Today's trending design concept, evolving to be tomorrow's standard design practices.
History of 3D Substation Design
Version 1.0 – 11 Years ago

Substation designed in AutoCAD (2009)

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» Version 1.1 – Permitting Support

Permit support created in AutoCAD (2010)  

Permit support Created in Inventor (2014)
Version 1.2 - Pilot Program (2014-2015)

- Objectives
  - Evaluated Market Conditions
  - Evaluated 3D Software Packages
  - Began doing cost and time comparisons
  - Collaborated with the IT department for computer hardware requirements
  - Determined target clients
  - Developed a short form business plan
» Version 1.2 – 3D Design vs. 2D Design

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» Version 1.3 – What we are currently doing?
  – Started 3D Design Committee Version 2.0
    • Defining standards/processes
    • Evaluating Additional 3D Software Packages
  – Where will we take the next generation of 3D design?
Example Projects
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Section's from 3D Model
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Comparison of 2D vs 3D

2D representation of an elevation view

3D isometric view extracted from a 3D model
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| Item | Description                  | Qty | REV
|------|------------------------------|-----|-----
| 1    | 305  | 1/2" O.D. PVC, COMPRESSION, CABLE TO 1/4" HOLE PAD  |     |     
| 2    | 306  | 1/4" O.D. PVC, 1/4" HOLE PAD W/ BUNG & W/ HOLE PAD W/ BUNG |     |     
| 3    | 307  | 1/4" O.D. PVC, 1/4" HOLE PAD W/ BUNG, W/ HOLE PAD W/ BUNG |     |     
| 4    | 308  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 5    | 309  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 6    | 310  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 7    | 311  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 8    | 312  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 9    | 313  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 10   | 314  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 11   | 315  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 12   | 316  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     
| 13   | 317  | 3/8" CABLE TO RELAY, 3/8" O.D. PVC, TO 3/8" HOLE PAD W/ BUNG |     |     

Note: Dimensions, quantities, and descriptions are not fully visible or legible in the provided image.
• Permitting Process
• Design Accuracy
  • Sections/Elevations
  • Details
  • Steel Design
• On-site Construction Aid
• Clearance Checks
• Auto-populated bill of materials
• Increased efficiency
• Single file contains the full design
  • Changes will automatically be reflected across all drawings
• Accurate bidding process
• WOW factor
• Proper workflow
• 3D Vendor Equipment
  • Format
  • File Size
  • Availability
• Training
• Industry knowledge
• Templates
• Drafting Standards
• Record Drawings
• Library – 3D file storage
• Autodesk Inventor 2019
• Substation Design Suite (Spatial Business Systems)
• Bluebeam Revu 2019
• BIM for Substations
  • Links within the models and drawings
  • Real-time data for substation equipment
  • On-site photo links
  • Vendor drawing links
  • Future possibilities are endless!?!?
3D SUBSTATIONS
Design & Construction
Presented by: Ryan Brorby, P.E.
3D Substation Construction
Overview

- Permitting Process
  - 3D renderings
- Design
  - Drawing creation
- Construction
  - Utilizing 3D
- Post Construction
  - 3D as-built drawings
Permitting Process: 3D Renderings

Benefits of 3D

- Local governments
  - Provides visual of final product
  - Offers better communication
  - More efficient (faster approvals)
- Urban designs
- Community members
  - Neighbors
Rendering Example
3D Construction

Why 3D construction?

- Successes on design/permitting side
- Involvement of operations in 3D
- Potential Efficiencies
  - Work order packages
  - Deliverables
  - Construction
Software Considerations

Autodesk Inventor (Minnkota)
- 3D design

Navisworks
- Printing to PDF

Bluebeam (PDF Viewer)
- 3D construction prints
  - 3D model
  - Material list

Autodesk BIM 360
- PDF Viewer
- Additional Cost
- Cloud-based
  - Security concerns
- Widely used in commercial building industry
Hardware Considerations

Mobile Devices for Field Use
- Microsoft Surface (Minnkota)
  - Mobile
  - Touch screen
    - Reduced size
    - No keyboard necessary
  - Acts as laptop for additional uses
- Traditional Laptop
  - Reduced “mobility” on-site
  - No touch screen
  - Plenty of memory

iPad
- Bluebeam constraints
  - Memory limitations
- Loading 3D image
  - Viewer only
3D Design Example on Field Device
Design and Build

Utilizing 3D PDF in field

- Zoom and rotate Image
  - Visually see any section cut
- Equipment & material
  - Additional information
    - Suppliers
    - Ratings
    - Inventory numbers
    - PO numbers
    - Delivery dates
Material

Substation material list
- Use as reference from 3D PDF material items
- Material list created directly from Inventor software
- Includes part numbers
- Improves accuracy of material needed including quantities
Bringing Changes Back to the Office

- As-built drawings
  - Field staff can update easily using mobile device
  - Offers real-time changes
    - Engineering and Operations can both access and review modifications
  - Improves communication
    - Easier to show in a 3D model
Quick update to show different wire
Construction As-Built Example
Pros and Cons of Using Bluebeam for As-Built Drawings

**Pros:**
- Ease of use
- Cost
- Immediate feedback from the field
- Ability to rotate/manipulate model (compatible with CAD)
- Response time is reduced
- Savings due to increased accuracy of markups

**Cons:**
- Accessibility of data (Wifi)
- Tools must be supported (IT)
- Lack of technical savvy
- Additional training is required (crews)
3D Construction
Before & After
3D Construction
Before & After
Design versus Build: Easy to Convey

Conceptual Design

After Construction
3D Construction Lessons Learned

- Mobile device (Surface)
  - Additional memory
    - Files can get large
  - Slow-moving image (rotating)
- Cleaning up metadata in Bluebeam
  - Reducing info (coordinates)
  - Transferring material info to metadata in Bluebeam

- Dimensioning
  - Bus, phase spacings, foundations, etc.
  - Utilize 2D preset views
- Suppliers 3D files
  - Can be too large
  - Too detailed
3D Construction Lessons Learned

- Drawings
  - Bulky paper prints gone
- Ease of drawing access
  - Able to bring mobile device on structures, equipment, bucket truck, import pictures, etc.
- Less questions to foreman
  - Workers better see what’s going on
  - Seeing actual image
- Material/equipment
  - More information
    - Sky’s the limit
- As-builts
  - Cleaner (no coffee stains)
  - Real time changes (both directions)
- Vendor 3D files
  - More readily available
3D Construction: Investment for the Future?

Initial consideration for going with 3D includes:

- Software and training
- Hardware for crews/engineers
- Ongoing training
- Increased design time initially – 3D drawings take time. Reduced in future (baseline/library)
- Consultants
- I.T. buy-in and support
Future Considerations

- Below grade construction
  - Grounding
  - Cabling
  - Foundations
    - Piers
    - Slabs
- Transmission line
  - PLS CADD is the equivalent for lines
  - Substation tap structures
- Control house layout
  - Cabinets
  - Lighting
  - Panels
    - Wiring prints
- Project planning
  - Better planning estimates
In Conclusion

- Minnkota sees benefits to continue
  - More to come
- Invest in better mobile devices
- More training (crews)
- Involve more groups at MPC
  - Provide more value using 3D
Questions or Comments?