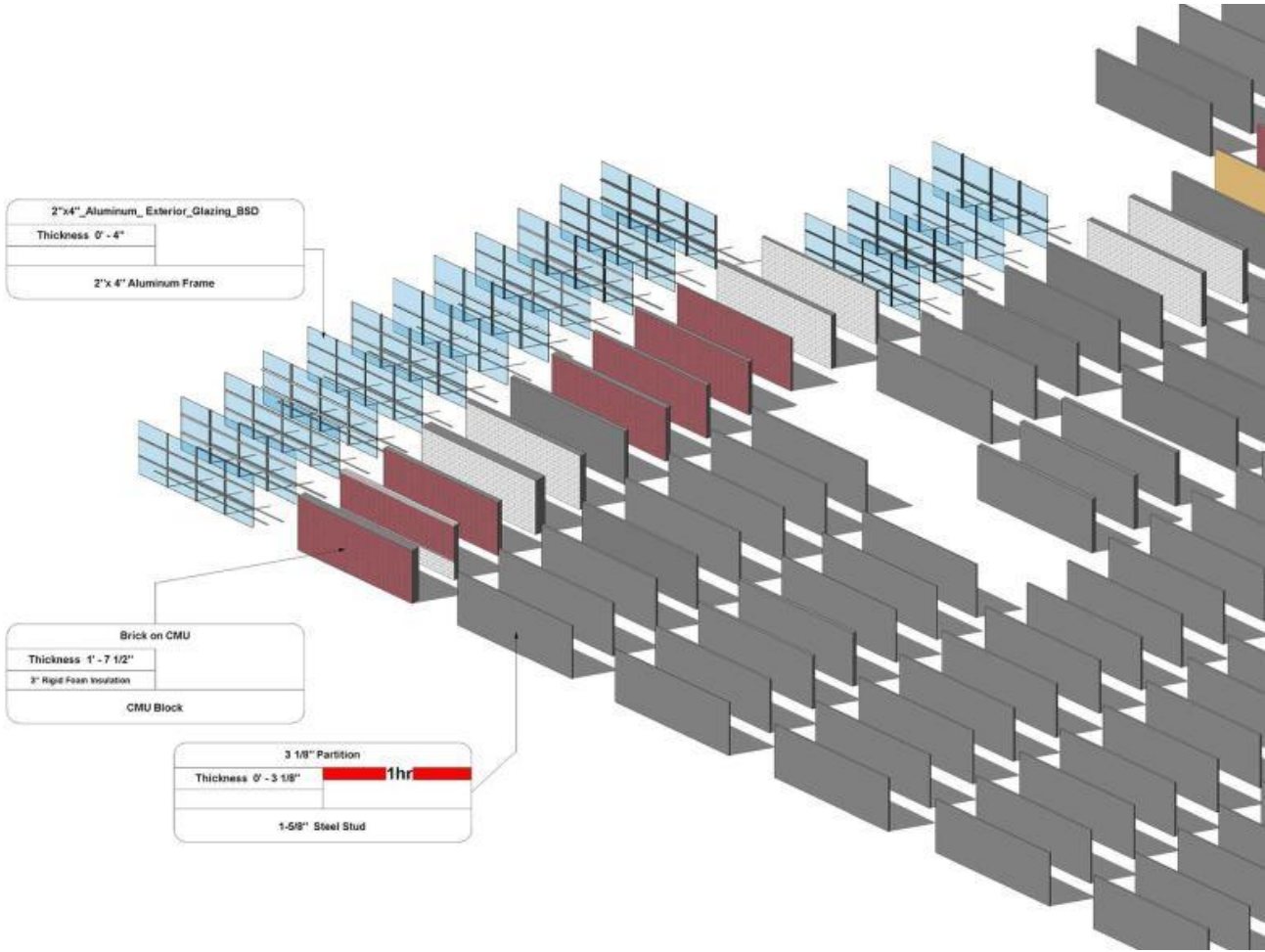

AI SUPPORTED DECISIONS
REALTIME ANALYTICS
LIFECYCLE SYSTEMS
PROJECT INTEGRATION
AUTHORING
DESIGN

IDENTIFY CURRENT DATA USES



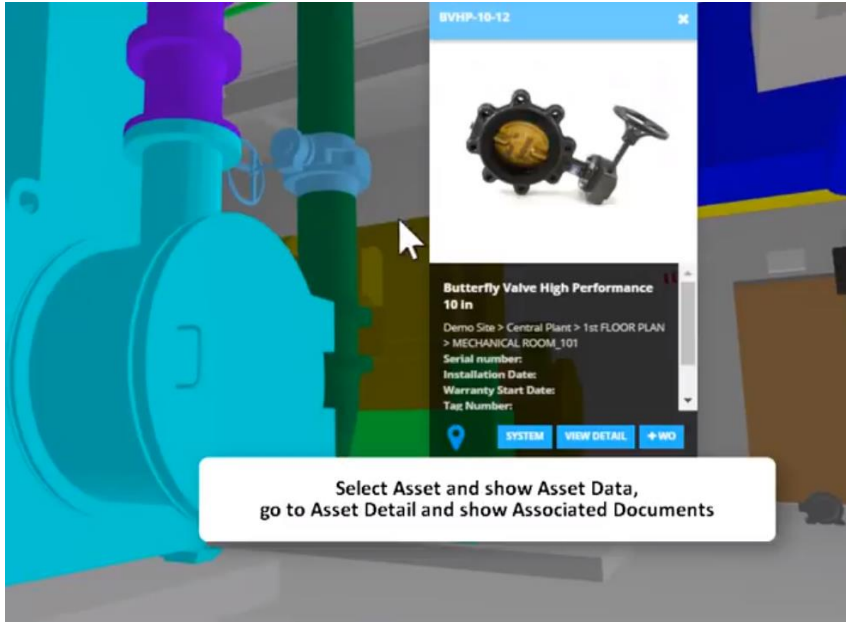
MODELS

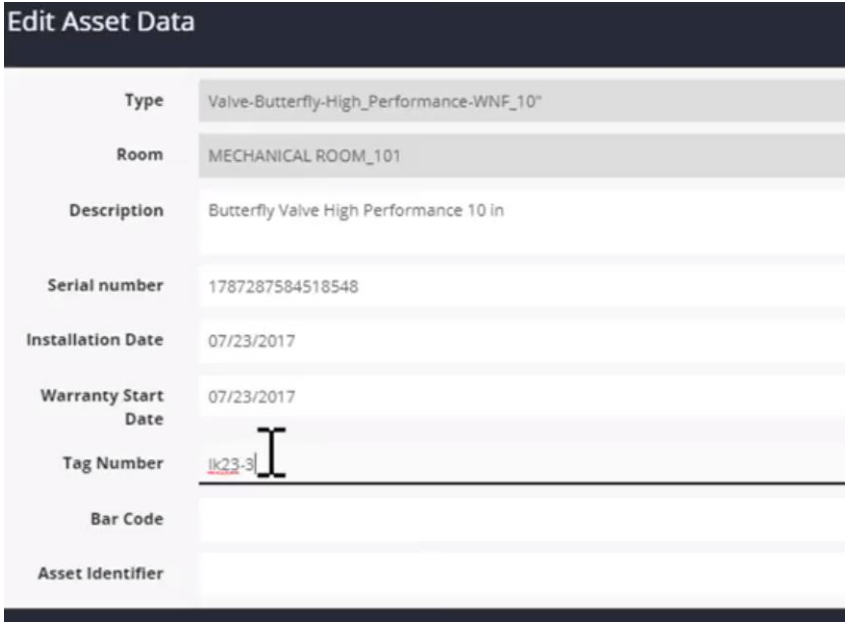
- BIM platforms all allow metadata writing
- Can take the form of component sizes, position coordinates, manufacturer data and anything pertaining to the model



FACILITY MANAGEMENT

- Lifecycle As-built content
- Replaces binders and specifications





PROJECT MANAGEMENT

- Project Data
- Shared Libraries

PROLOG

Microsoft® SQL Server®

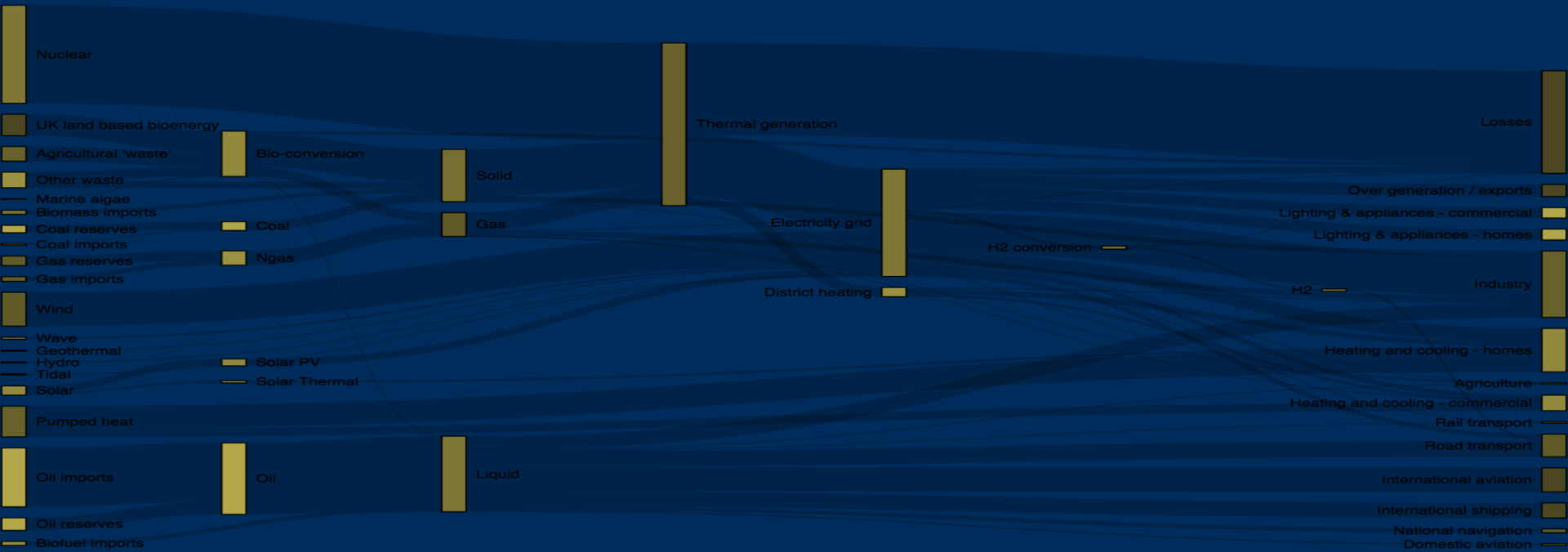
ORACLE®
PRIMAVERA P6

PROCORE®

FIELD EQUIPMENT

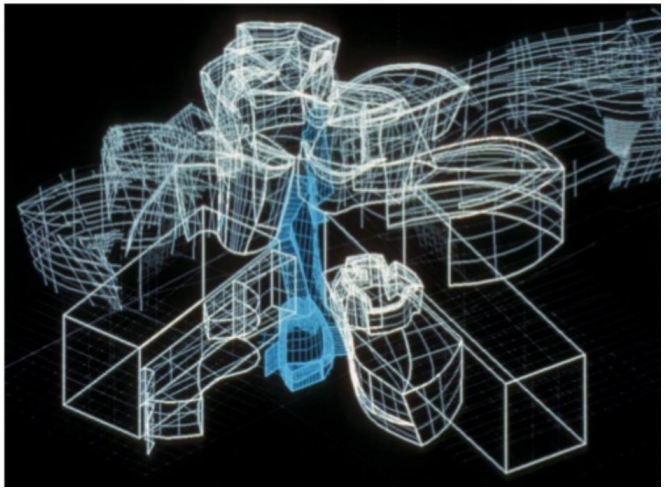
- GPS Enable devices
- Drone Surveillance
- Laser Scan Point Clouds
- 360 Photos

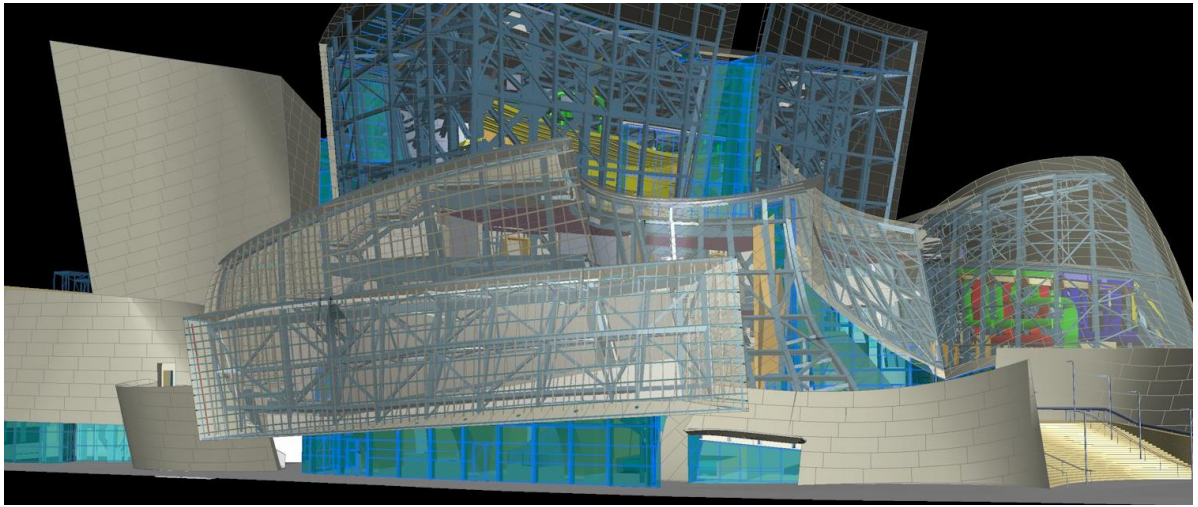
DATA-CENTRIC AEC WORKFLOWS



DESIGN

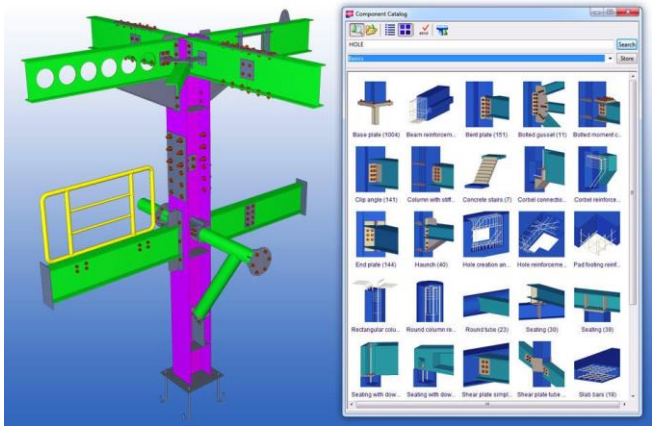
- Concept design is tricky
- Lots of big moves but not enough to get you a finite level of information for fabrication

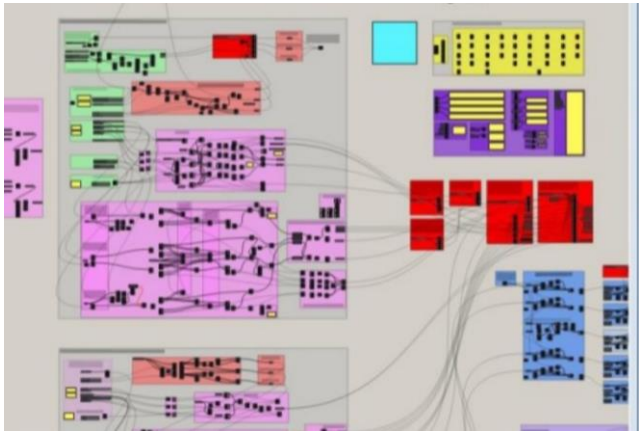


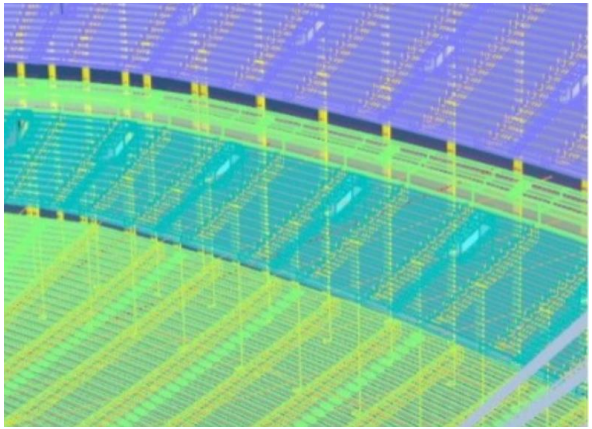


FABRICATION

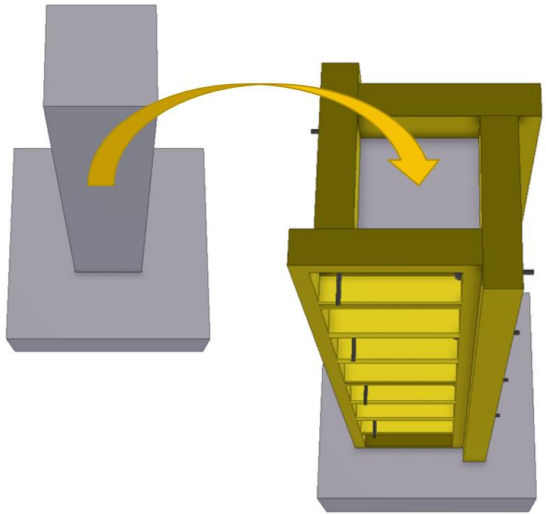
- Be prepared with data ahead of time to get your content where it needs to be
- Designers can take it and run for complex plans

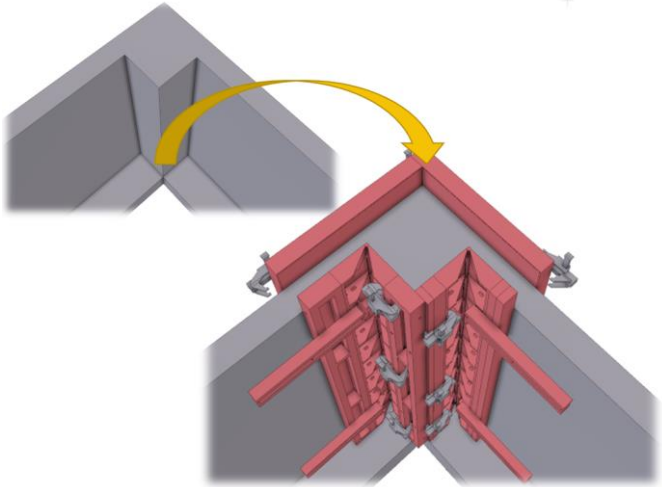






OPERATIONS & CONSTRUCTION



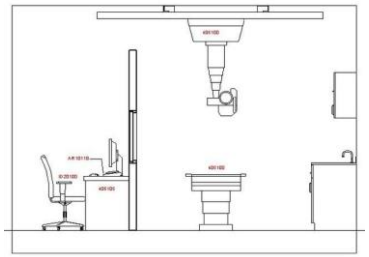


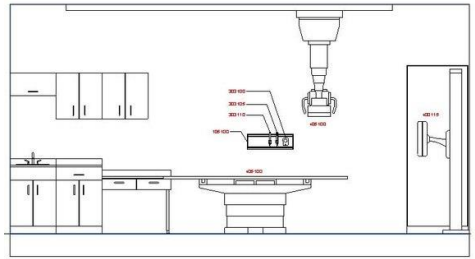
- Providing manufacturer data for assemblies and parts
- Creating content libraries for all fabricated parts of a building for record keeping in future renovations

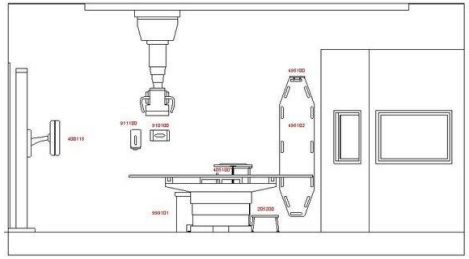
MANUFACTURER DATA

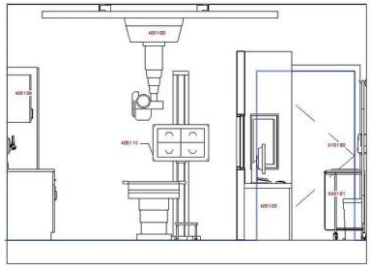
<Radiology Exam Room / Furniture Schedule>

A	B	C
Family	Description	Count
105100	Services Console, 600mm	1
205200	Stool Step	1
212101	Hampers, Linen, Round, Tilt-Lid	1
303100	Medical Gas, Suction Regulator	1
303105	Medical Gas, Oxygen, Flowmeter	1
303110	Medical Gas, Air, Flowmeter	1
400115	X-Ray Unit, Detector Stand	1
405100	X-Ray Unit, General Radiography, Digital	1
405105	General Radiography, Control Console (Part of item 405100)	1
405106	General Radiography, Generator Cabinet (Part of item 405100	1
495100	Transfer Board Wall Storage Rack	1
495102	Patient Transfer Boards, Radiology , Narrow	1
910100	Dispenser, Gloves, 1 Box	1
911100	Dispenser, Hand Sanitizer	1
950100	Base Cabinet, 600x600mm, with Sink and 2 Doors	1
950103	Base Cabinet, 600x600mm, with 2 Doors and 1 Drawer	1
951102	Wall Mount Desk, 900x600mm, with 2 Drawers	1
954101	Wall Cabinet, 600x300mm, 2 Doors	2
954104	Wall Cabinet Short, 600x300mm, 1 Doors	1
999101	Waste Containers, 8 Gallon	1
AR10110	Telephone	1
ID20100	Chair, Swivel, High Back	1
Grand total: 23		



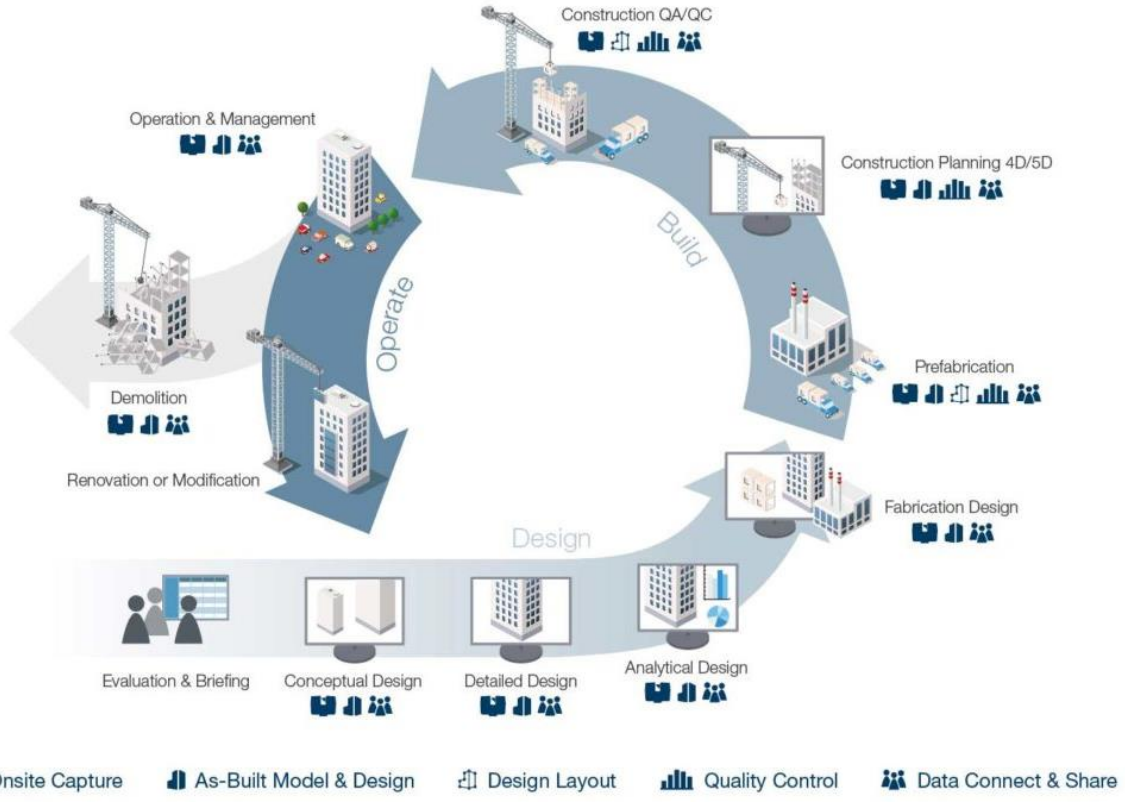




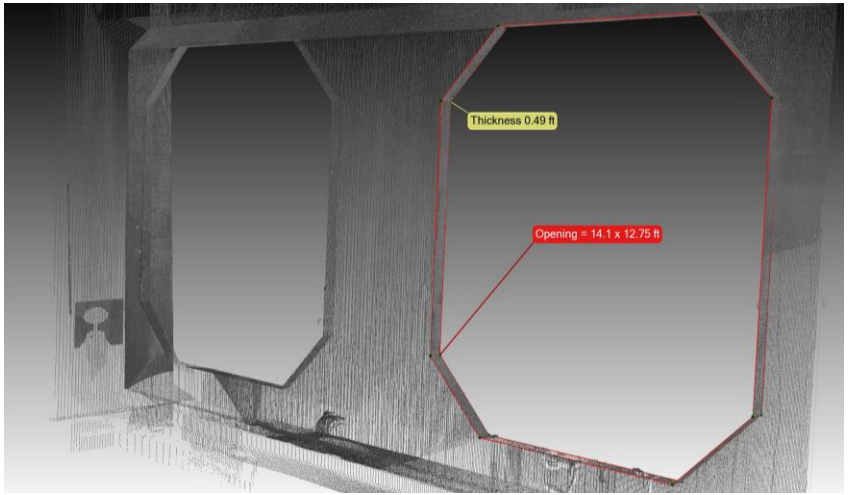


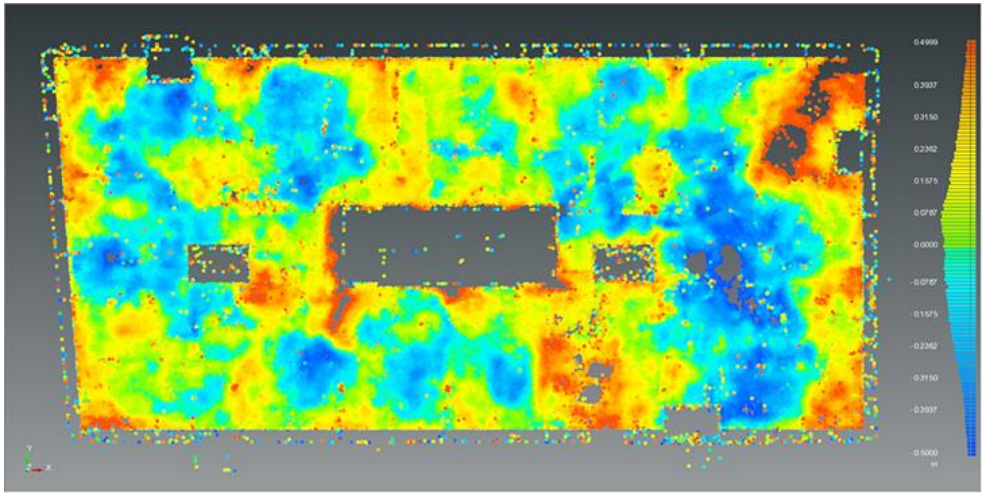
LASER SCANS POINT CLOUD DATA

- Point Clouds from Laser scan equipment will become common place
- Higher resolution point clouds can become part of the model environment
- Continuous scan updates for projects can incorporate into life cycle asset management
- Scans can have built in data for elevation, GPS, range and other relevant information
- Terrain data
- Material information
- Scan content thicknesses
- Scanning informs the modeling and lifecycle management with real word content



LASER SCANS POINT CLOUD DATA

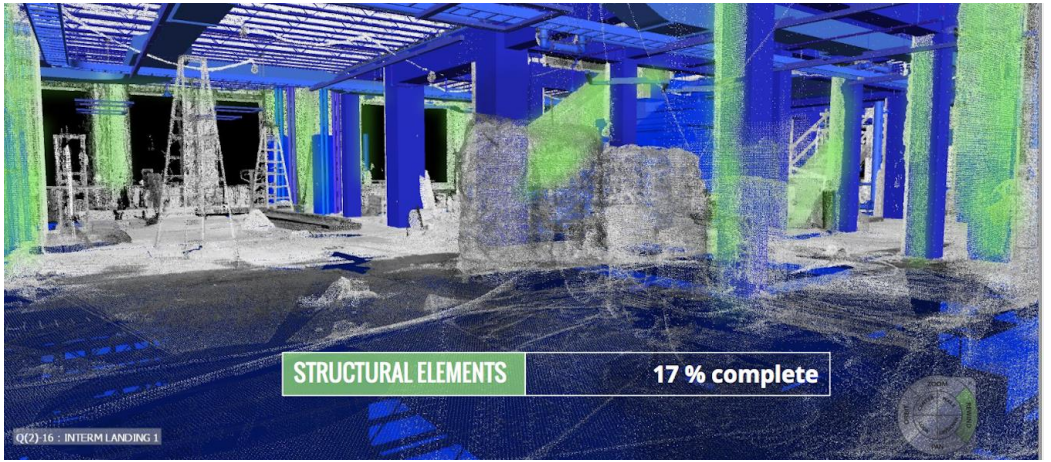




- Sizing members
- Finish Floor flatness post pour and cured as built copy

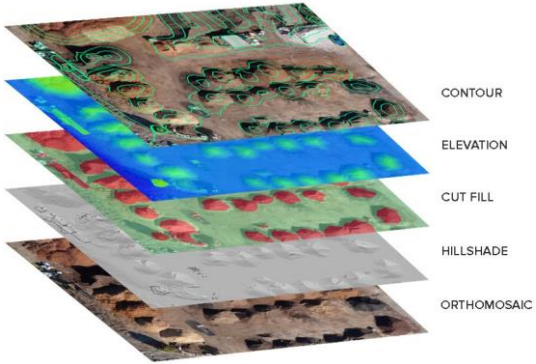
LASER SCANS

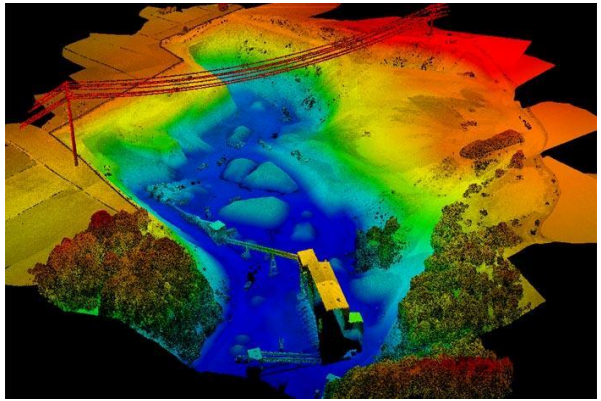
- Compare scans to federated models for construction progress
- Verify work progress matches the design



LASER SCANS

- Large area laser scans
- Aerial Lidar
- Photogrammetry mesh
- Data can analyze urban infrastructure, water resources, terrain data
- Datasets can be analyzed by machine learning algorithms which can be trained to search for critical information that can be fed back to decision making





POINT CLOUD METADATA

point - constrained type

(2.1,4.7,1.0,9,..)

Point type = XML schema
X : float, offset, scale, description
Y : double, ...

patch (group of points) - compressed - indexed

&

generalisations

$e^{-x^T Ax}$
$e^{-x^T Bx}$

pointclouds - 1 per table

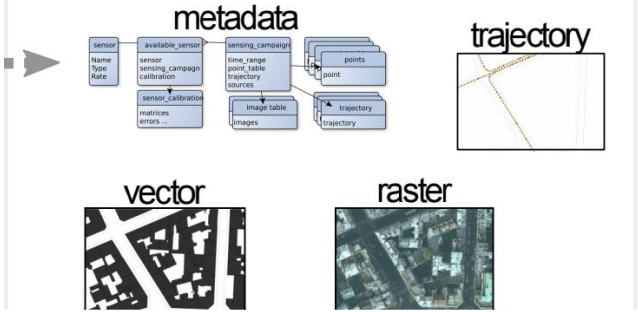
5	1000111101...
6	1000101001...
7	1000001110...

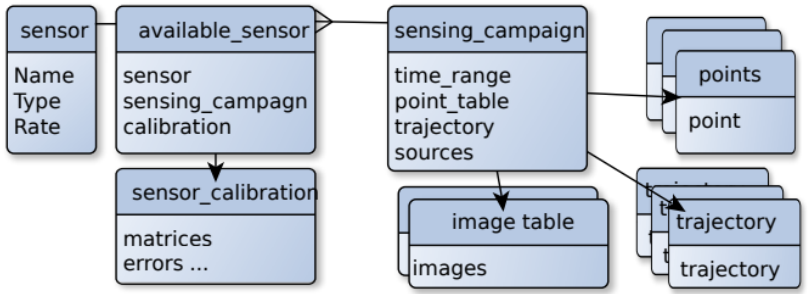
&

coverage maps

todo map

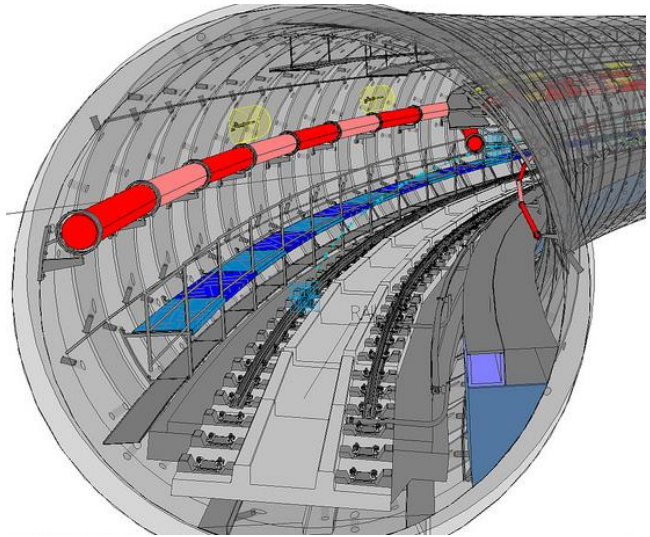
Metadata - relationnal - classical / extended

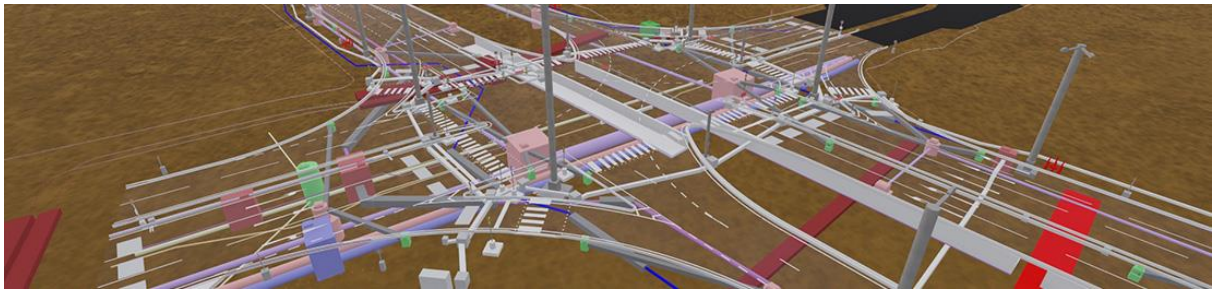




CIVIL INFRASTRUCTURE

- Horizontal Civil models with embedded GPS information



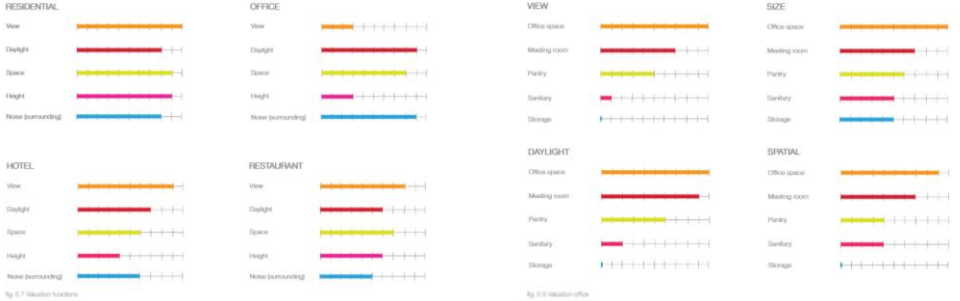


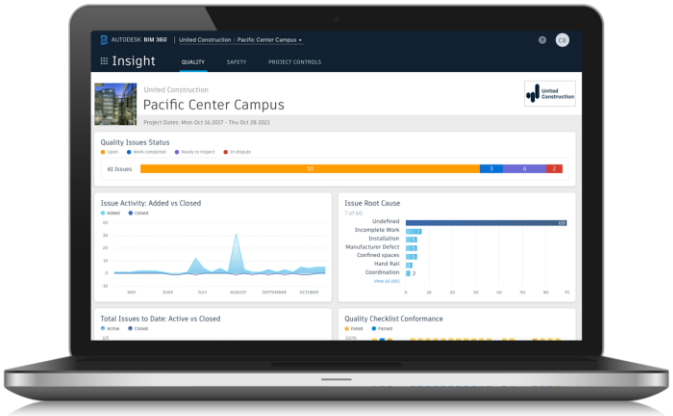
LIFECYCLE MANAGEMENT

- Evaluate new capital projects
- Plan maintenance tasks
- Fast response to incidents
- Risk evaluation for unplanned work

REPORTING AND ANALYTICS

- Model content can be sent directly to reporting platforms to gain insights
- Boost communication between teams and organizations
- Use data for AI systems
- History of data can be used to make better informed decisions and avoid risk

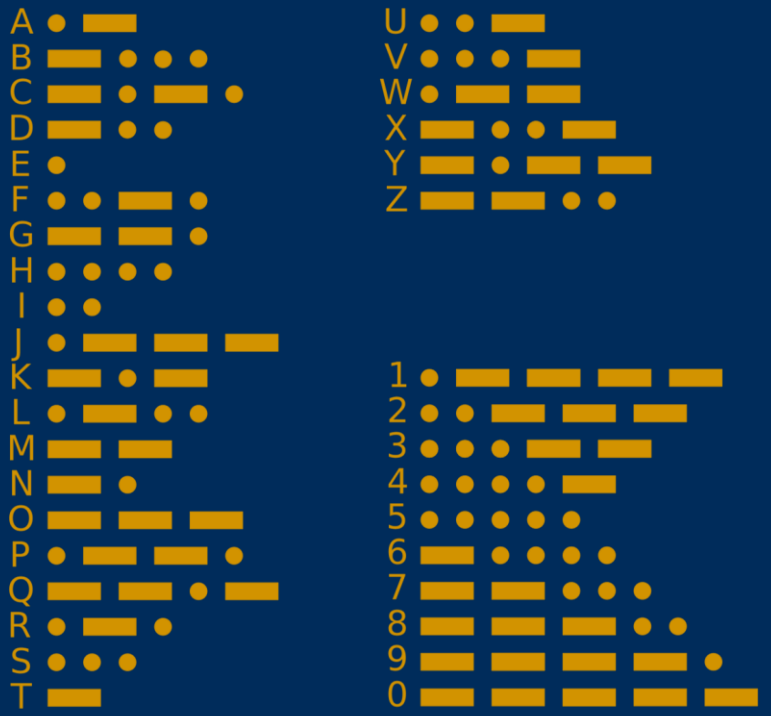


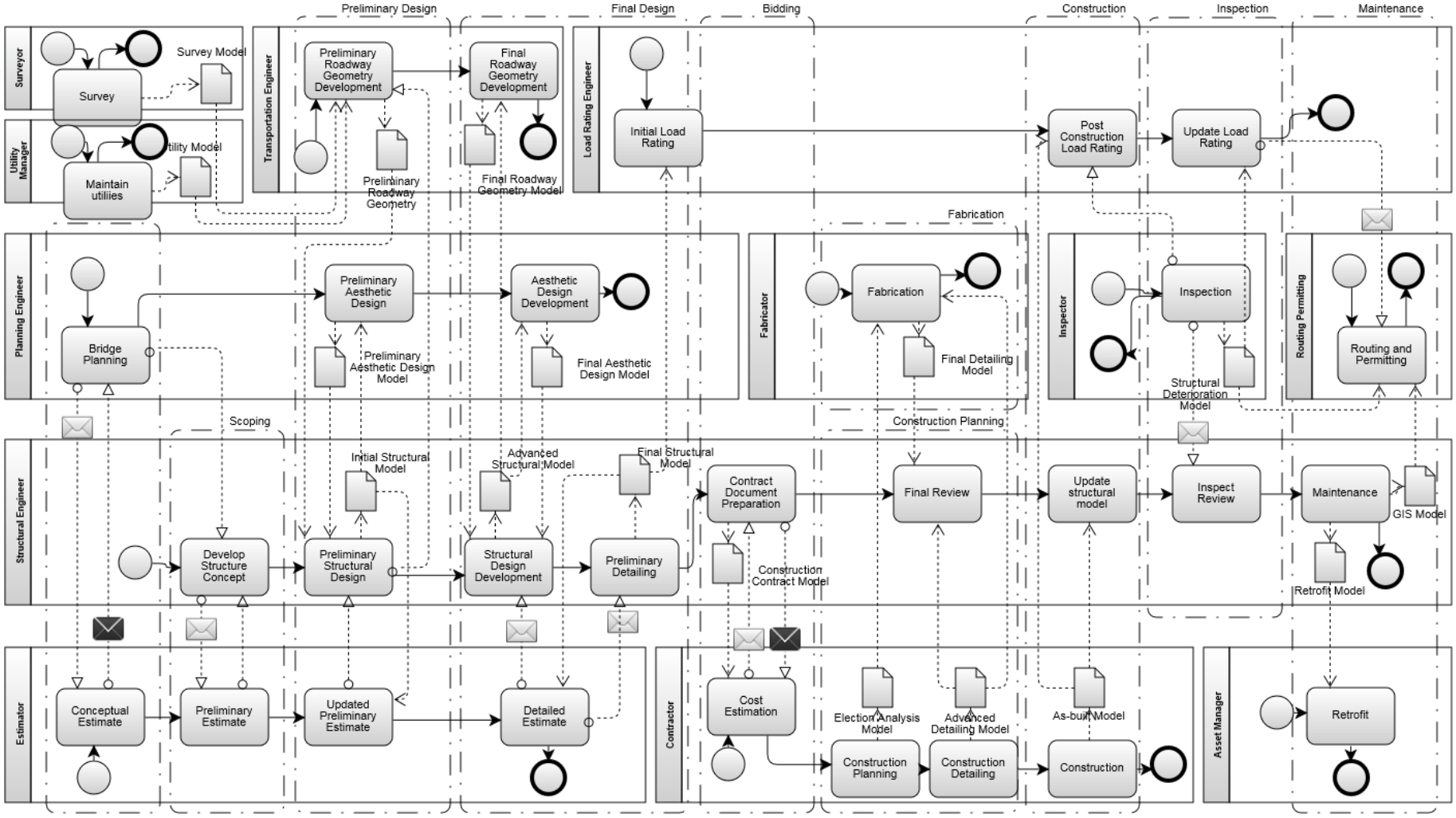


GIS

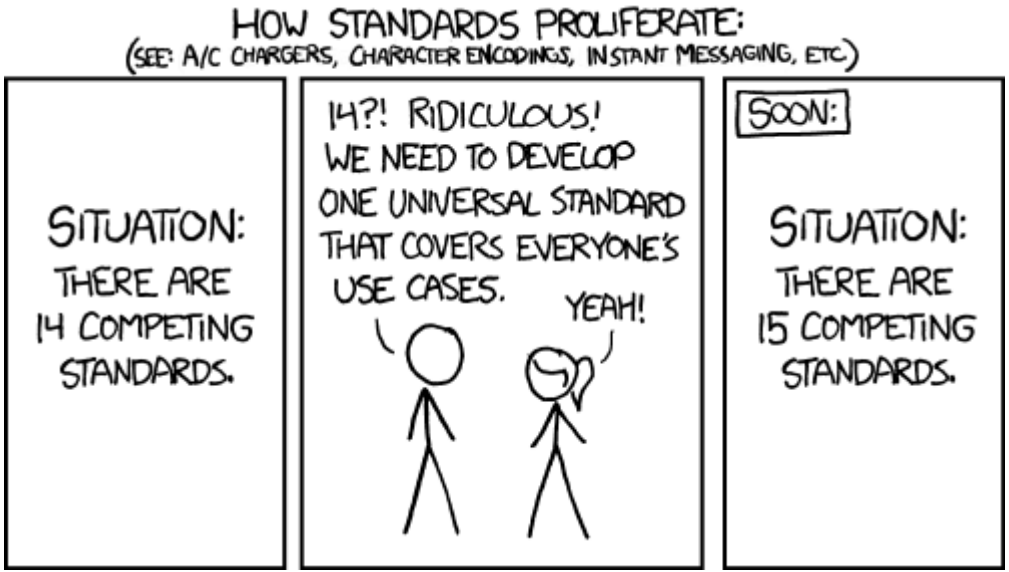
- Geographic Information Systems
- City planning and Large scale infrastructure can acquire larger data libraries as methods become standardized

INTERNATIONAL STANDARDS



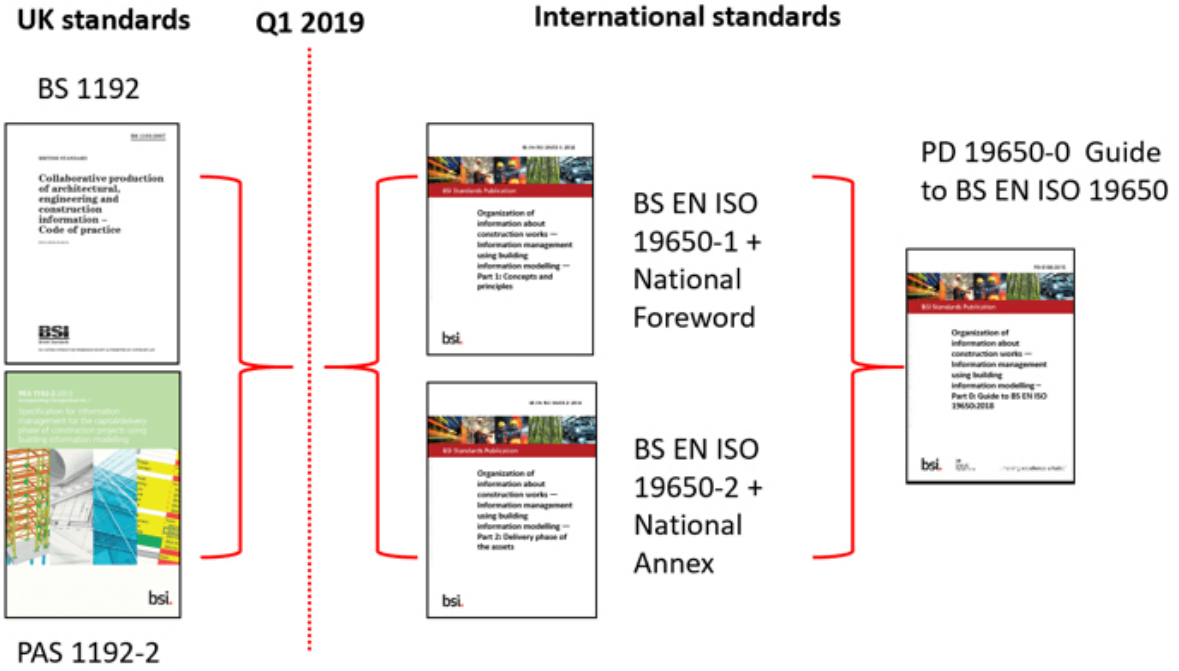

Preliminary Design
Final Design
Bidding
Construction
Inspection
Maintenance
Surveyor
Survey
Survey Model
Utility Manager
Maintain utiliies
tility Model
Transportation Engineer
Preliminary Roadway Geometry Development
Preliminary Roadway Geometry
Final Roadway Geometry Development
Final Roadway Geometry Model
Load Rating Engineer
Initial Load Rating
Post Construction Load Rating
Update Load Rating
Fabrication
Planning Engineer
Bridge Planning
Preliminary Aesthetic Design
Preliminary Aesthetic Design Model
Aesthetic Design Development
Final Aesthetic Design Model
Fabricator
Fabrication
Final Detailing Model
Inspector
Inspection
Structural Deterioration Model
Routing Permitting
Routing and Permitting
Scoping
Construction Planning
Structural Engineer
Develop Structure Concept
Initial Structural Model
Preliminary Structural Design
Advanced Structural Model
Structural Design Development
Final Structural Model
Preliminary Detailing
Contract Document Preparation
Construction Contract Model
Final Review
Update structural model
Inspect Review
Maintenance
GIS Model
Retrofit Model
Estimator
Conceptual Estimate
Preliminary Estimate
Updated Preliminary Estimate
Detailed Estimate
Contractor
Cost Estimation
Election Analysis Model
Advanced Detailing Model
As-built Model
Construction Planning
Construction Detailing
Construction
Asset Manager
Retrofit

STANDARDS


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)
SITUATION: THERE ARE 14 COMPETING STANDARDS.
14?! RIDICULOUS! WE NEED TO DEVELOP ONE UNIVERSAL STANDARD THAT COVERS EVERYONE'S USE CASES.
YEAH!
SOON:
SITUATION: THERE ARE 15 COMPETING STANDARDS.

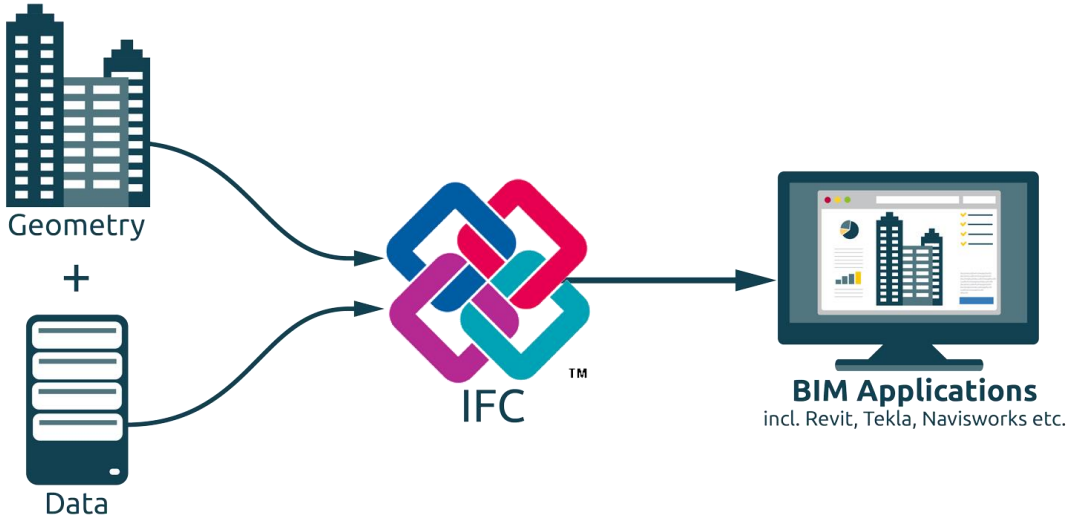
PAS into ISO

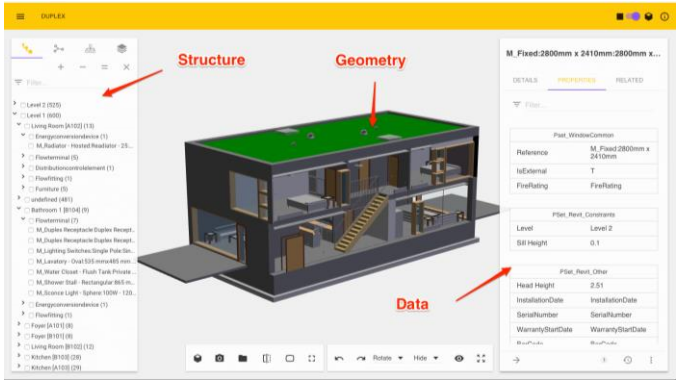
- BS and PAS 1192 will transition to ISO 19650 series for international quality management of BIM assets
- “BS EN” designation for UK projects
- BS EN ISO 19650-1 will replace BS 1192 for concept models
- BS EN ISO 19650-2 will Replace PAS 1192 for delivery assets
- All UK BIM Alliance efforts will go towards the ISO standards moving forward
- Release of ISO 19650 expected end of 2018

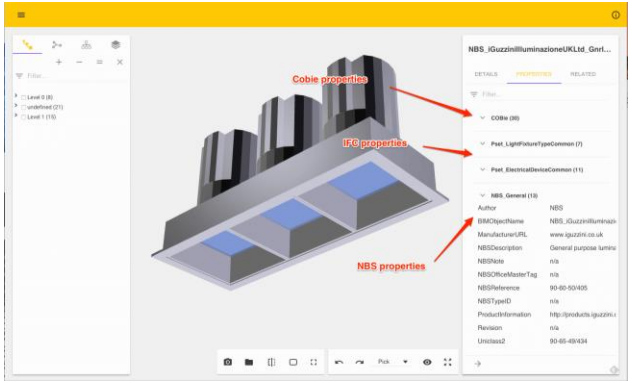


IFC

- Industry Foundation Classes
- The basic ‘operating system’ that transports the information and the data.
- ISO 16739
- National Institute of Building Sciences (NIBS)
- IFC are non-proprietary exchange formats so you can share BIM models between different platforms
- Essentially a data exchange format







National Institute of BUILDING SCIENCES

ISO-IFC Alignments

- ISO will align all the standards into one system
- IFC4 Will take over from existing IFC formats
- Between ISO Quality Management and IFC information management a true international BIM exchange and management format is possible

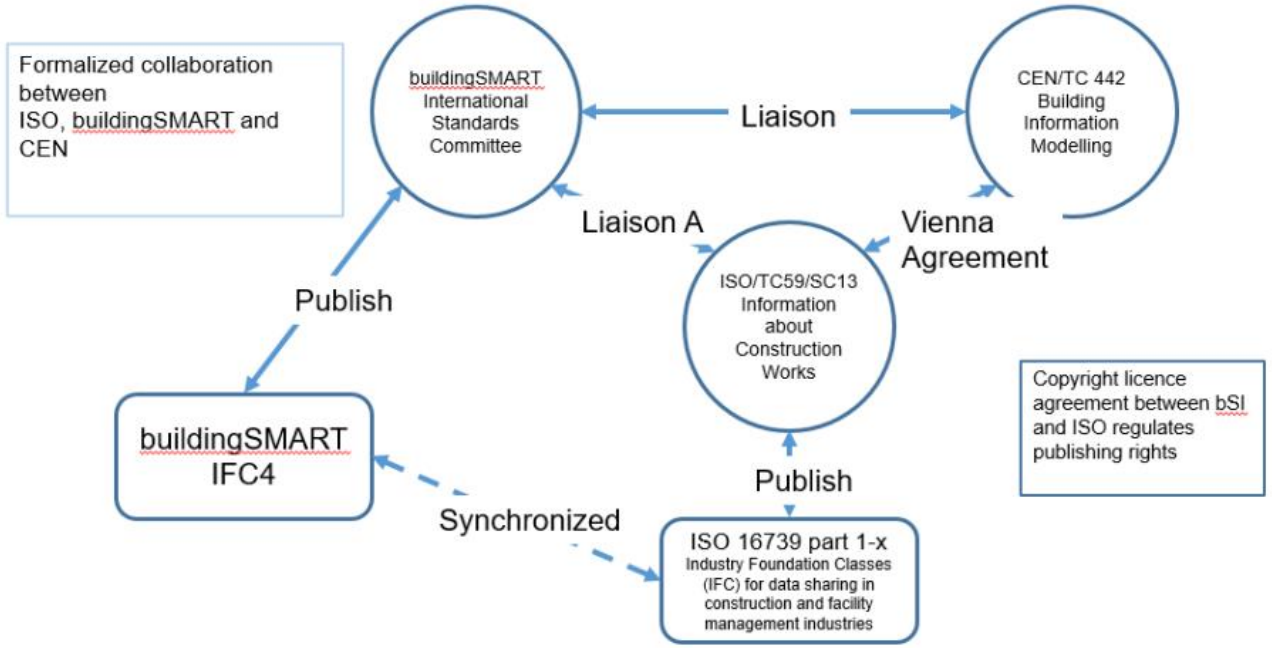
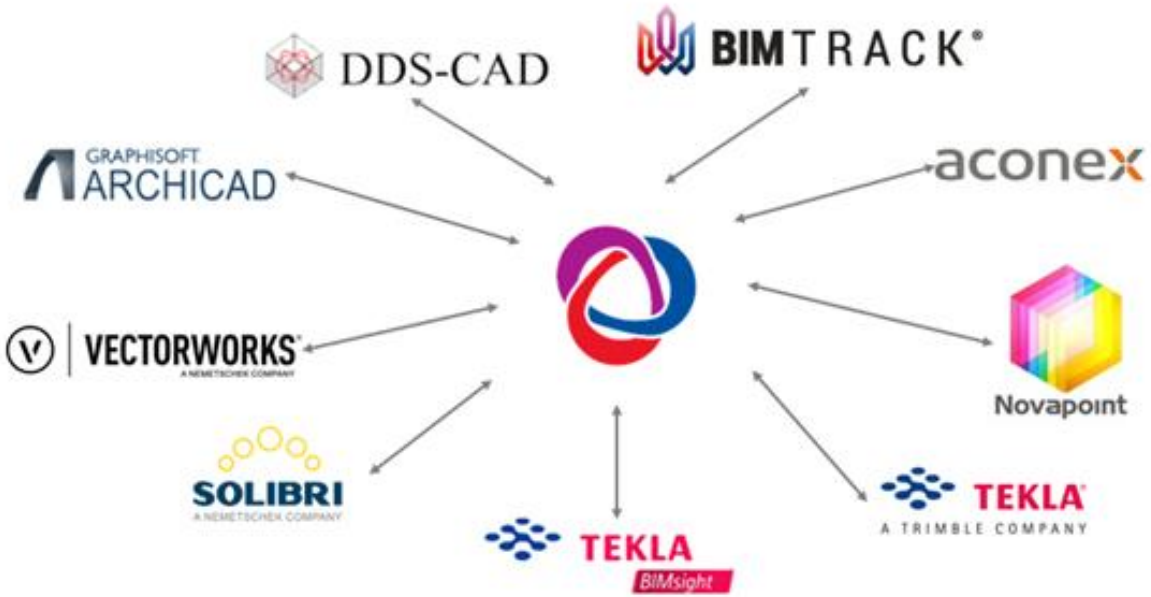


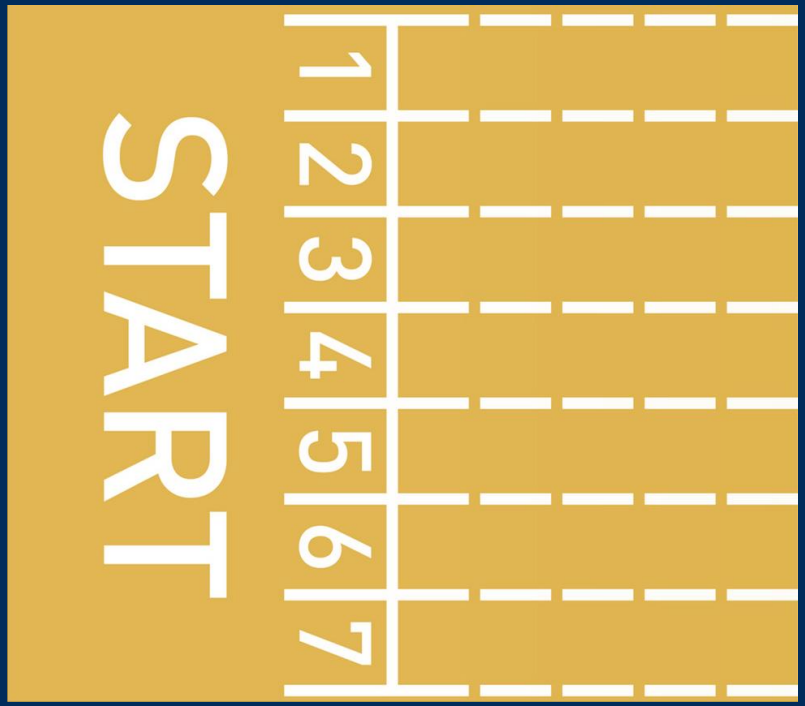
Figure 7: IFC development coordination

BCF

- BIM Collaboration format
- In 2010, Tekla and Solibri came up with an initial XML schema, called "bcfXML v1", to encode messages containing BIM-topics
- buildingSMART standard
- Keeps record of changes in a BIM project in XML format with additional comments and model content during collaboration
- IFC can’t be edited so this was the solution
- For 3rd party vendors this format will become more useful managing many different BIM formats



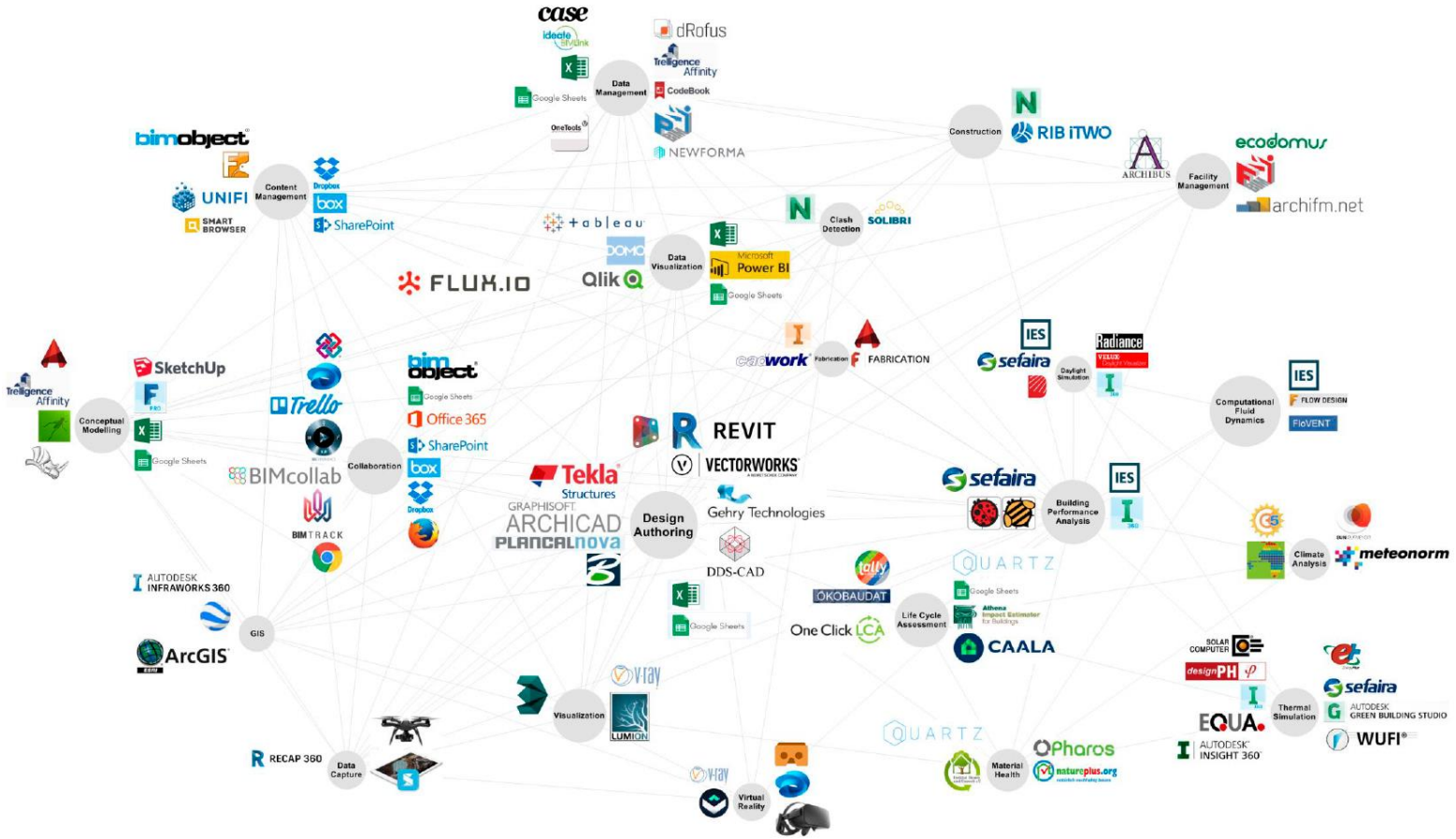
HOW TO GET STARTED



FIRST STEPS

- First, you need to select the model you would like to build.
- Collect your content & Understand how each part can be used. Learn about the characteristics: dimension, color, weight, shape.
- Start building small chunks until you've mastered all the uses.
- Finally, after you've built the model you've wanted, take all the pieces apart and start experimenting.

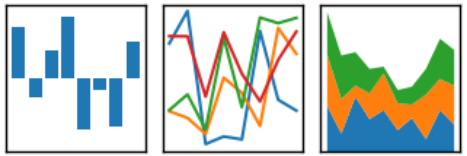
BIM SOFTWARE ECOSYSTEM

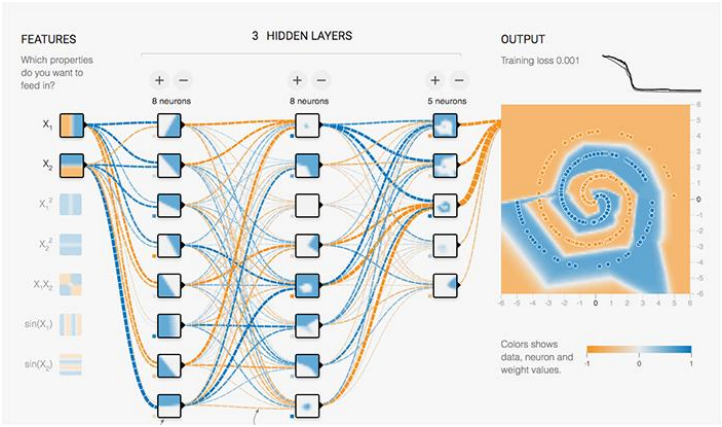


DATA ANALYSIS

pandas

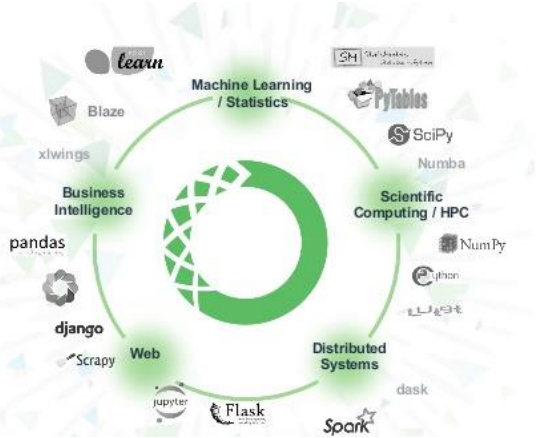
$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$

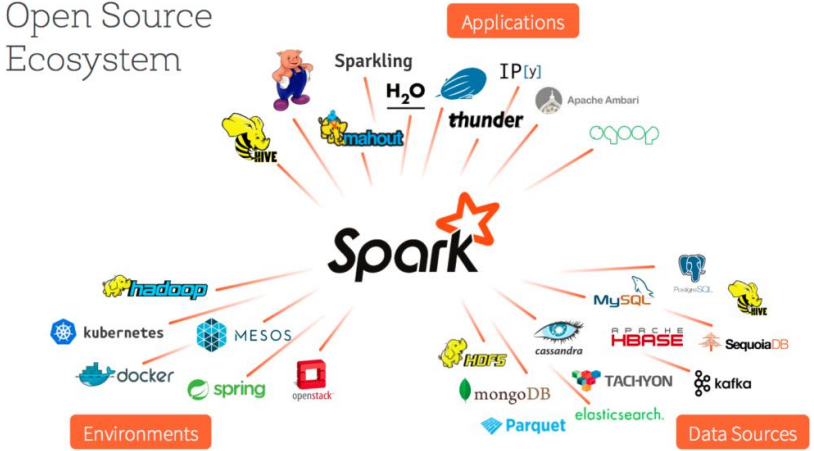




ANACONDA DISTRIBUTION

Python & R distribution with 1000+ curated packages that makes it easy to get started with Data Science





AI AND ML


IBM Watson

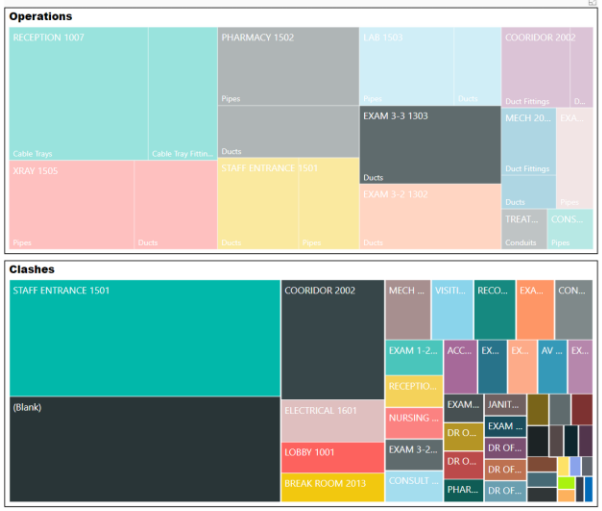

Amazon
Machine
Learning


Cloud ML Engine

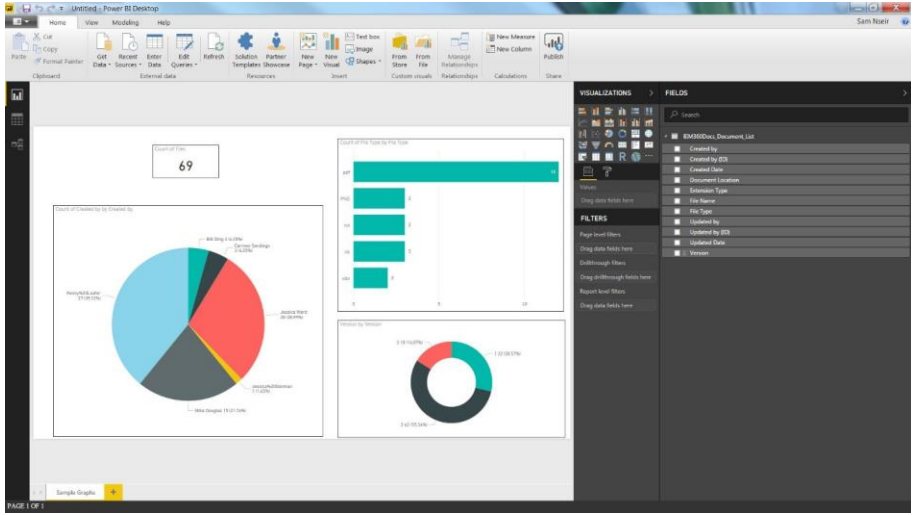

Azure Machine Learning

USING THE DATA

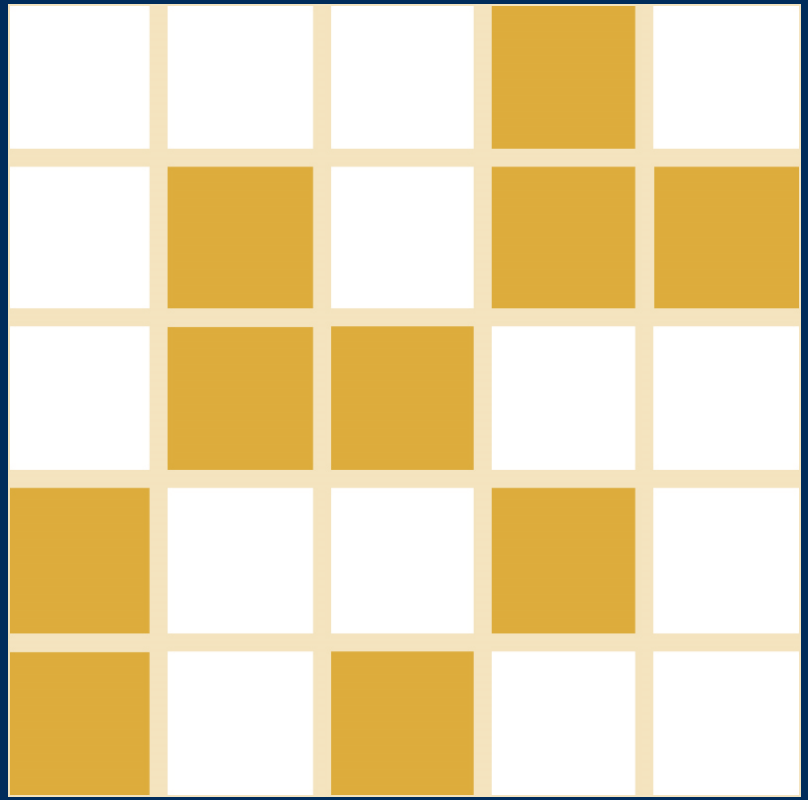
- Power BI by Microsoft is a common industry tool
- Take exported content from your project models and schedules to get analysis and insights
- Can be shared as dashboards on websites for any device
- Tableau and SAP are also popular tools for similar analysis



Room	TimeStamp (bins)	Name	Count of OperationType
EXAM 3-3 1303	11/8/2017	Jack	1
EXAM 3-3 1303	11/7/2017	Jack	5
Total			**6**



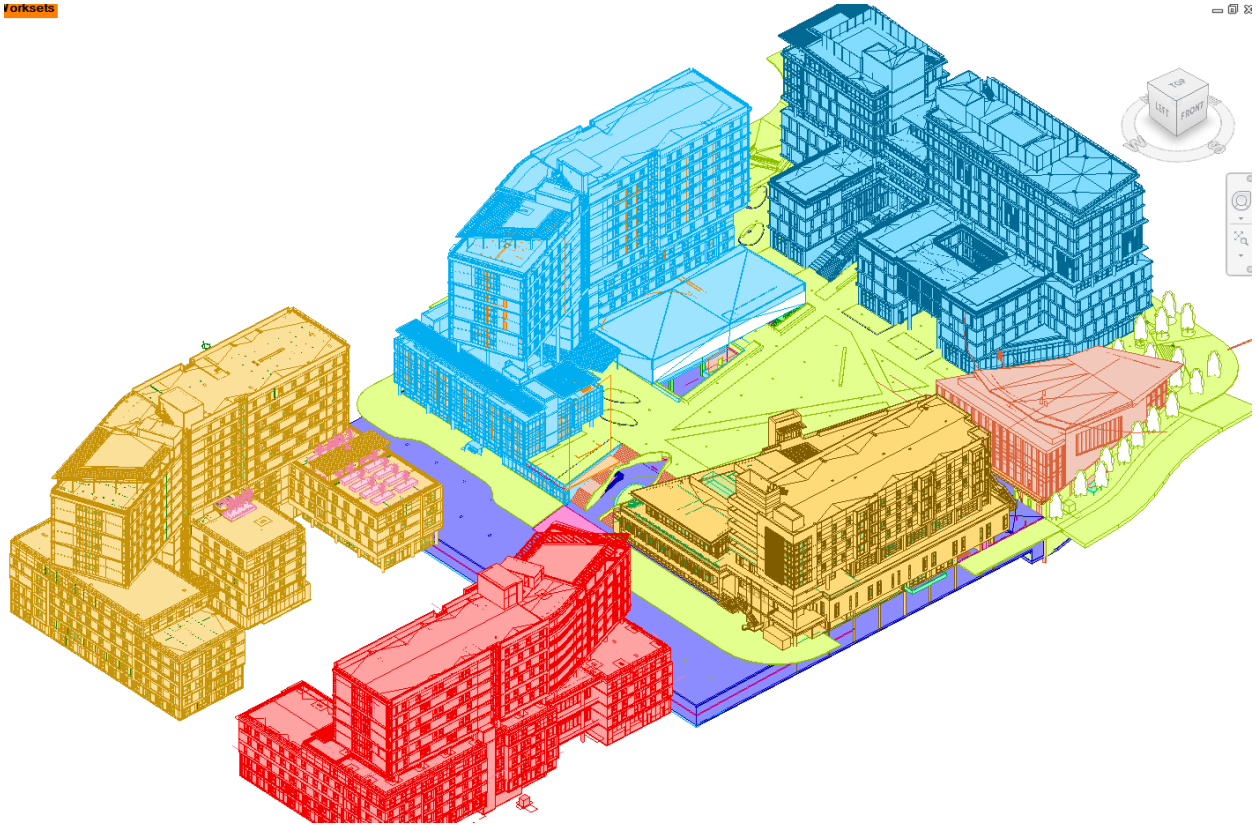
PROJECTS



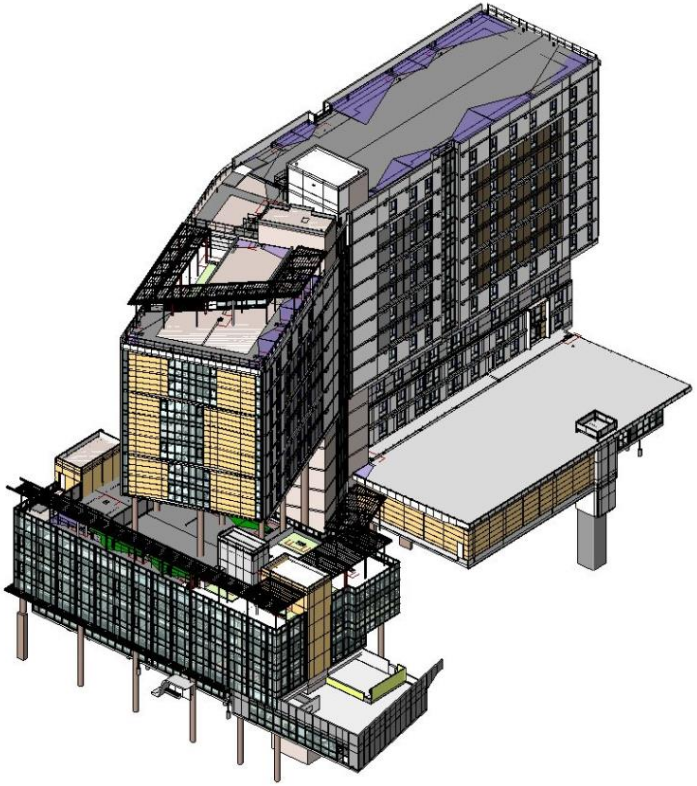
UCSD NORTH TORREY PINES COLLEGE

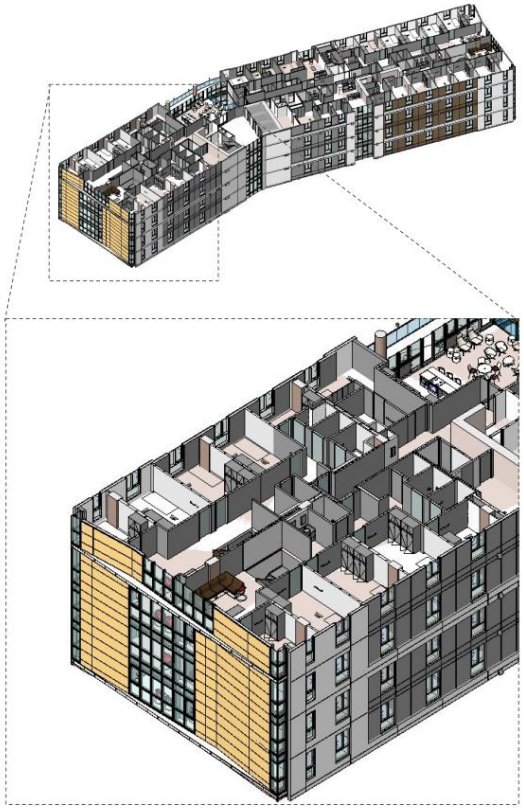
DESIGN

- Design Build Project by HKS and Clark Construction
- 500,000 SF (46,000 SM) project with 6 buildings and a parking structure
- Concept in November 2016
- 100% Construction Documents by June 2018
- Turn key completion by August 2020
- Client pushes to get best practices implemented
- Multiple models (55) live on cloud accessible to anyone on the project team
- Effectively all the data in the project – Plans, details, schedules, parts, counts, etc



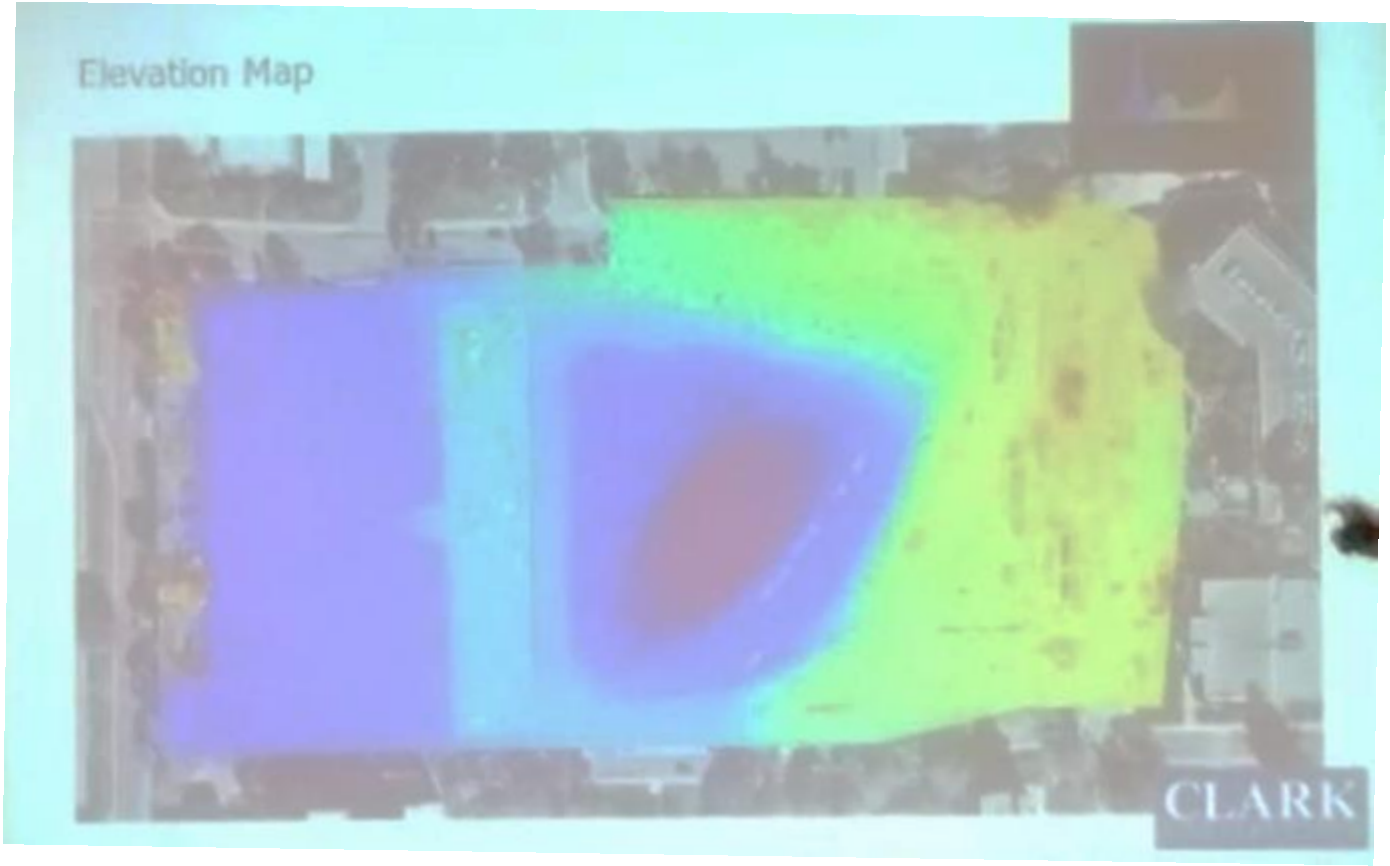
MODEL AUTHORING





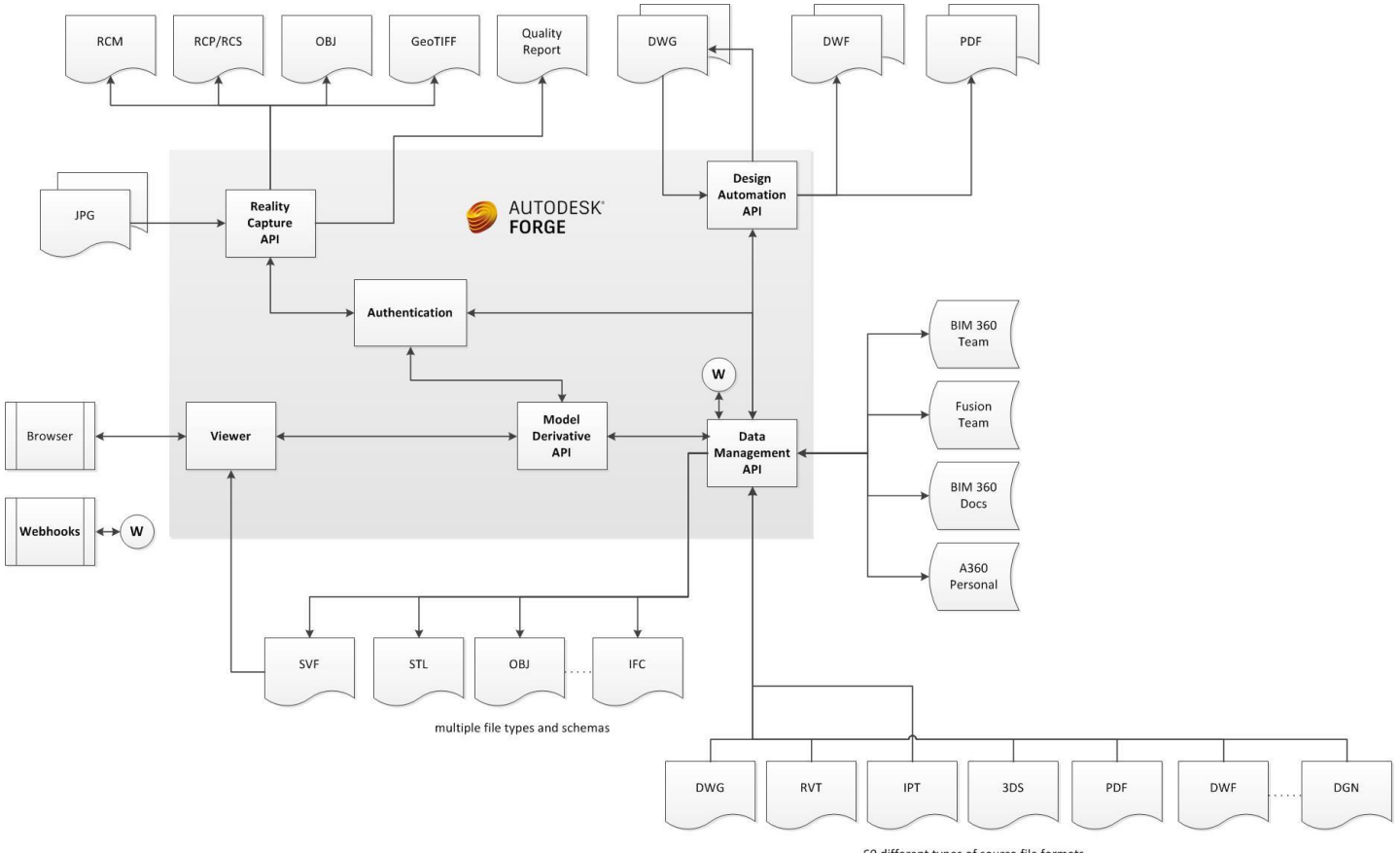
CONSTRUCTION

- Construction site has an Elevation map from Aerial analysis using drones



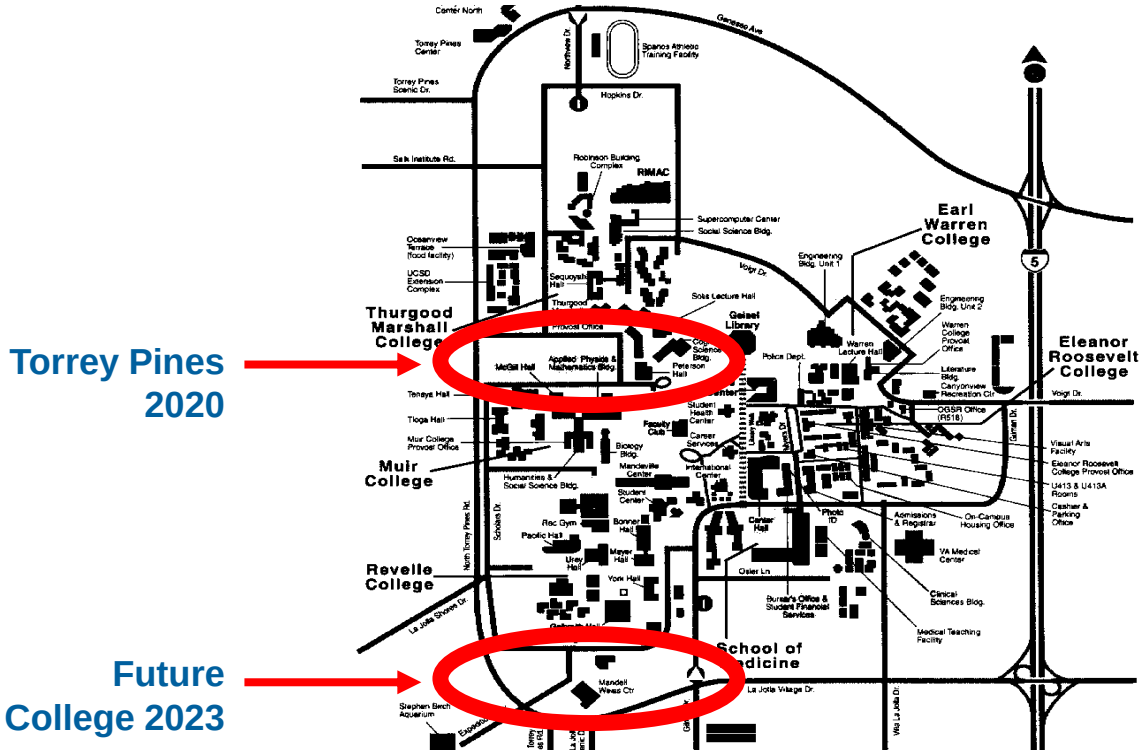
ASSET MANAGEMENT

- UCSD Facility Management went from CAD to BIM Life Cycle Management with the Torrey Pines project
- New requirements came onboard during CA phase for a Data Asset BIM model deliverable
- Cobie, Omniclass, Specifications and manufacturer data are requirements for the deliverable
- Entire FM system will be powered by IBM Maximo

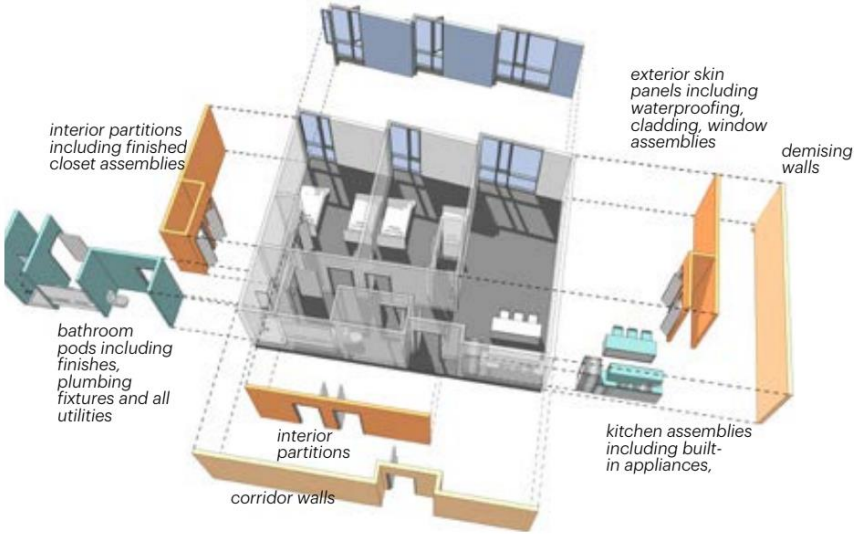


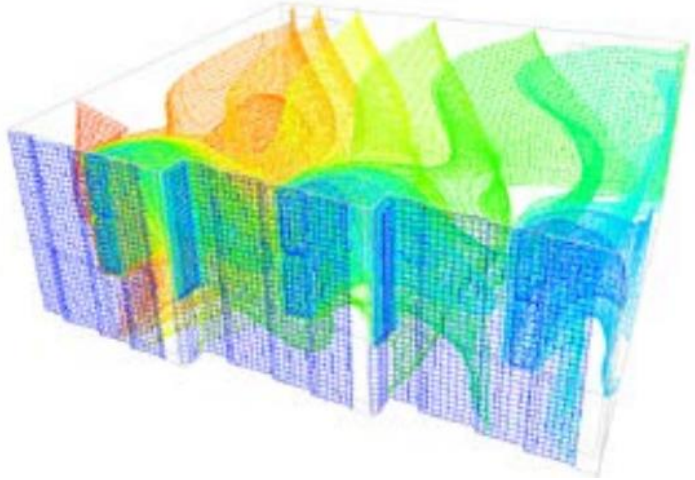
UCSD FUTURE COLLEGE

UCSD FUTURE COLLEGE



UCSD FUTURE COLLEGE

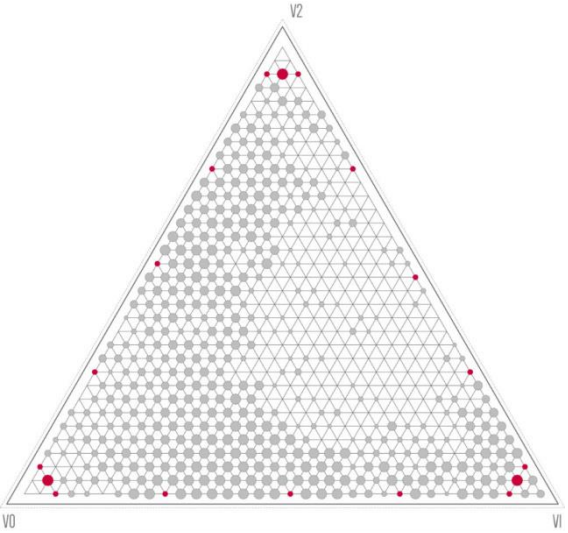


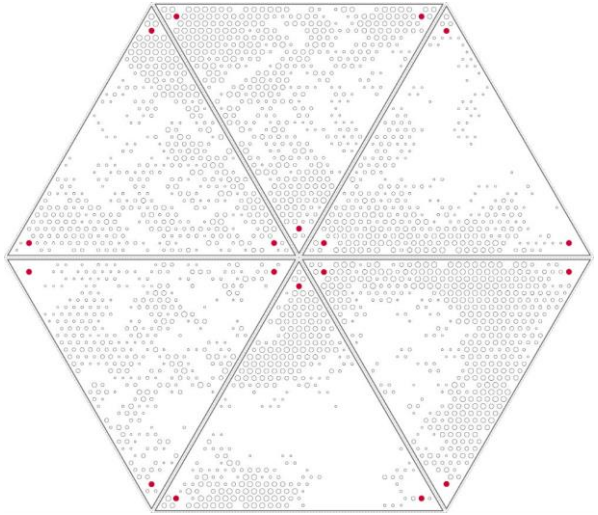


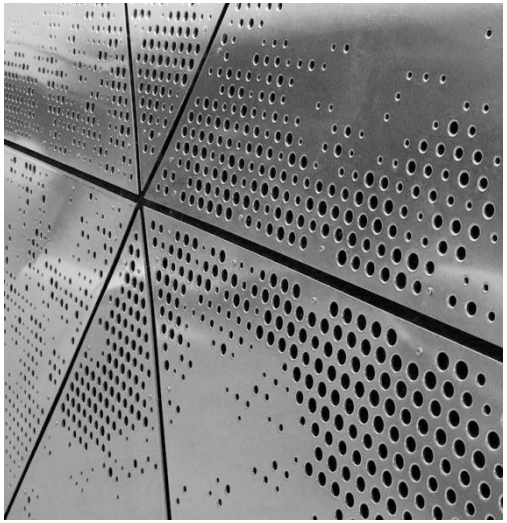
LA STADIUM

- Canopy has 36,000 panels with 20 million perforations punched into them
- Data points from meshes can be exported for fabrication

GENETIC ALGORITHMIC DESIGN







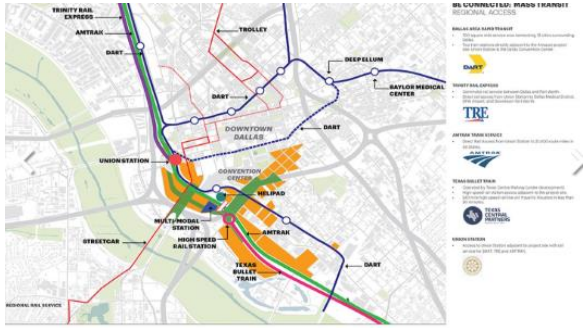
- Standardized ½” circle diameter increments mapped onto a triangle
- Data points from meshes can be exported for fabrication

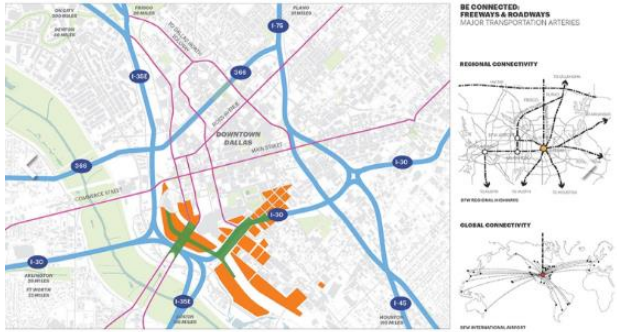
LA STADIUM & HOLLYWOOD PARK

- Plans to develop entire property into its own district
- Digital Twins, IOT and 5G will be part of the infrastructure

HQ2 DALLAS PROPOSAL

HQ2 DALLAS PROPOSAL

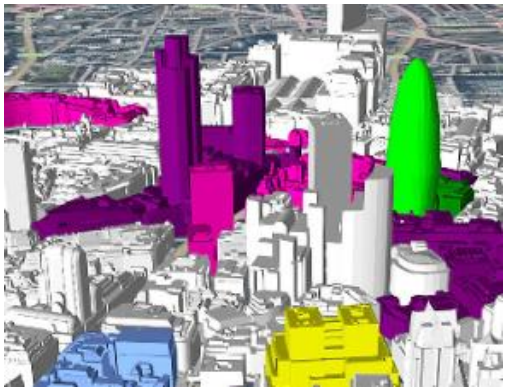


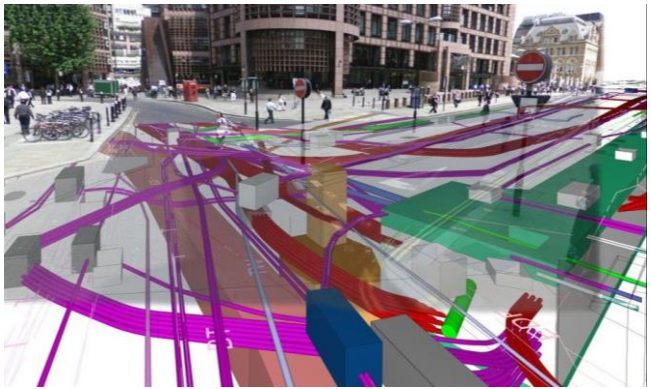


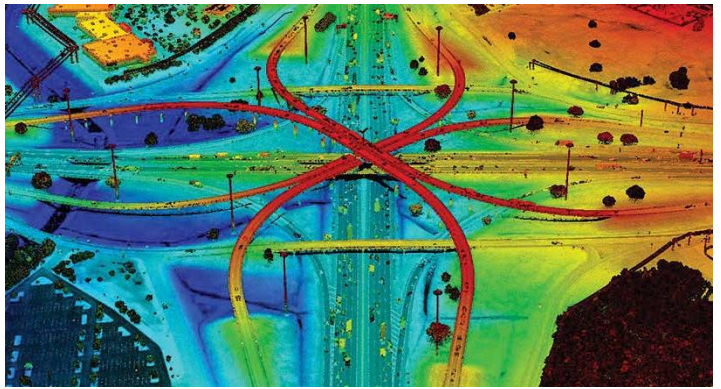
FUTURE

Smart Cities

- Everything in smart city concept has to be catalogued and organized or it won’t be very useful
- IOT utilities will make an impact on how cities are planned
- Data –embedded models can help planners and developers make decisiosn
- Aerial Lidar can fill in the gaps of modeling data







TAKEAWAYS

THEMES

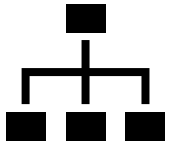
DATA IS GROWING

OWNERS WANT MORE OF IT

DON’T GET LEFT BEHIND

AEC INDUSTRY TRENDS

- Construction Technology investment is increasing
- Over $1 Billion in funding has been allocated to construction startups in 2018 alone
- The largest portion is collaboration software
- Connected devices will increase the requirements of BIM MetaData immensely
- Data Analysis and Content Sharing in AEC will become the norm not the exception



- Clients requiring Metadata as part of the deliverable
- Models reporting more data every year
- Regulating bodies can require projects to be submitted with metadata in the models for compliance review

- Facility management systems will use data in their regular operations
- Insights from the Model data will be used for analytics by building engineers and designers
- All BIM projects will become more integrated by all parties requiring common standards and interoperability workflows from the start

KEYPOINTS – WHERE TO GET STARTED

- Data won’t be a writeable content it will become an asset
- Model interoperability will become the norm – no platform is dominant with everyone sharing content consistently
- Solutions will be built within an ecosystem of domain expertise not platform expertise
- Create model templates with parameters writeable to IFC files and other open platforms
- Have your own Roadmap for Data Asset Management and Data Analysis to get the most value out of every project
- Study your data with analytical platforms to get the most value out of your project
- Don’t let perfect be the enemy of the good

"Without data
you're just another person
with an opinion."

W. Edwards Deming

“The best way to predict the future is to create it”

— Abraham Lincoln

Thank You!

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- NATIONAL BIM - https://www.nationalbimstandard.org/
- USIBD - http://www.usibd.org/