



Utilizing 3-D Models for Better Bridge Asset Inspection and Management

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Why Use 3D Models?

- We are nearing the End of an Era
 - Relied solely on “Paper” for years, as a primary representation for engineering and construction
 - Bridge is still the only industry constructing 3D projects using mainly 2D drawings.
- We need a Fundamental “Re-Thinking” of the antiquated processes that are still being used in bridge projects



The world is becoming **INSTRUMENTED**



The world is becoming **INTERCONNECTED**



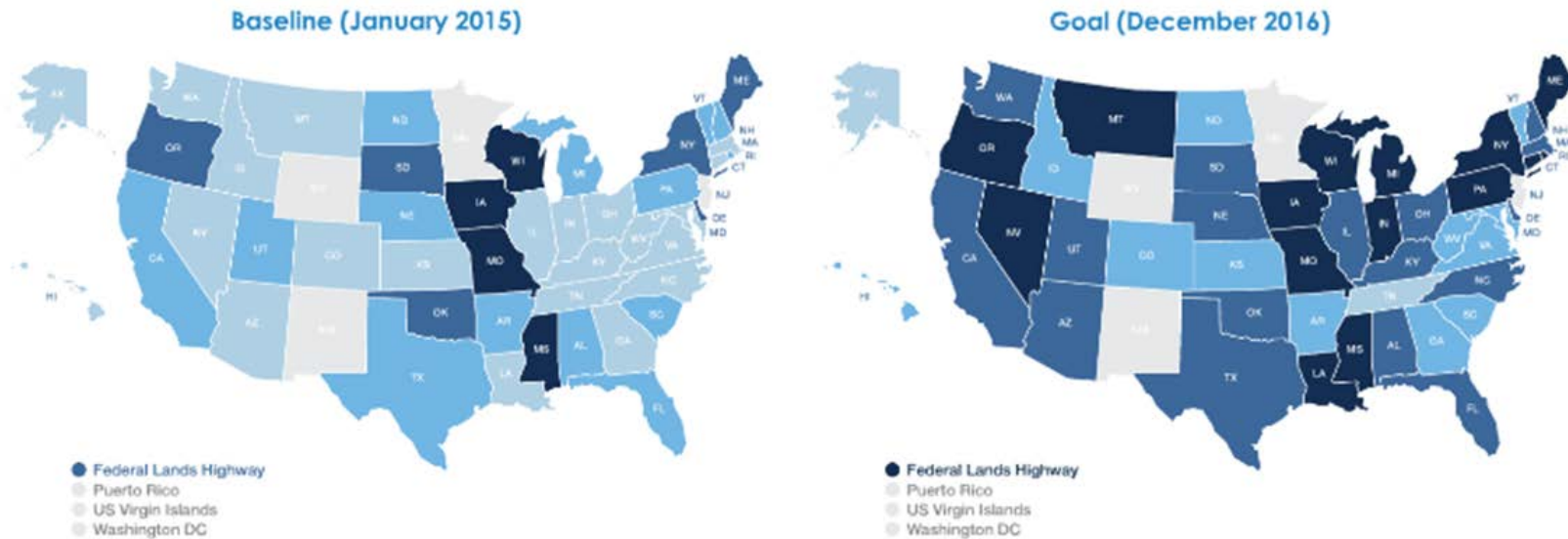
The world is becoming **INTELLIGENT**



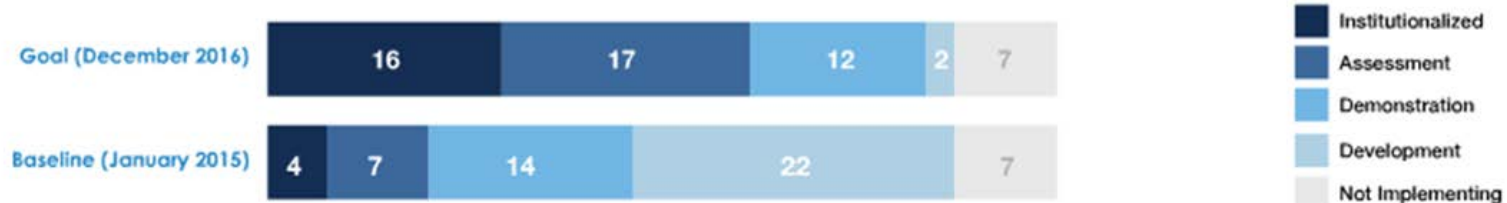
3D Modelling At US DOT's

3D Engineered Models: Project Planning, Design and Construction

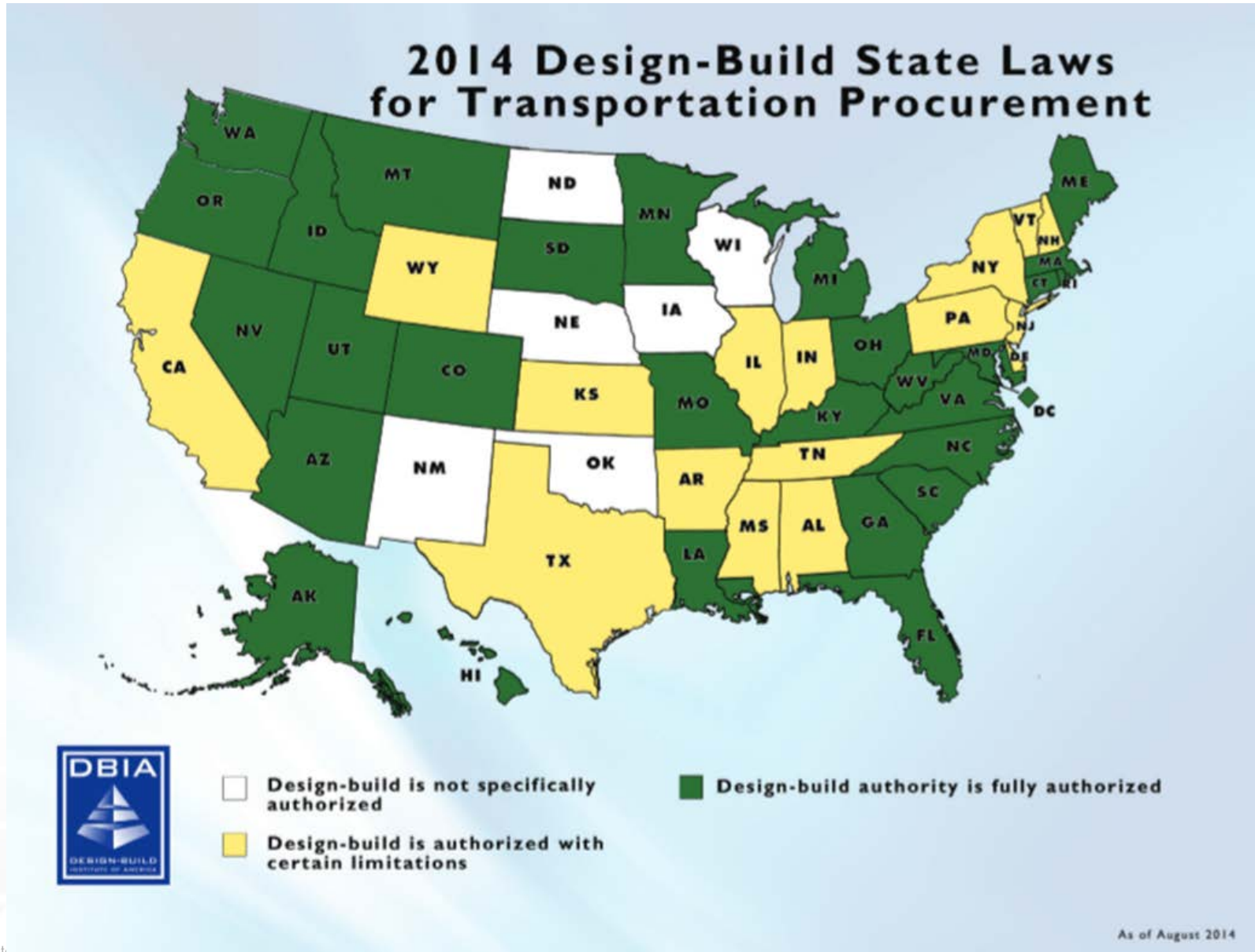
Using 3D engineered models in project planning, design and construction is becoming a widespread practice in the United States, with 29 states planning to implement it in 2015 and 2016. An additional 15 states and Federal Lands Highway plan to integrate 3D modeling in planning, design and construction into highway agency culture by the end of the two-year EDC-3 cycle.



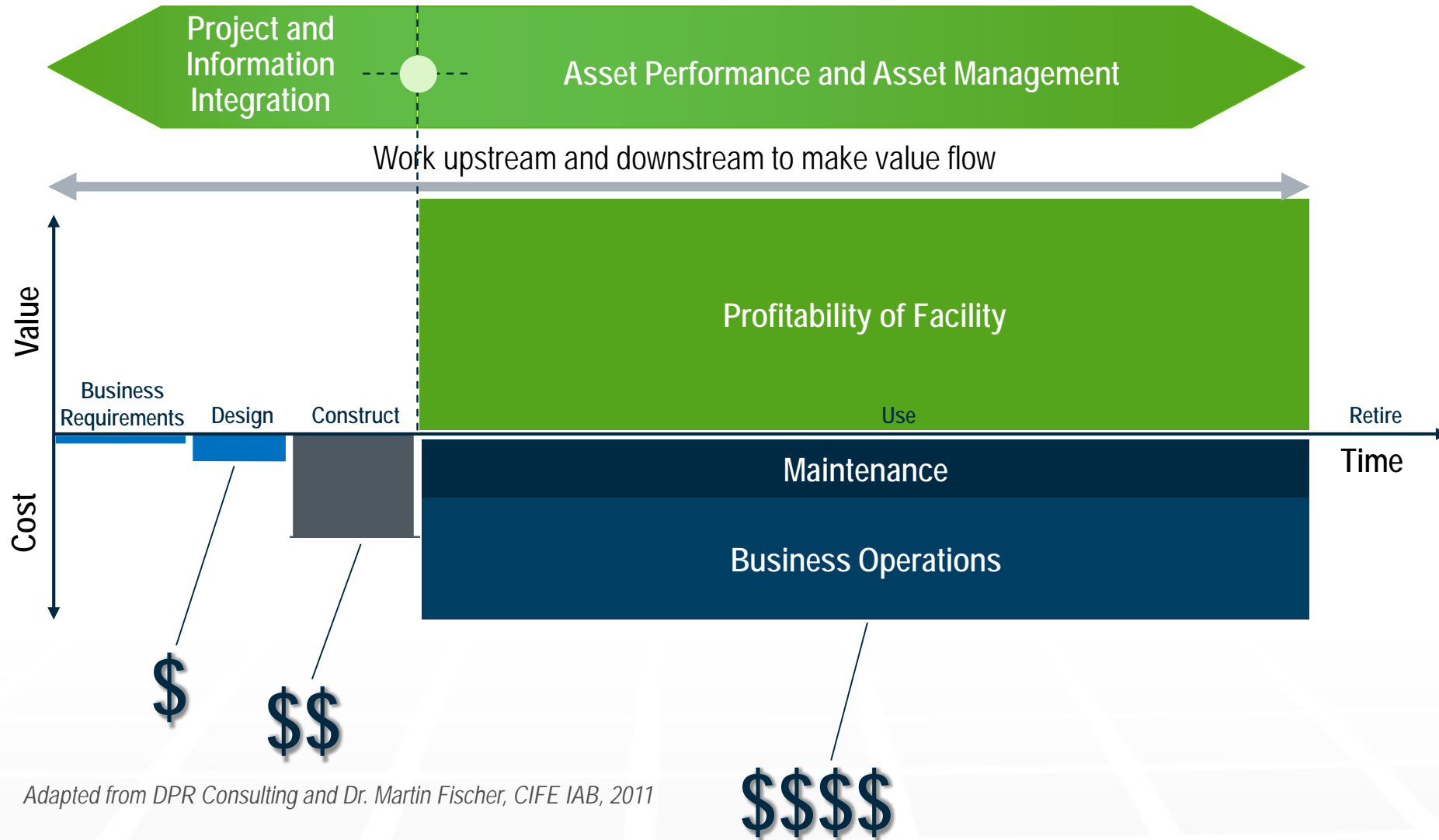
Number of States in Various Implementation Stages



Contracting Trends At US DOT's



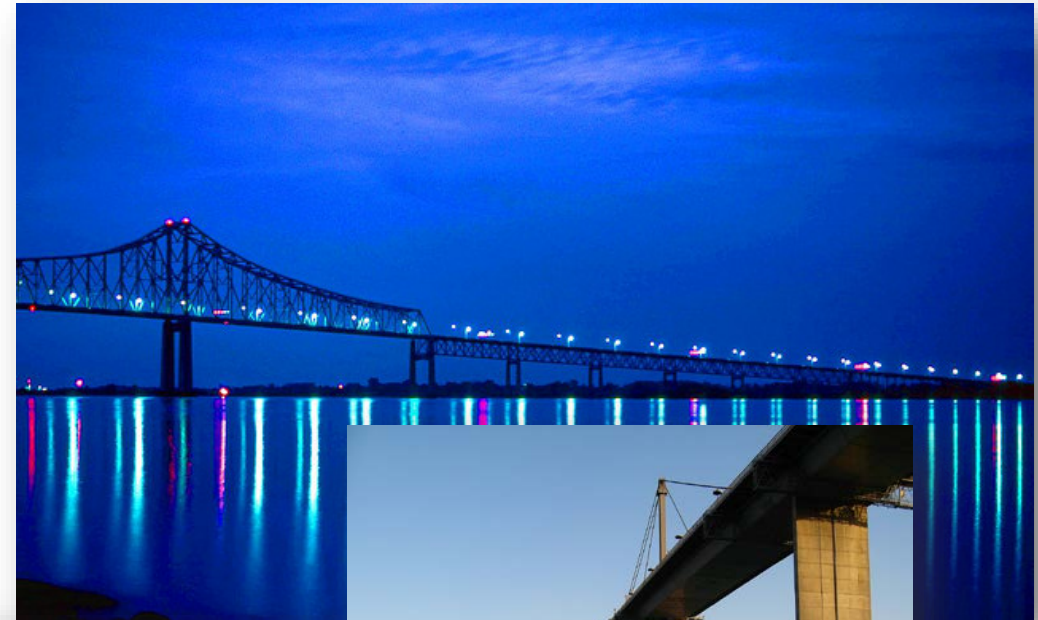
Whole Life Value



Adapted from DPR Consulting and Dr. Martin Fischer, CIFE IAB, 2011

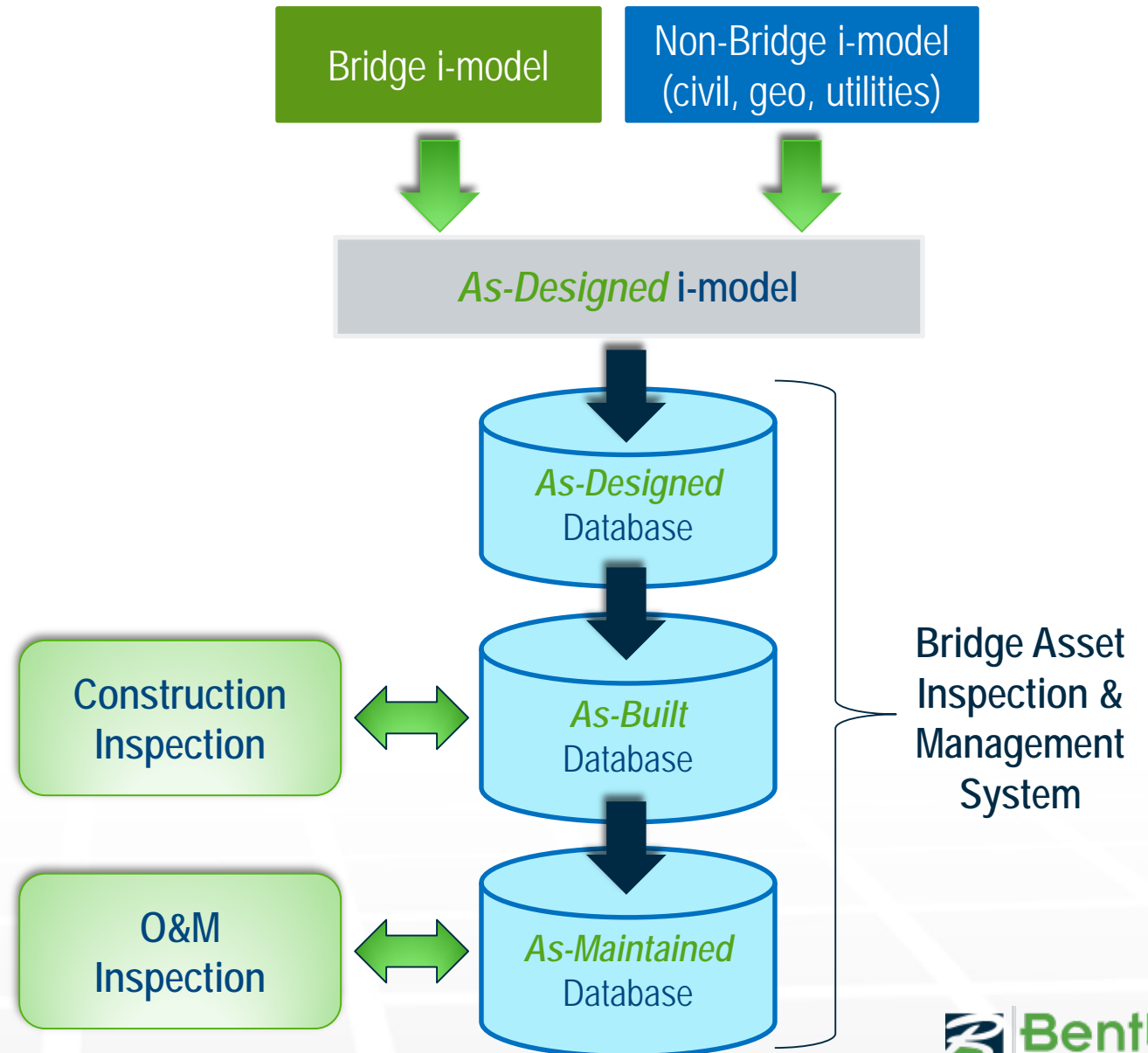
Complex Bridge Inspection & Management

- Complex bridges can have *enormous* amounts of *data* that needs to be *collected* and *organized*.
- Requires the ability to collect specialized data for different *component types* and trades (electrical, mechanical, etc.).
- A necessity to have access and *reference* to large volume of *pictures, sketches*, and other electronic files that may be stored in multiple locations
- Usually contains a massive amount of *historic data*



As-Designed → As-Built → As-Maintained

- Import *As-Designed* i-model into BIMS and create a new Asset, in the “under construction” status.
- Capture construction information with Field Inspection mobile tablets to create an *As-Built Database*
- Once construction is completed, move asset into “active” status.
- Proceed with O&M inspection, for an *As-Maintained* Asset




Element Based Bridge Detail

Ability to drill down to bridge, span, superstructure, main span, verticals, north truss and whatever specific parts required.

The screenshot displays the BridgeInspect Collector web application interface. The browser window title is "BridgeInspect Collector - Windows Internet Explorer" and the address bar shows "http://drpa.bridgeinspect.com/manageassets.aspx". The application header includes the "StructureSuite" logo and the text "DRPA Bridge and Structure Inspection System". Below the header, there are navigation tabs for "Main", "Administration", "Views", "GIS", and "Help". The main content area is titled "Manage Assets and User Assignment" and features a "Filter Assets:" input field with a "Filter" button. The primary focus is a hierarchical tree view of assets. The tree starts with "All Assets" and branches into "Commodore Barry Bridge". Under "Commodore Barry Bridge", there are sub-nodes for "Spans", "Deck", and "Superstructure". The "Main Thru Span" node is expanded, showing "Verticals" and "North Truss". The "North Truss" node is further expanded, displaying a list of verticals labeled "U18-L18" through "U35-L35". A red arrow points from the "Main Thru Span" node in the left pane to the "North Truss" node in the right pane, illustrating the drill-down capability.

Extensive Structure Details



Main Administration Views

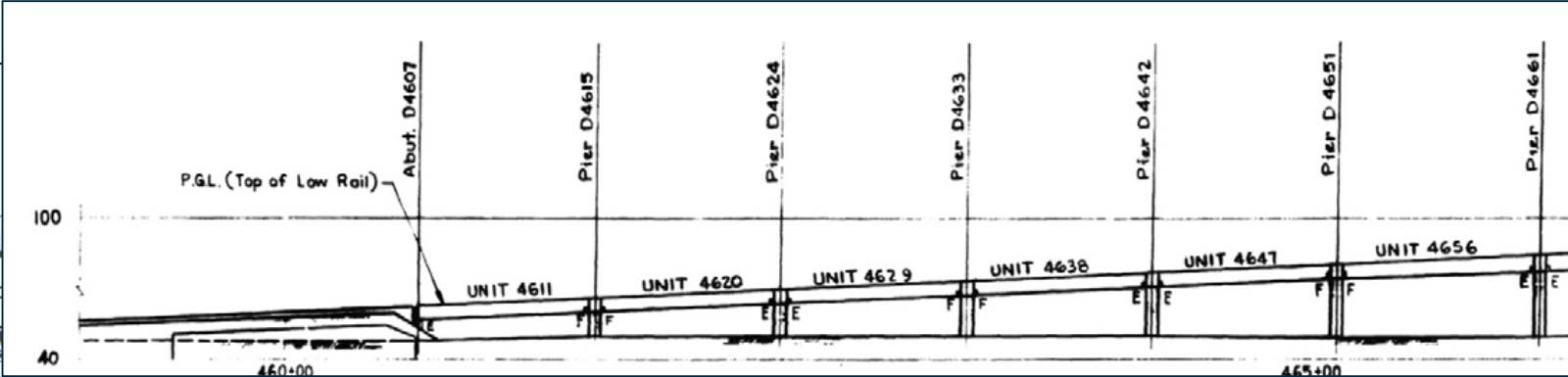
Minnesota Avenue Aerial Struc

Inspection Date	Asset Code	Asset Name	Owner	Asset Type	Submitted To	Status
12/08/2009	Minnesota Avenue Aerial Structure	Minnesota Avenue Aerial Structure	Webb, Gerald	Bridge	Approved on 6/24/2010	X

Minnesota Avenue Aerial Structure Sub-Assets:

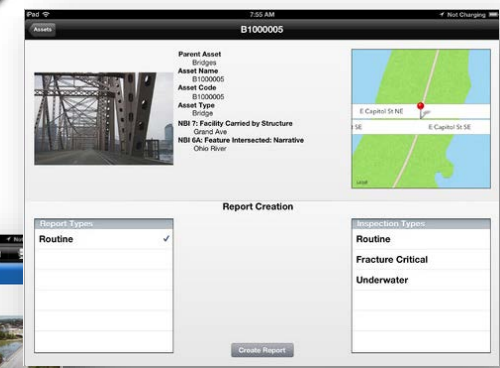
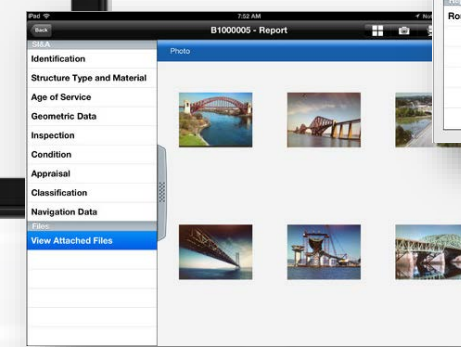
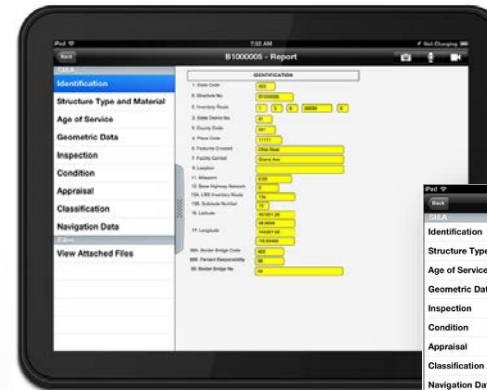
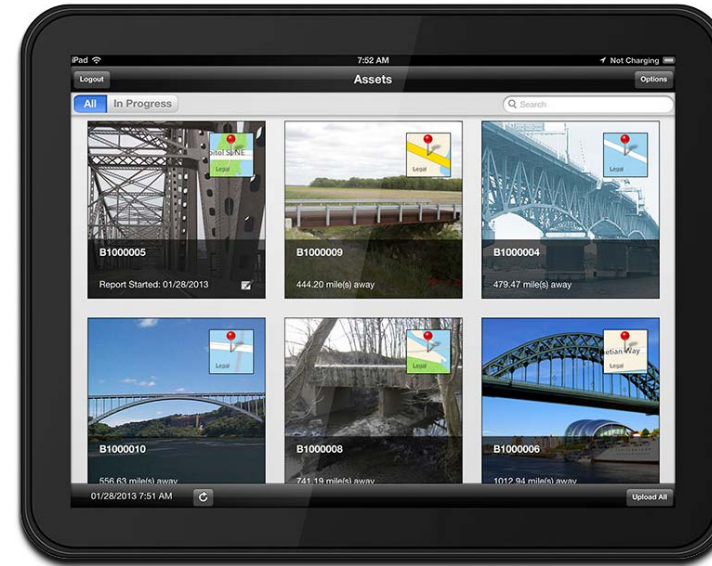
Show Assets in by Displayed Inspection Type:

Inspection Date	Asset Code	Asset Name	Sub-Assets	Owner	Asset Type	Submitted To	Status
12/08/2009	1116600	Abutment 2432 IB&OB	None	Webb, Gerald	Bridge	Approved on 6/24/2010	X
12/08/2009	1116700	Span 2437 IB	None	Webb, Gerald	Bridge	Approved on 6/24/2010	X
12/03/2009	1116800	Span 2437 OB	None	Limones, Jose	Bridge	Approved on 6/24/2010	X
12/03/2009	1116900	Crossbox/Pier 2442 IB&OB	None	Limones, Jose	Bridge	Approved on 6/24/2010	X
12/08/2009	1117000	Span 2447 IB	None	Webb, Gerald	Bridge	Approved on 6/24/2010	X
12/03/2009	1117100	Span 2447 OB	None	Limones, Jose	Bridge	Approved on 6/24/2010	X
12/03/2009	1117200	Crossbox/Pier 2452 IB&OB	None	Limones, Jose	Bridge	Approved on 6/24/2010	X
12/08/2009	1117300	Span 2457 IB	None	Webb, Gerald	Bridge	Approved on 6/24/2010	X
12/03/2009	1117400	Span 2457 OB	None	Limones, Jose	Bridge	Approved on 6/24/2010	X
02/04/2010	1117500	Crossbox/Pier 2462 IB&OB	None	Webb, Gerald	Bridge	Approved on 6/24/2010	X
02/04/2010	1117600	Span 2467 IB	None	Webb, Gerald	Bridge	Approved on 6/24/2010	X
12/07/2009	1117700	Span 2467 OB	None	Limones, Jose	Bridge	Approved on 6/24/2010	X



Tablet Field Data Collection

- Allows inspectors to spend more time in the field and less time writing reports
- Advanced mobility for inspectors in the field
- Sleek, intuitive graphical interface
- Enables offline data collection
- Capture photos, video, audio and GPS information
- Cloud service synchronization with home system



Capture & Reference Geolocated Media

Tap the camera icon to add a new picture

Tap Use Photo to attach it to the field

Type any description or notes

Retake Use Photo

Back

Image

Description

File Type
Photo

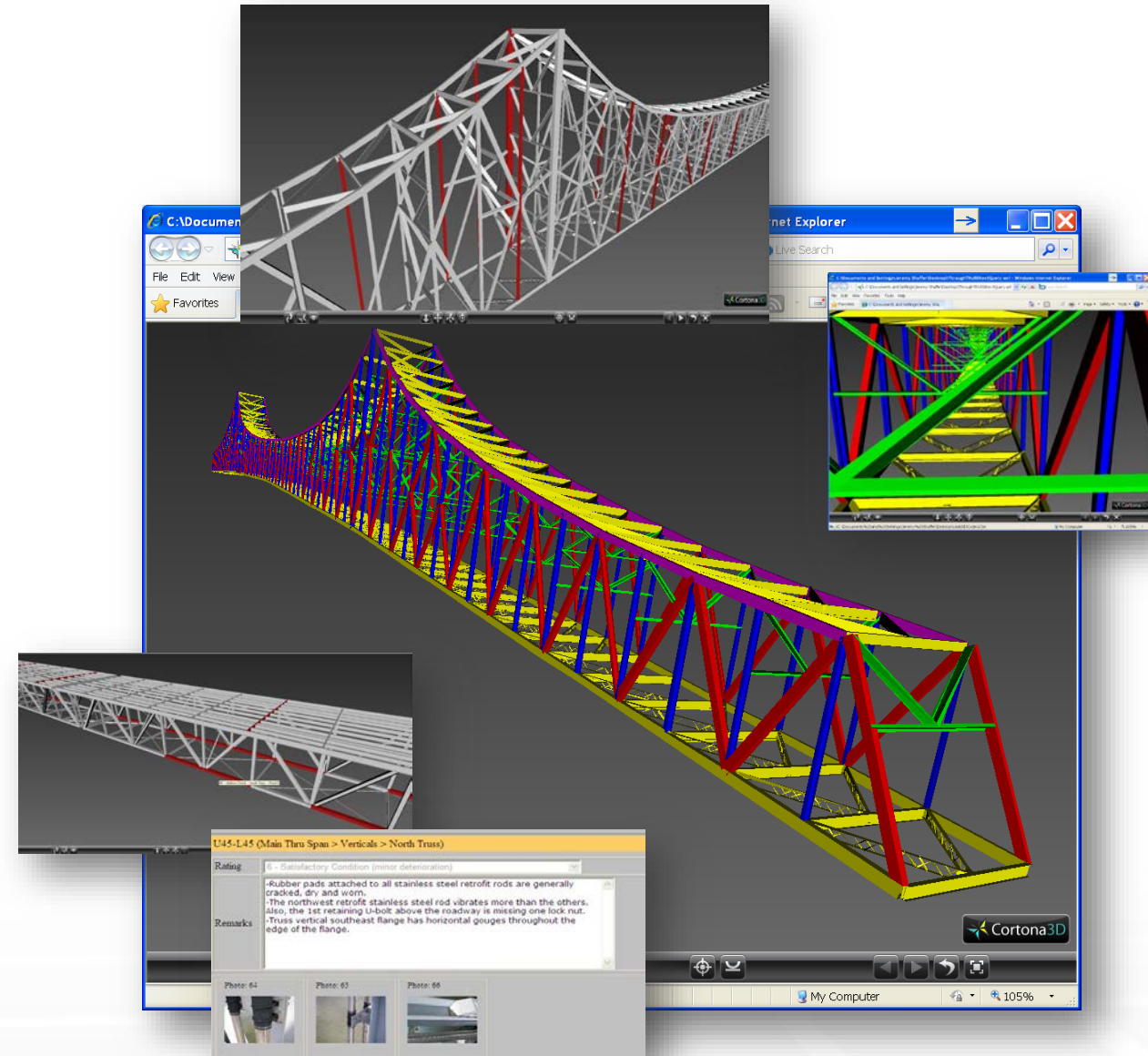
Categories
None

PDF Options
Set As Cover
Include in Printed Report

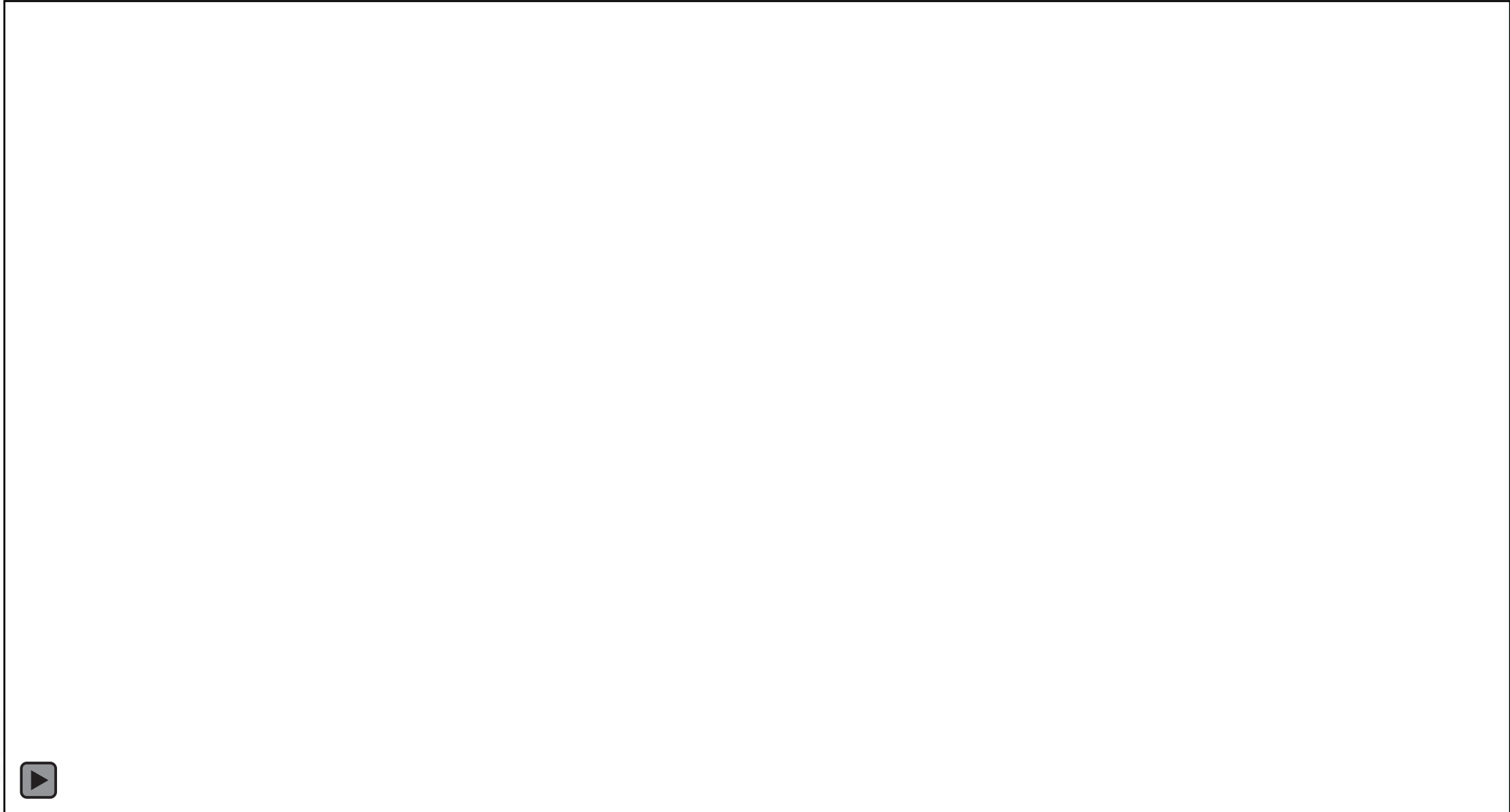
Photo

3D Comprehensive Models

- Reuse analytical or As-Build 3D Solid Model
- Represent only the details that user cares about
- Utilize color for different layers – condense to single color for search results
- Ability to turn on/off layers
- Information all driven off database and web-interface

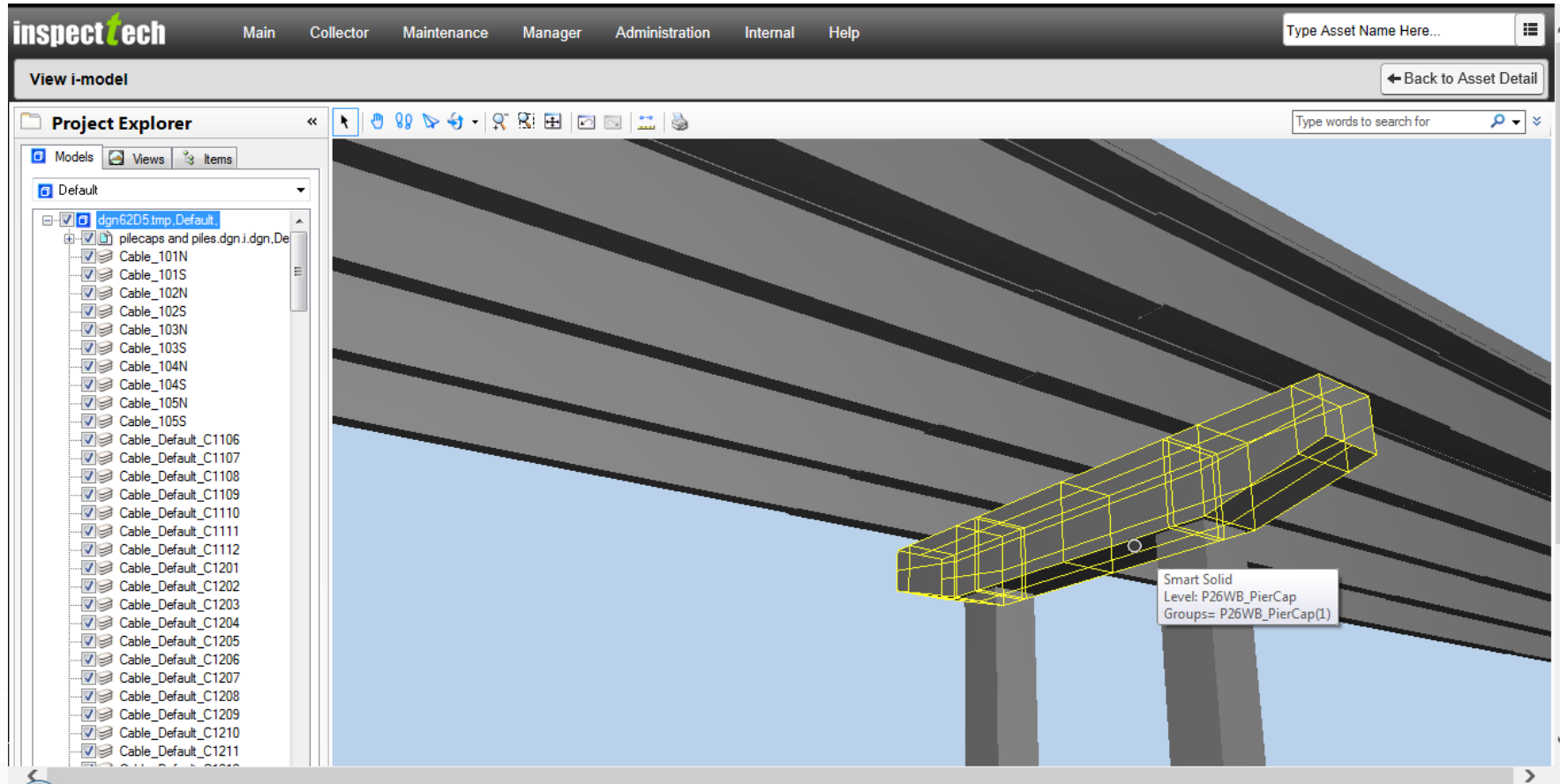


Integration Of 3D Models



Interactive Inspections

- Collect and report condition data at the component level



Interactive Query Results On The 3-D Model

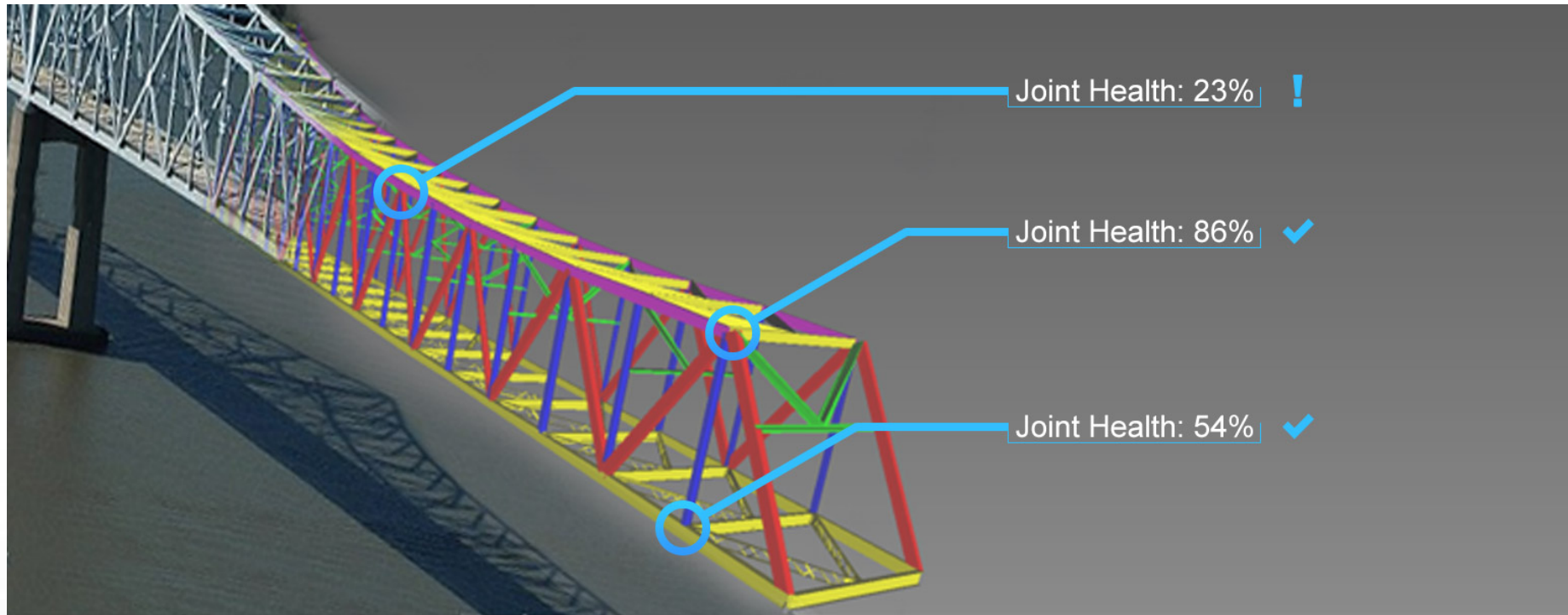
The screenshot displays the BridgeInspect Manager web application interface. The browser window title is "BridgeInspect Manager - Windows Internet Explorer". The address bar shows the URL: http://drpa.bridgemanage.com/cad_query_result.aspx?CADSQGUID=d5a6ea5. The page header includes the Delaware River Port Authority logo and the text "Bridge and Structure Inspection Management System". The date "Friday, March 11, 2011" and "Messages: 0 new (view)" are displayed. The main navigation menu includes "Main", "GIS", "Query", "Reports", "Administration", and "Help". The "StructureSuite" logo and "inspecttech" branding are also present. A "Quick Select" field is available with the placeholder text "Type asset name here" and a "View asset" link.

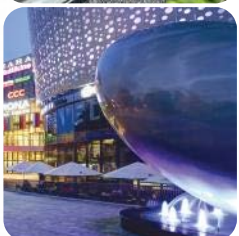
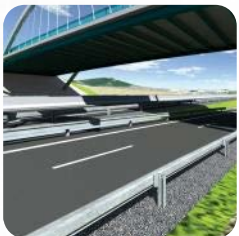
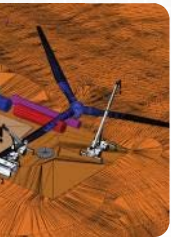
The central 3-D model shows a complex truss structure with several vertical members highlighted in red. Below the model is a toolbar with various navigation and viewing controls. A detailed query results panel is overlaid on the right side of the screen, showing the following information:

- Asset Path:** U45-L45 (Main Thru Span > Verticals > North Truss)
- Rating:** 6 - Satisfactory Condition (minor deterioration)
- Remarks:**
 - Rubber pads attached to all stainless steel retrofit rods are generally cracked, dry and worn.
 - The northwest retrofit stainless steel rod vibrates more than the others. Also, the 1st retaining U-bolt above the roadway is missing one lock nut.
 - Truss vertical southeast flange has horizontal gouges throughout the edge of the flange.
- Photo Gallery:** Three photo thumbnails are displayed, labeled "Photo: 64", "Photo: 65", and "Photo: 66".

Visual Display Of Critical Information

- i-Models support encapsulation of all data from simple to complex asset





Case Studies

Tappan Zee Bridge



Unique Project Requirements

- For the first time, an entire section (28.7) dedicated to providing a 3-D GIS spatial model of the project:
 - Table-based line items for all parts (AASHTO Guide Manual for Bridge Element Inspection 1st edition; 2011)
 - Unique Reference Identifier – linked to the design model
 - Groupings/Sub-groupings/Sets of relevant parts
 - Specifications, Ratings, and/or Maintenance records associated with the part
 - Spatial support : X,Y, N, S, Beg/End, Span #, Barrier #, EB/WB, NYSDOT standard inspection orientation
 - Etc.



New York State Thruway Authority

**TAPPAN ZEE HUDSON RIVER CROSSING
PROJECT**

DB CONTRACT DOCUMENTS PART 3

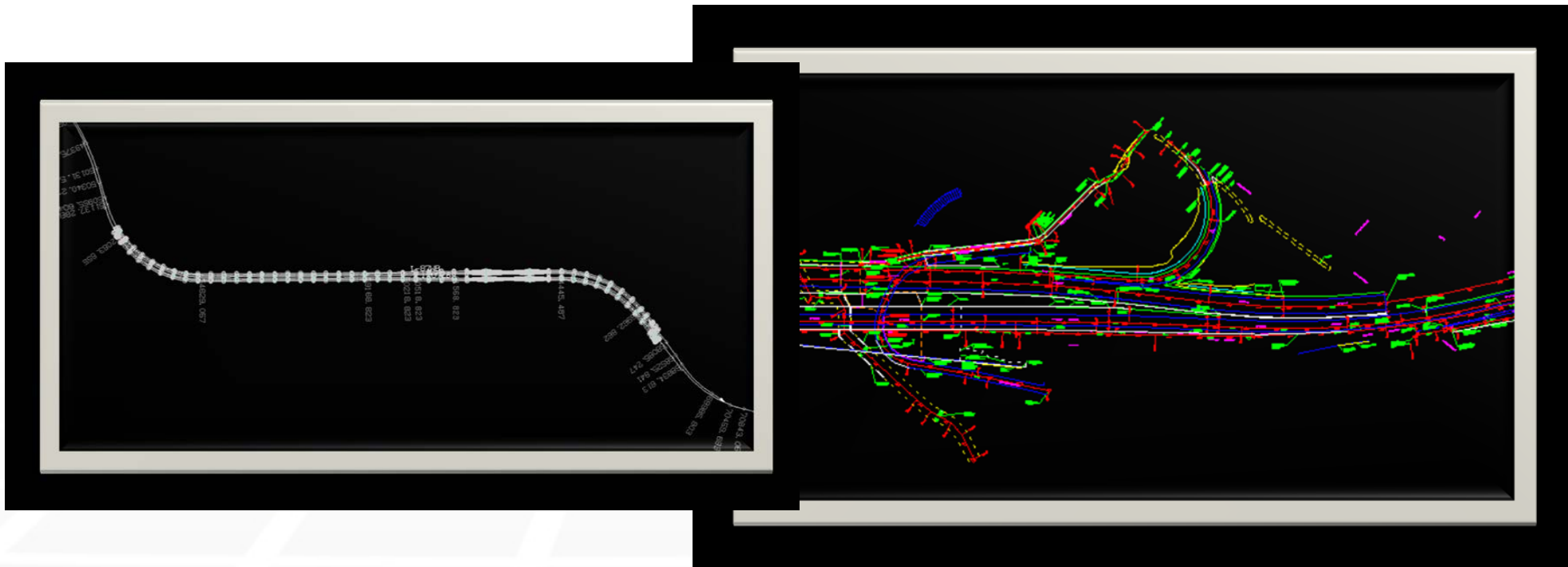
PROJECT REQUIREMENTS

CONFORMED
November 21, 2012

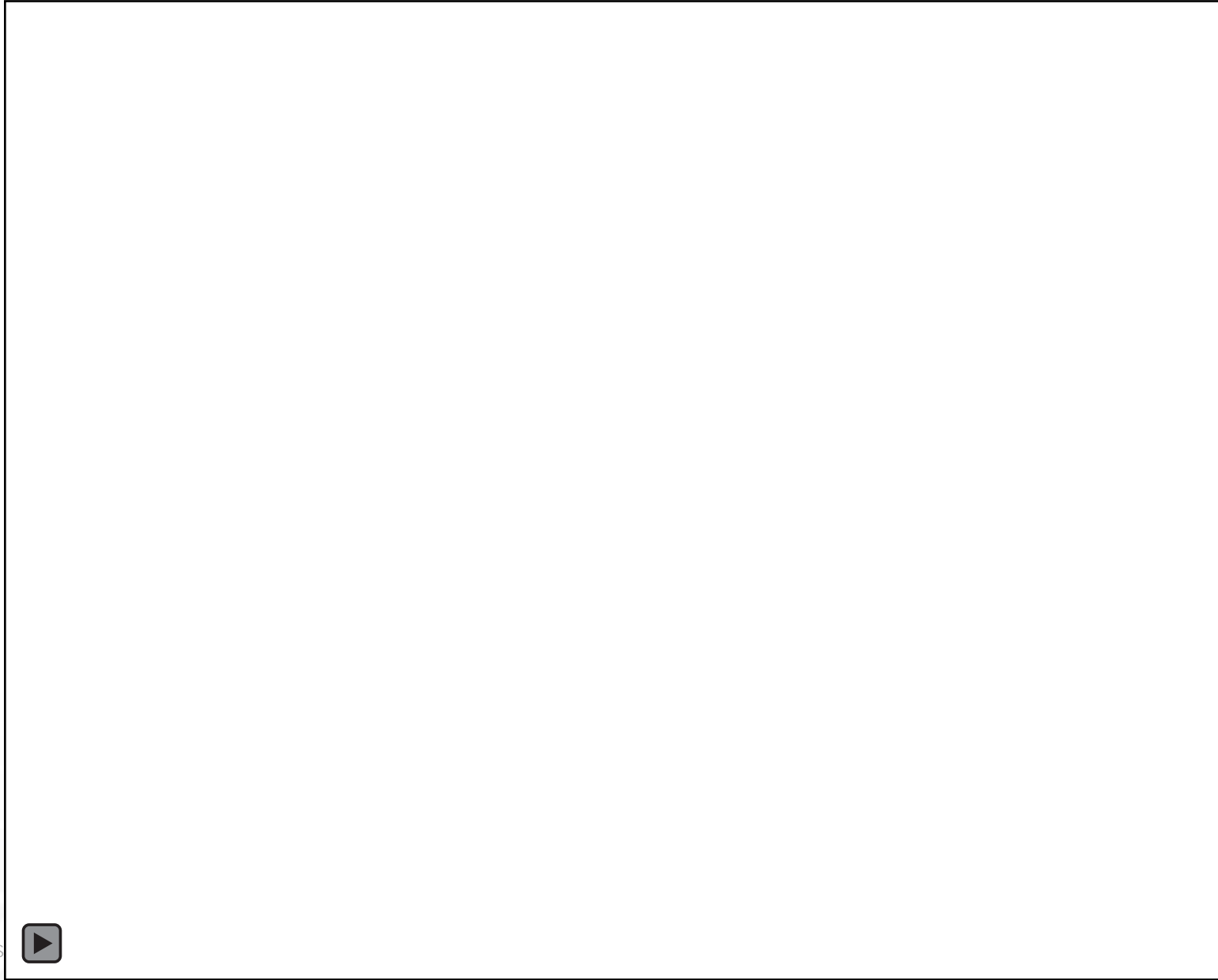
Contract D214134
PIN 8TZ1.00
Project TA#: TANY 12-18B

As-Designed Geo-Referenced Database

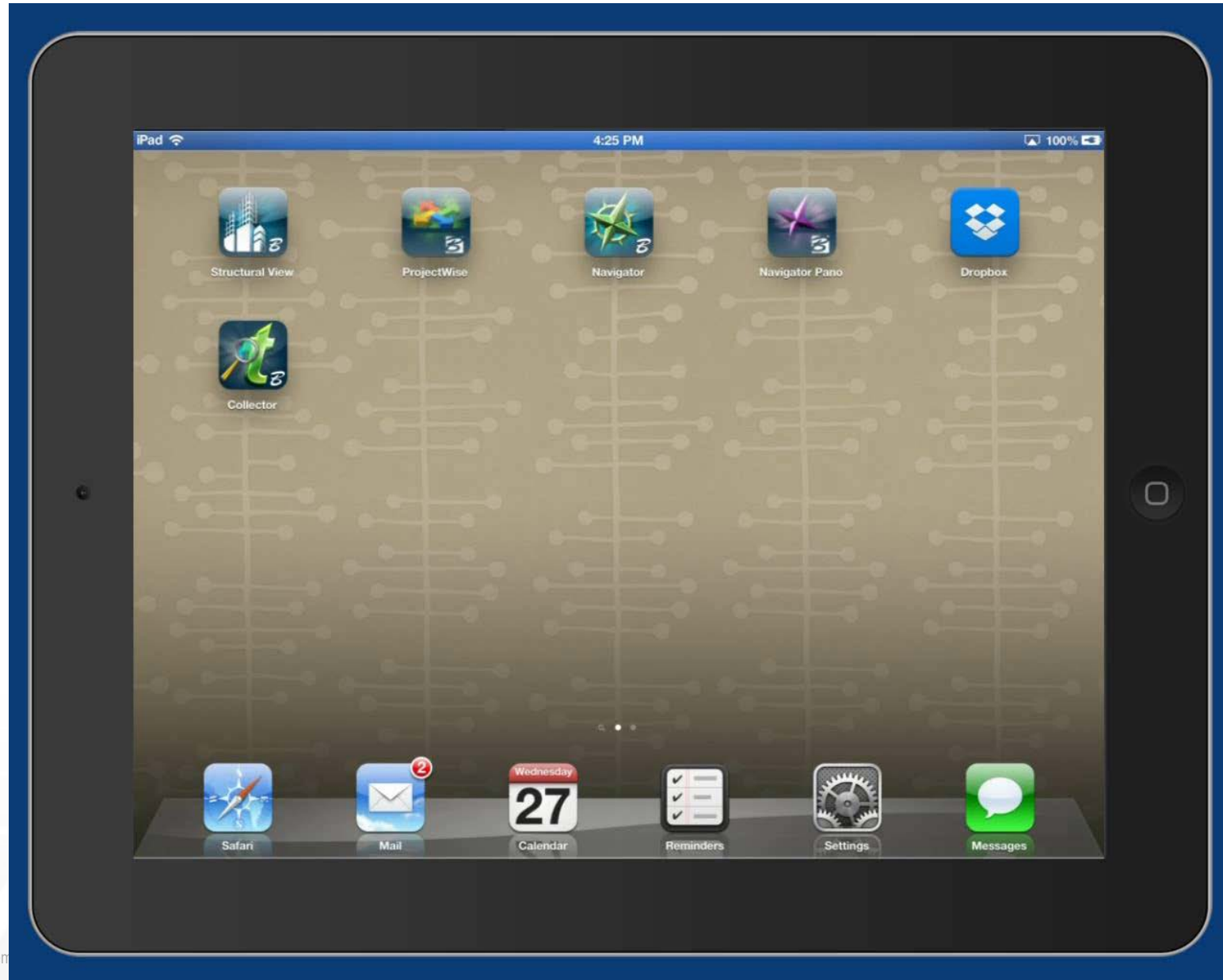
- Design Models – Civil / Roadway
 - Roadway Geometry (Alignment / Profile / Super elevation) models
 - Information used by other Design Teams

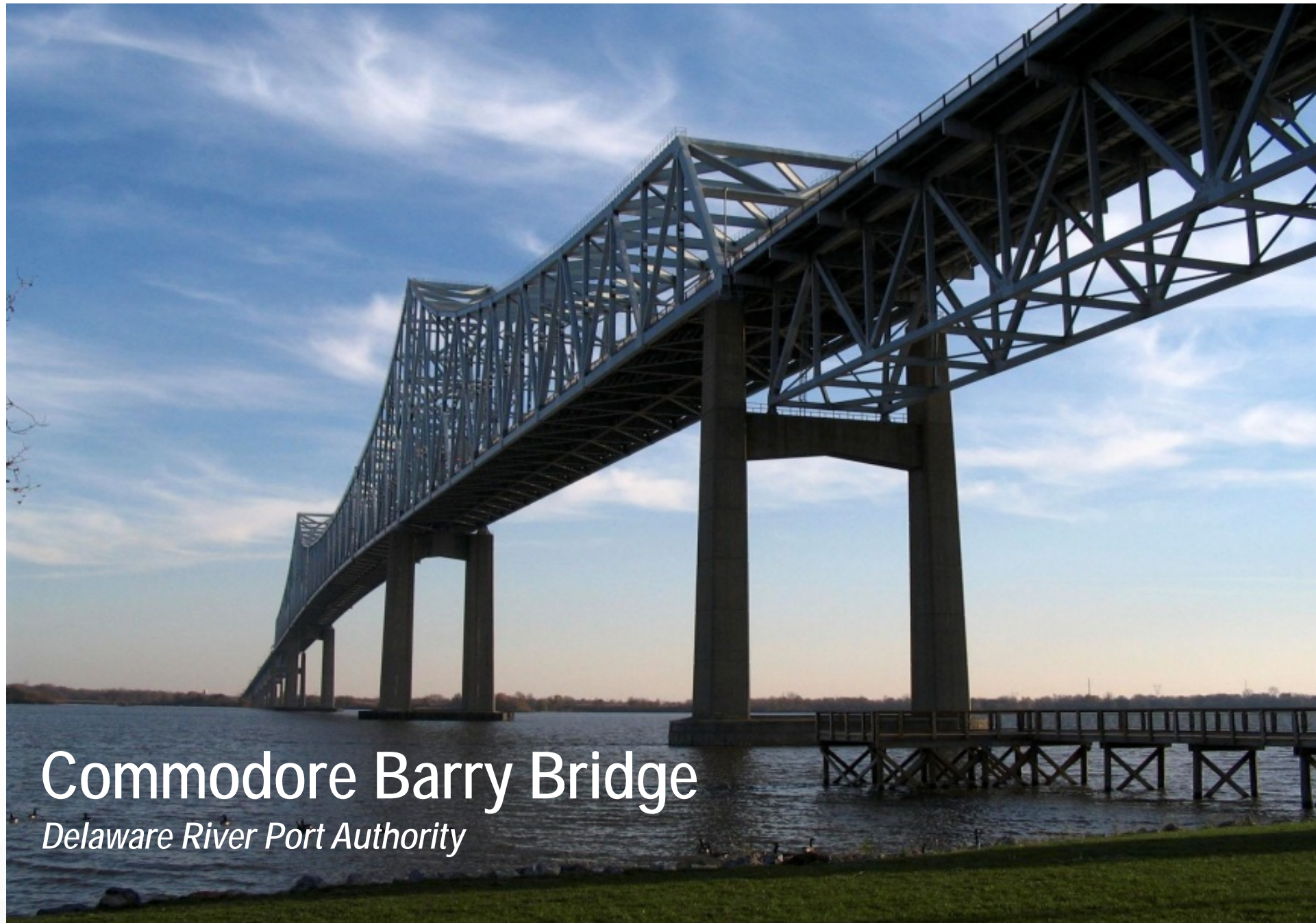


Project Hybrid Model



Mobile Inspection





Commodore Barry Bridge

Delaware River Port Authority

Existing Conditions

- Maintained by Delaware River Port Authority
- Longest cantilever through truss bridge in the U.S. (4th longest in the world)
- In-depth inspections once every two years

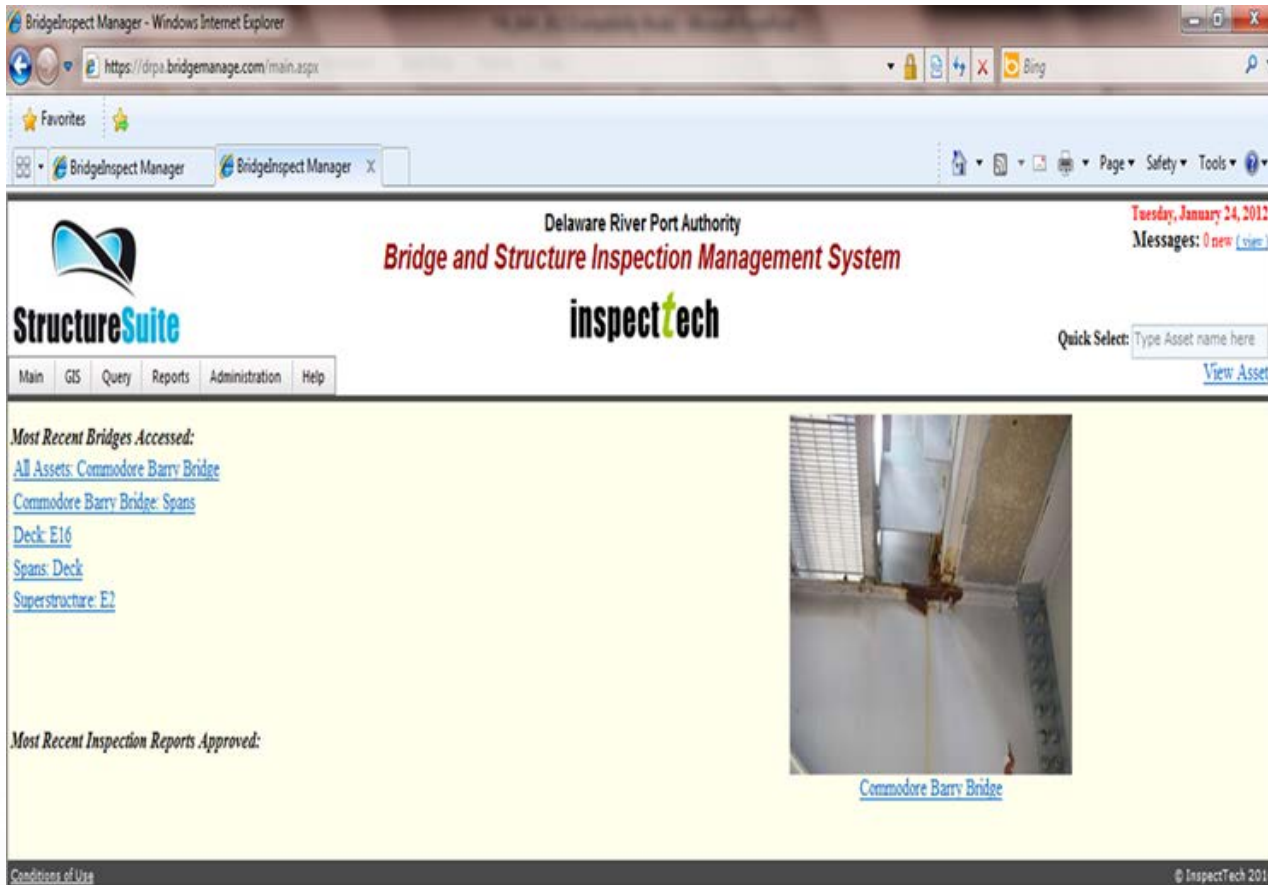


Original Inspection System

- Combination of paper and very limited computer databases
- Databases not integrated – manual entry of data in multiple locations (also certain data submitted to PennDOT and NJDOT systems)
- Narrative data kept in printed folders or computer hard drives
- Time-consuming task of manually retrieving data from multiple hard copies and databases
- Each biennial inspection report is $\pm 2,000$ pages
- Nearly impossible to manually query from paper reports

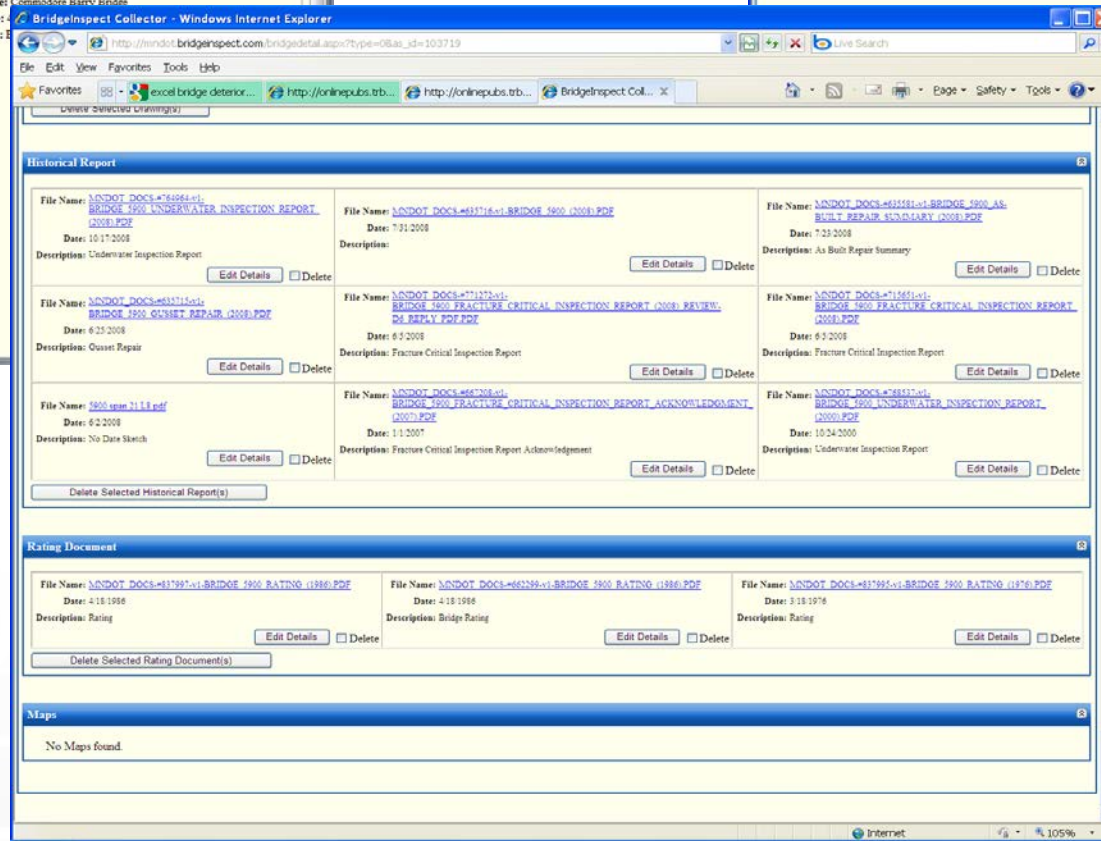
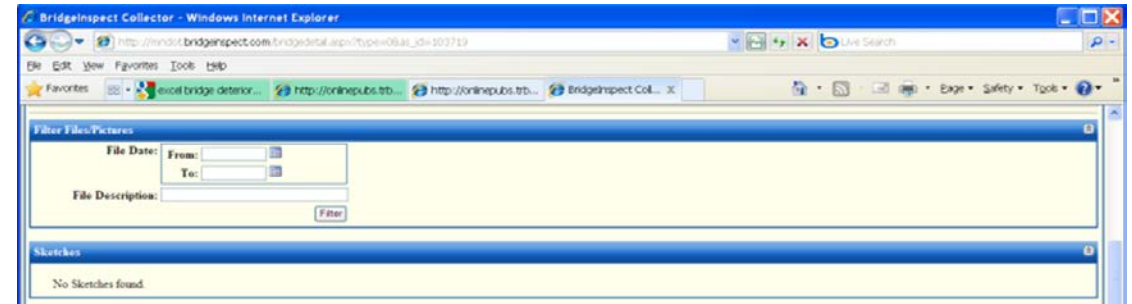
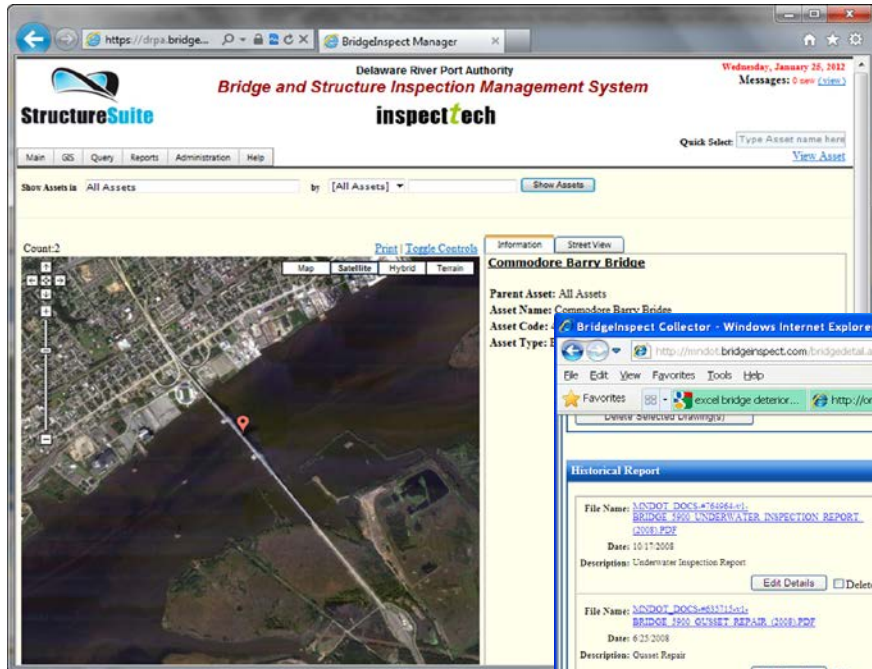


Modern System



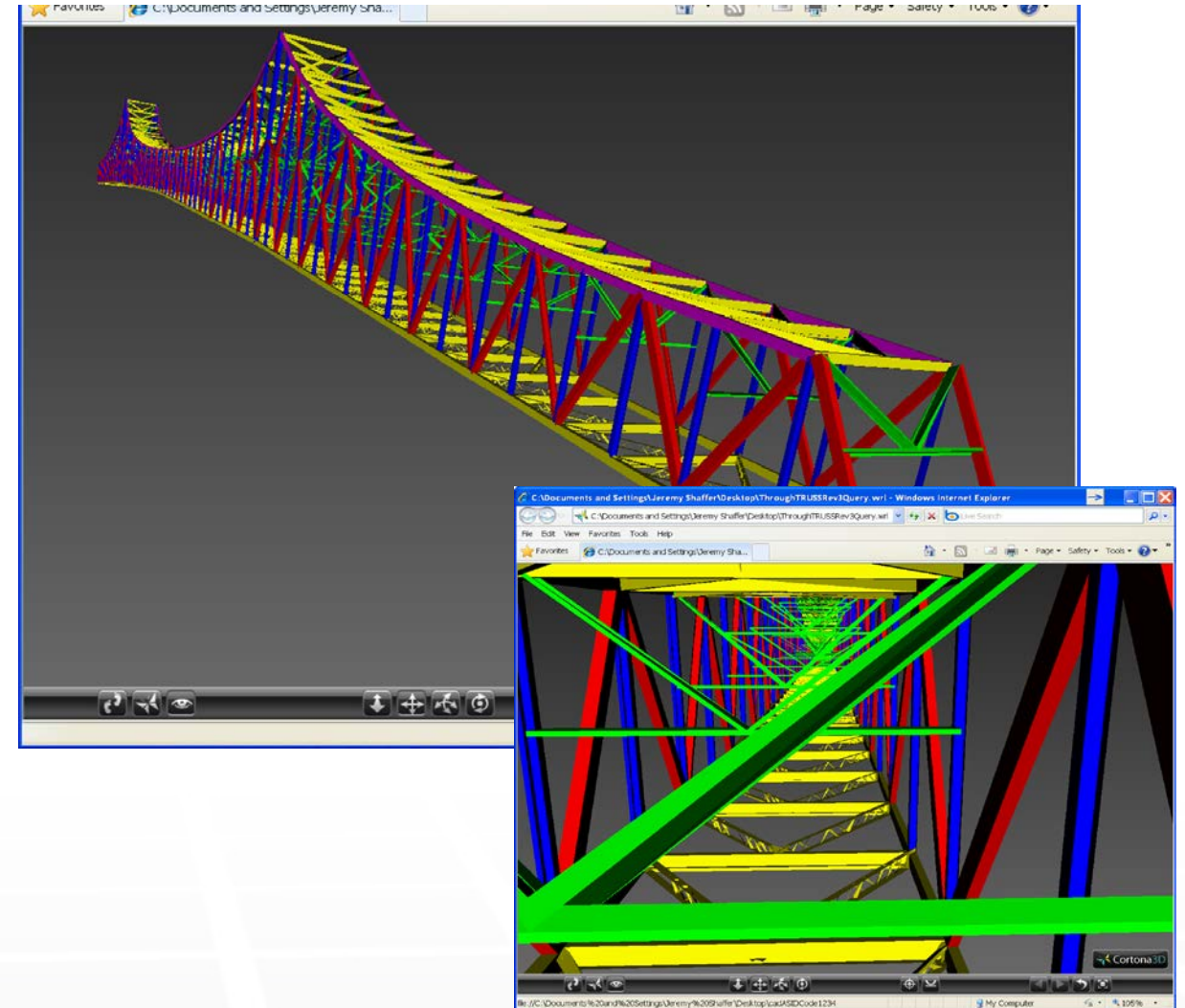
- The new system that *integrates data* from a *variety of sources*
- Fully supports *multiple* types of *inspection forms*
- Ability to allow all *other information* to be *linked* and stored in “central source of truth” location
- *Tablet* based field data collection
- Users can directly *add files*, historic data, or day-to-day *maintenance tasks* into the system

Central Repository



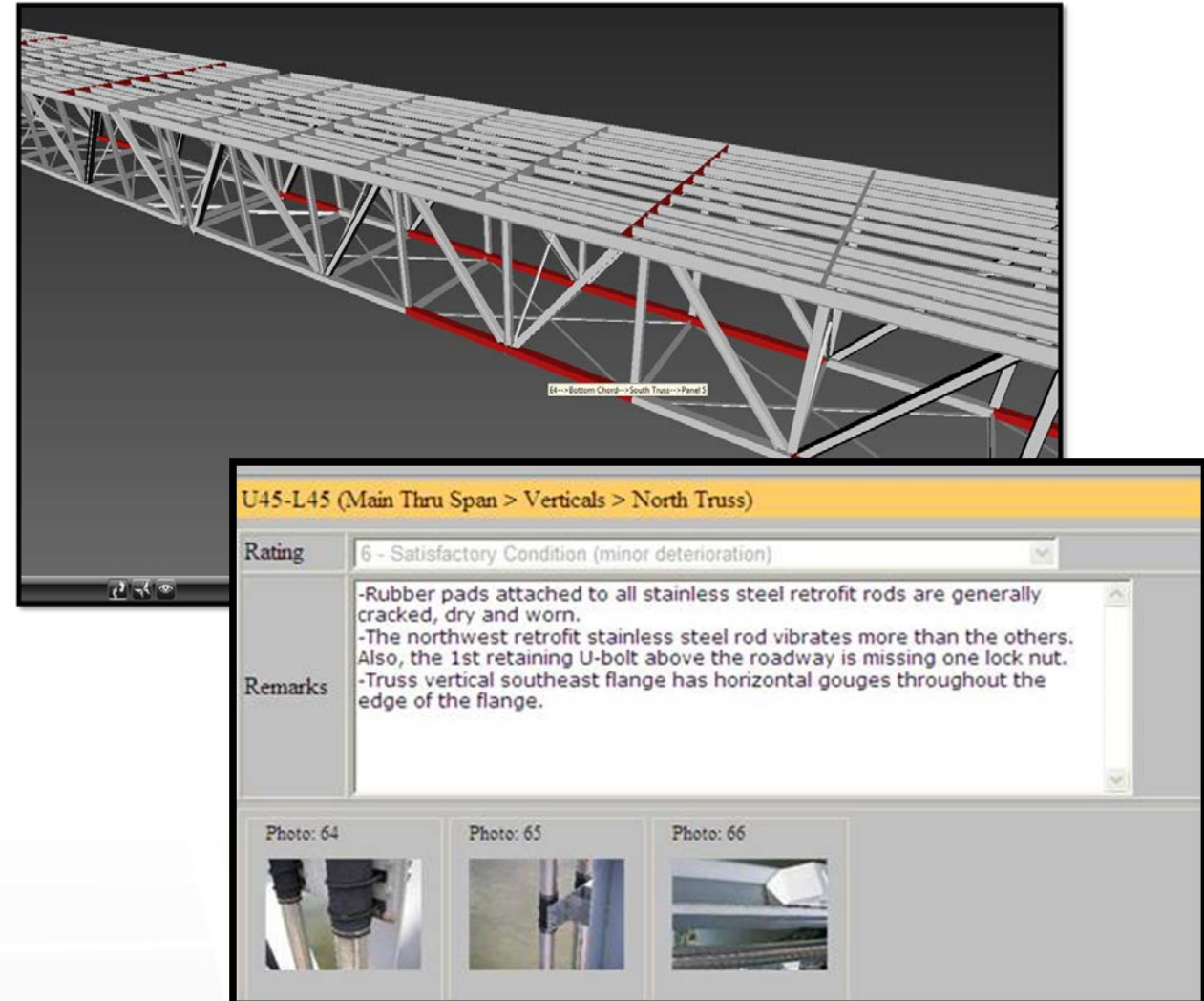
3D Model Capabilities

- Represents *only* the *details* that are *important*
- *Problem areas* and component relationships can be *seen quickly* and easily
- Utilizes *color for different layers*, or condense to single color for search results
- Ability to *turn on/off* layers of complexity



Powerful Query Capabilities

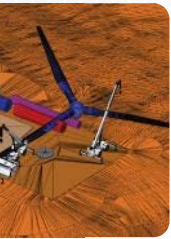
- Allows for full searching using ad-hoc query tools to return the exact data users are interested in
- Search by entire structure, span or specific component type
- Can combine fields and criteria as needed to make simple or complex queries using Boolean logic (AND, OR, etc.)



Advantages Of 3D Models For Bridge Inspection

- Provides a clear, and *interactive spatially located* visual reference of the bridge and its elements
- Model is *linked to report data, historic data*, uploaded and attached files, or any other crucial information (inspections, as-built drawings, load ratings, work orders, etc.).
- Ability to *continually add valuable historical information* connected to 3D model.
- Information *can be taken mobile*, as a 3D model
- One "*single source of truth*" to find all the information





Thank You!

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