

AUTODESK UNIVERSITY

# Maximizing Data and Strategic Partnerships to Drive Prefabrication



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**DEMAIN**  
Building Tomorrow



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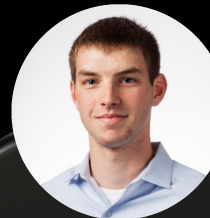
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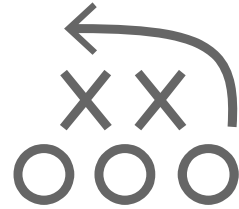
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# Agenda

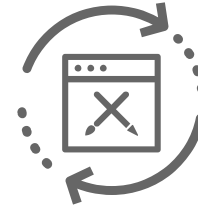
Maximizing Data and Strategic Partnerships to Drive Prefabrication



Mapping out the journey and advantage of developing strategic partnerships to drive innovation



Learn how an engineer and contractor leveraged unique workflows to drive a healthcare HVAC project



Understand the journey and advantages of assimilating an engineering firm and a contractor's pre-construction team



Evaluate how data can drive beyond pre-fabrication into manufacturing for utility scale solar projects

# Mapping Out the Journey and Advantages of Developing Strategic Partnerships to Drive Innovation



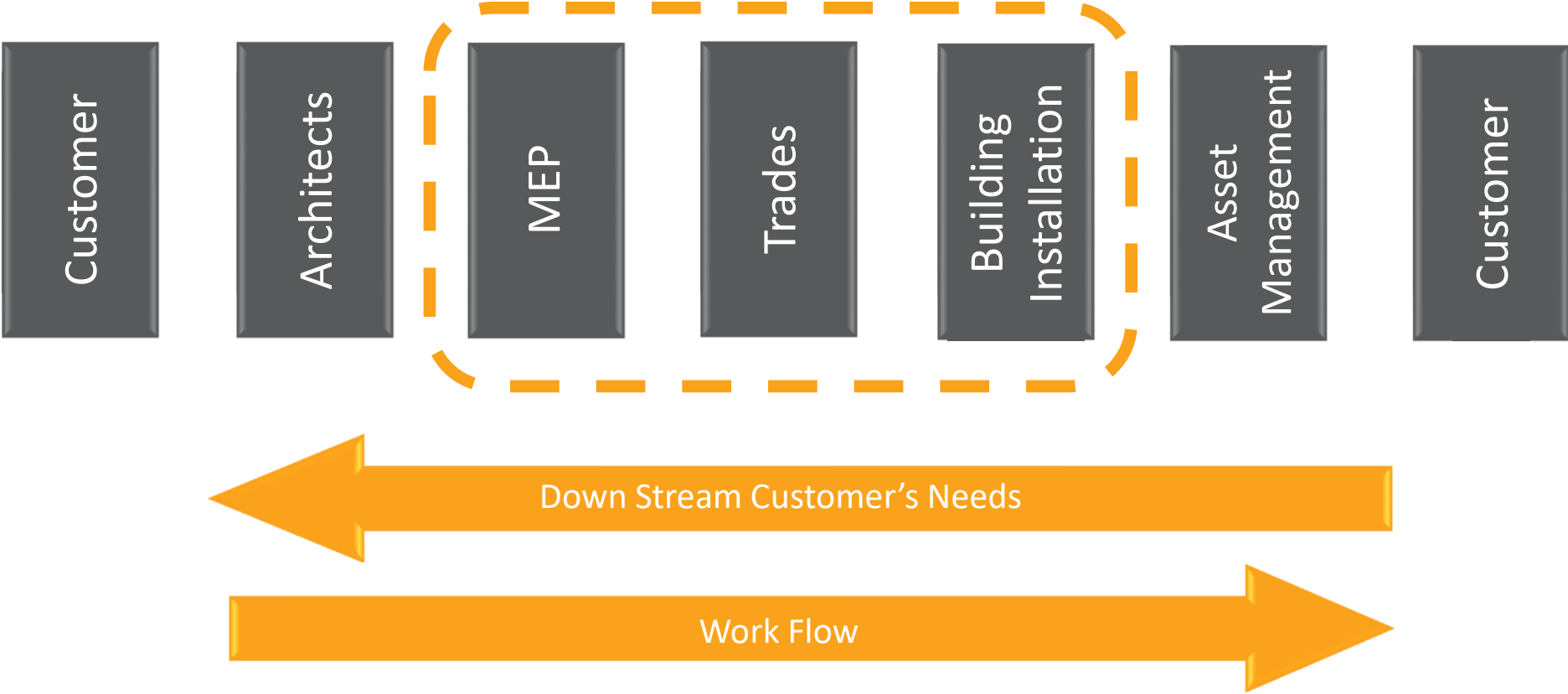
**Jim Tavernelli, PE, MBA**  
President & COO  
KLH Engineers

# How Do Contractors View MEP Engineers?

- Necessary evil for permitting – just a stamp
- Arrogant / Hands-off
- Incomplete drawing packages littered with CYA notation, generic details, and a phonebook sized spec book
- No consideration for coordination or constructability
- Enabling bottlenecks, delayed RFI response
- Increase the need for inhouse engineering competency



# Construction Value Stream



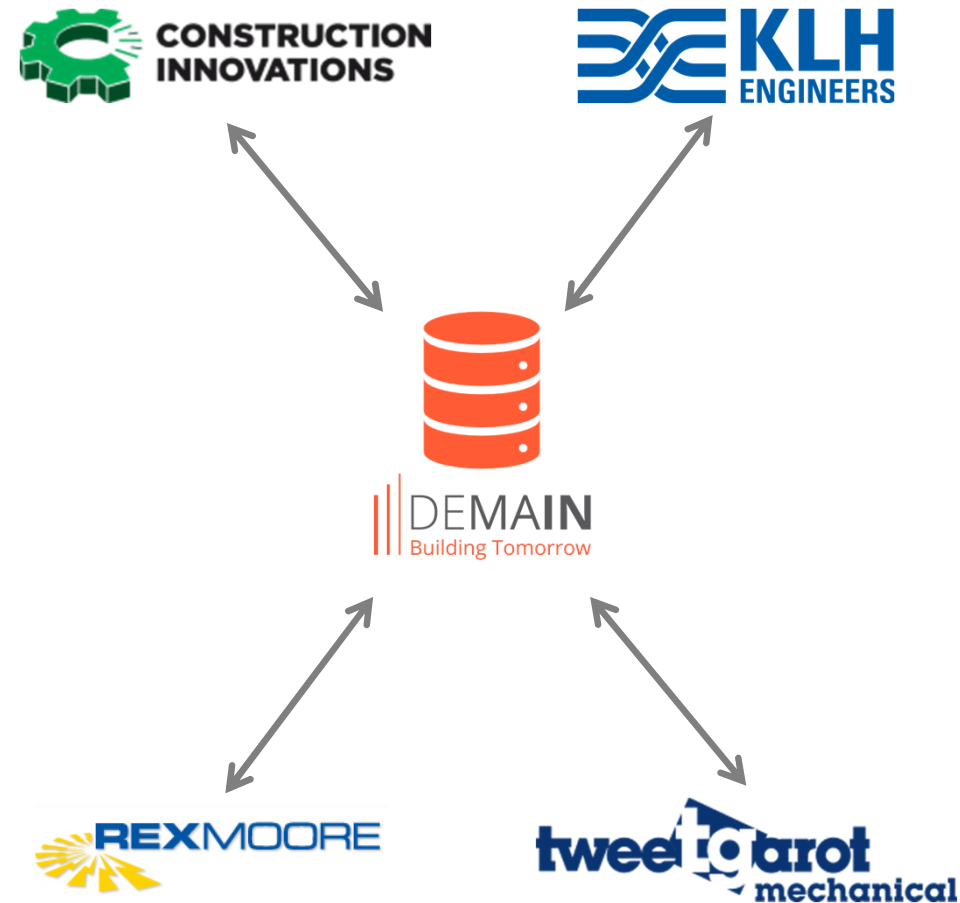
# Searching for Likeminded Partners



Bringing Joy to Construction

# Shared Cloud Infrastructure

- Demain has migrated to a shared cloud infrastructure
- Provides the IT foundation to bridge design and construction by allowing Demain members to:
  - Share custom software
  - Centralize data and files
  - Connect inter-company workflows
  - Communicate via the model and data





# Engineer & Contractor Leverage Unique Workflows to Drive Healthcare Project



**Kevin Eldridge, PE**  
Lead Mechanical Engineer  
KLH Engineers



**Chris Hronek**  
Fabrication Database Manager  
Tweet/Garot Mechanical

# The Project

## The Building:

- Orthopedic Surgery Center
  - Patient rooms, ORs, etc.
- ~60,000sf
- HVAC and plumbing scope
- Design Build



## KLH Tasks:

- Engineering calculations and design
- Modeling
- Conversion to fabrication
- External BIM coordination
- Assist with quantities and spool drawings

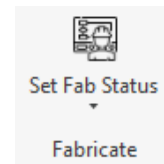
## Tweet/Garot Tasks:

- Constructability & install
- Guide KLH on best practices during modeling phase
- Spool drawings
- Ductwork fabrication
- Field coordination

# Engineer + Contractor Workflow

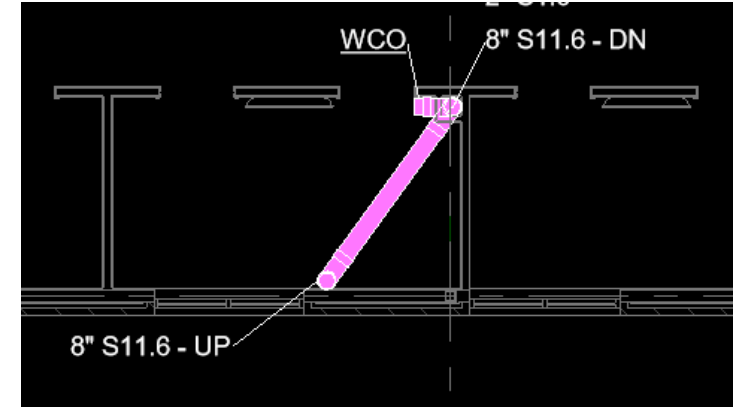
## Project Sequences & Interface:

- Tweet/Garot & KLH Kickoff
- KLH initial permit design with Tweet/Garot as EOR
- Simultaneous:
  - Full project BIM coordination meetings
  - Weekly KLH & Tweet/Garot meetings
  - Conversion of coordinated elements to fabrication
  - Start of construction
- Completion of field installation drawings
- Completion of construction
- Tweet/Garot & KLH Debrief

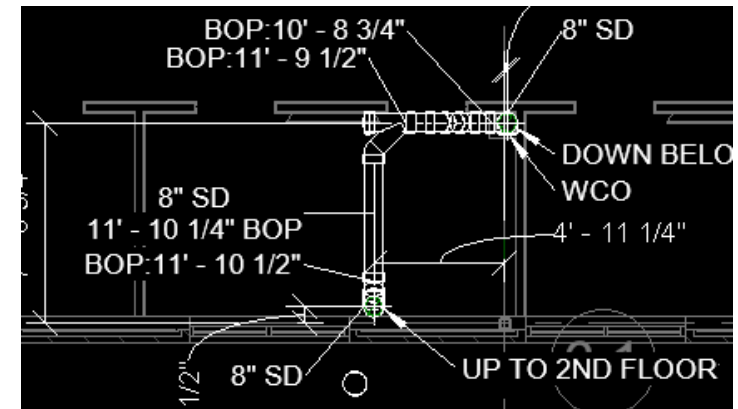


Fabrication  
Status Tool,  
Developed by  
Demail

Design Model

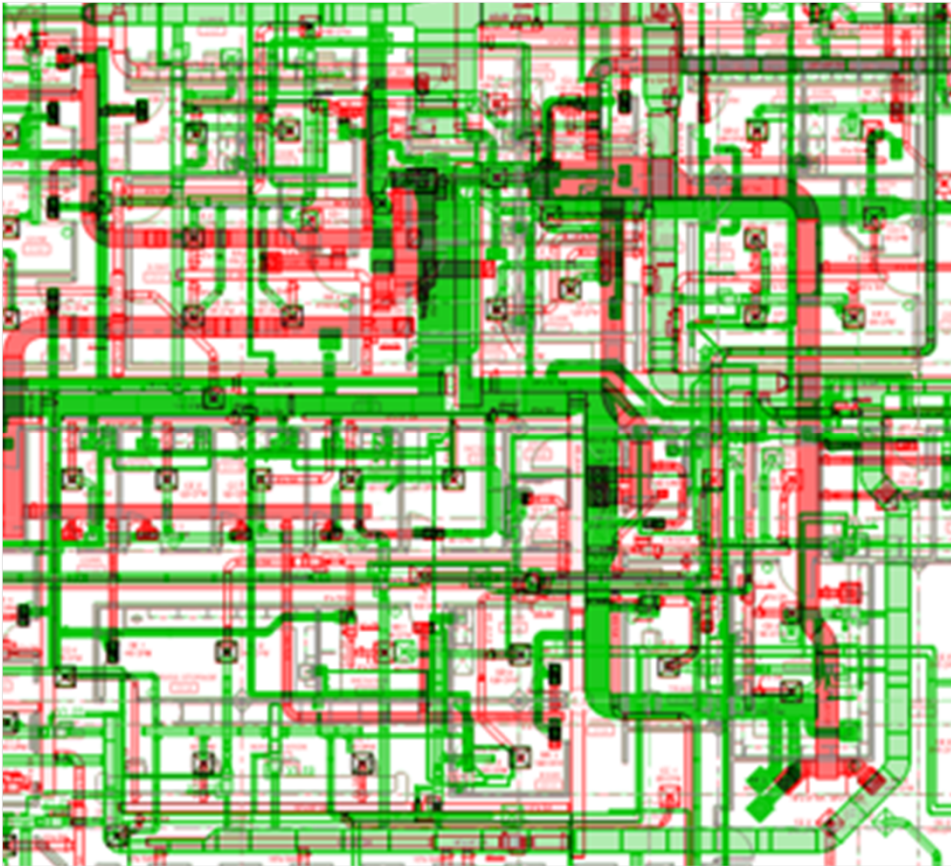
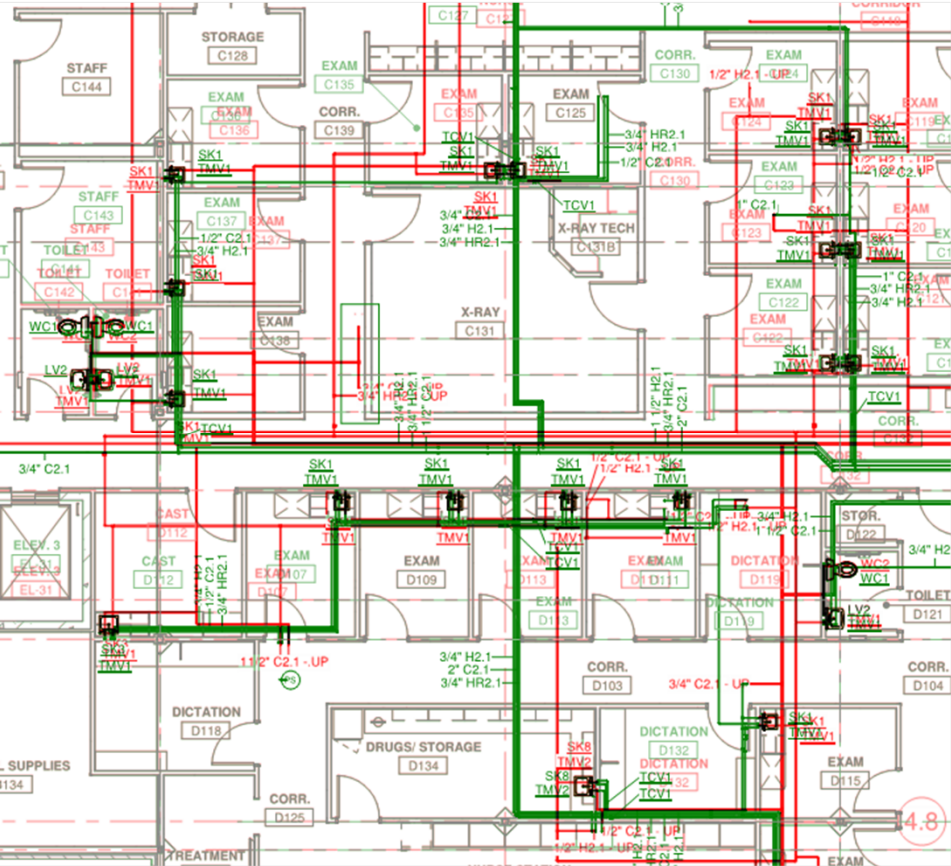


Converted to Fabrication



# Lessons Learned

Red = design Green = installed



# Key Takeaways

**1**

We are just getting started! “Fabrication Status” tool did not, in the end, deliver a full solution. Tool needs further development.

**2**

Moving forward, work to eliminate all wasted time and inefficient conversion processes to focus on the real work getting done.

**3**

The project was profitable for both KLH and Tweet/Garot. Future collaboration and efficiencies should only drive profitability higher.

**4**

Great experience for both parties. Valuable perspective and efficiencies were realized on both sides

# Understand the Journey and Advantages of Assimilating an Engineering Firm with a Contractor's Pre-Construction Department



**Brandon Johnson, PE**  
Director of Electrical Engineering  
Software Business Analyst  
KLH Engineers



**Spencer Murphy, PE**  
Engineering Department Manager  
Rex Moore Group

# Identifying Strengths

## KLH

- Revit
- Software team
- Software creation process

## Rex Moore

- Installation
- Pre-fabrication
- Pre-construction

**Goal #1** – Align Engineering Departments

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# Aligning Teams





## Standards

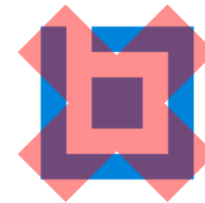
- Legends, details, notes, etc.
- Breaking old habits
- Advantages: new ideas, get current with latest codes

## Software

- Rex Moore – move to Revit with KLH training and support
- KLH trained experts within Rex Moore for ongoing support

**End Result** = both teams following the same process

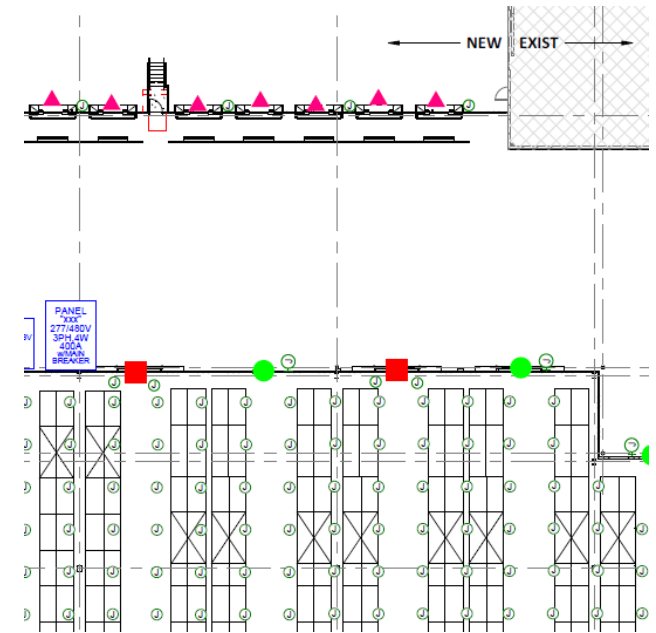
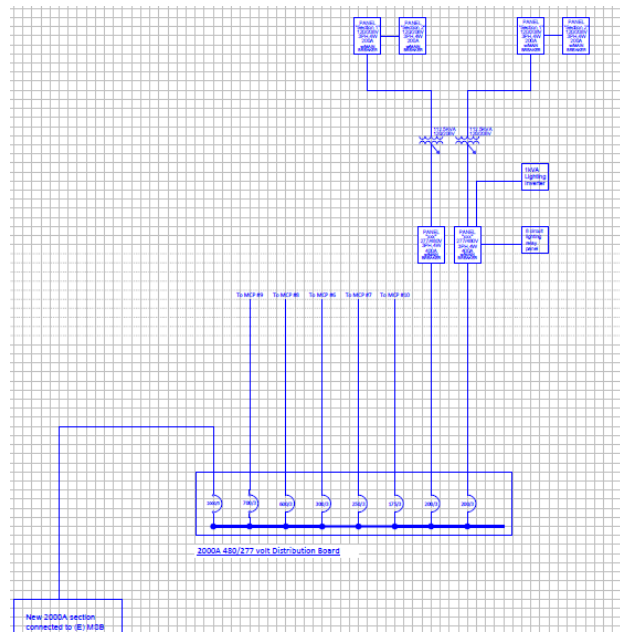
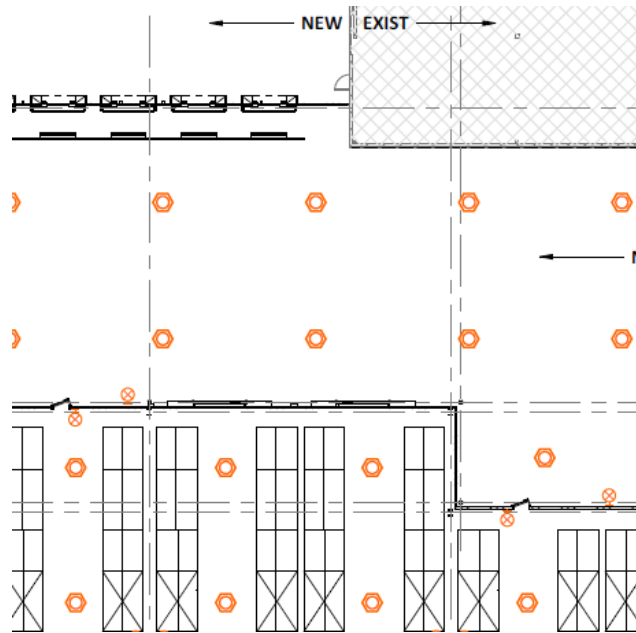
| SYMBOL  | DESCRIPTION  |
|---|--|
| <b>TELECOMMUNICATIONS</b>   |  |
|  | <del>WALL VOICE OUTLET<br/>EM = EMERGENCY VOICE OUTLET, W = WALL TELEPHONE OUTLET</del>                |
|  | FLOOR VOICE OUTLET  |
|  | OFFICE DATA OUTLET   |





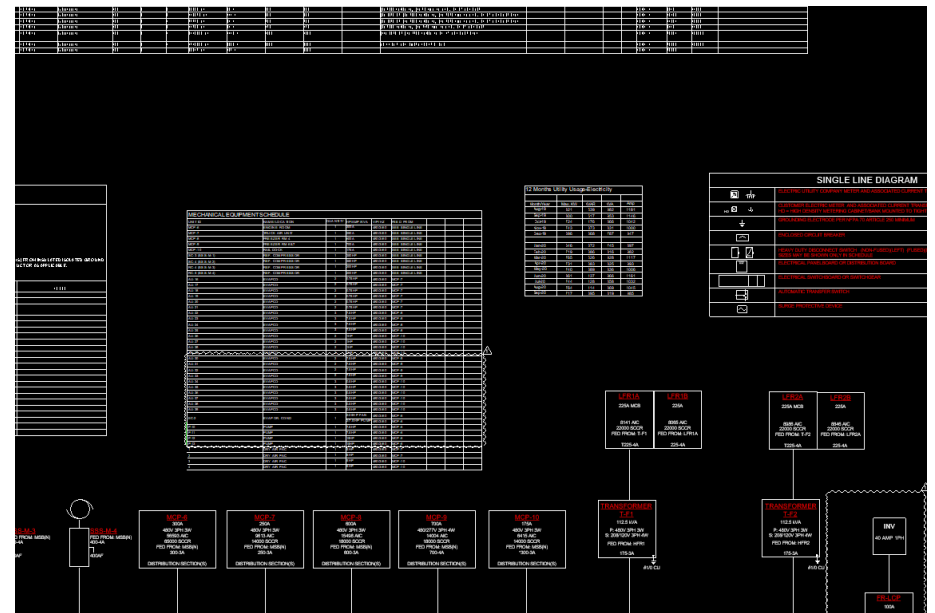
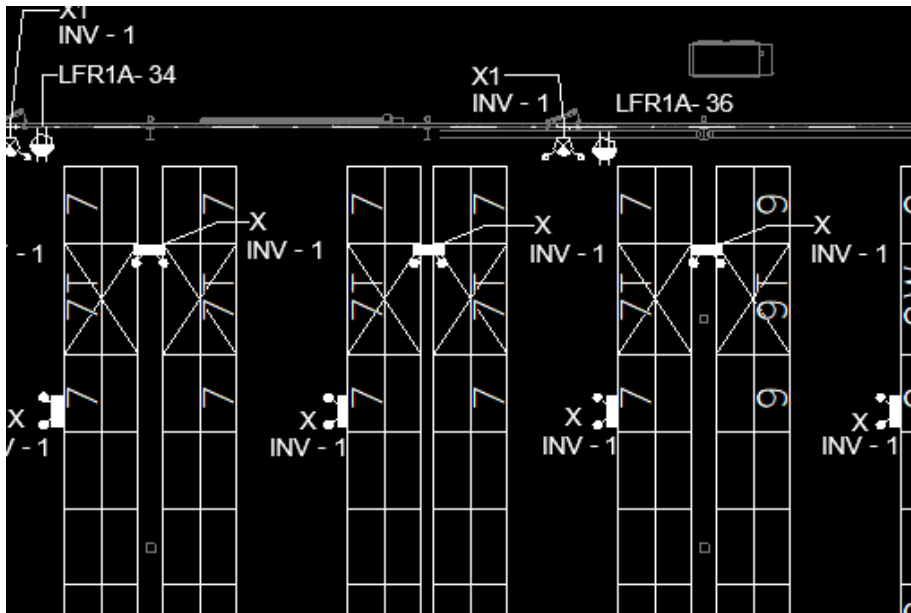
# Information Flow (Sales)

Sales/Estimation Creates PDF Plans and Estimate



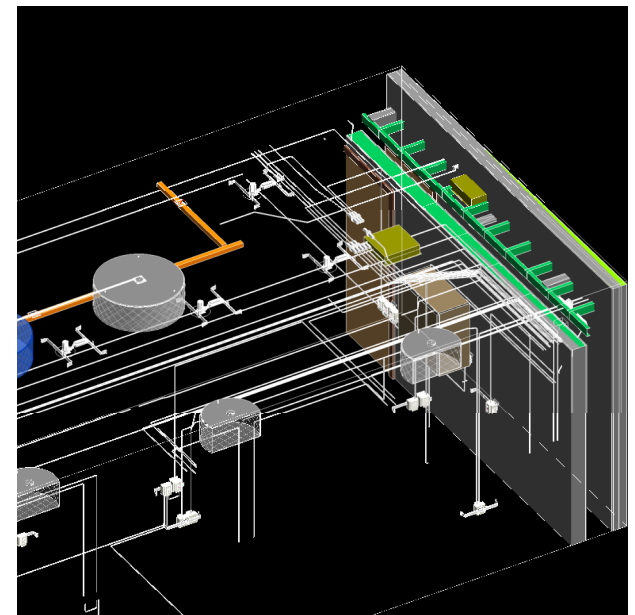
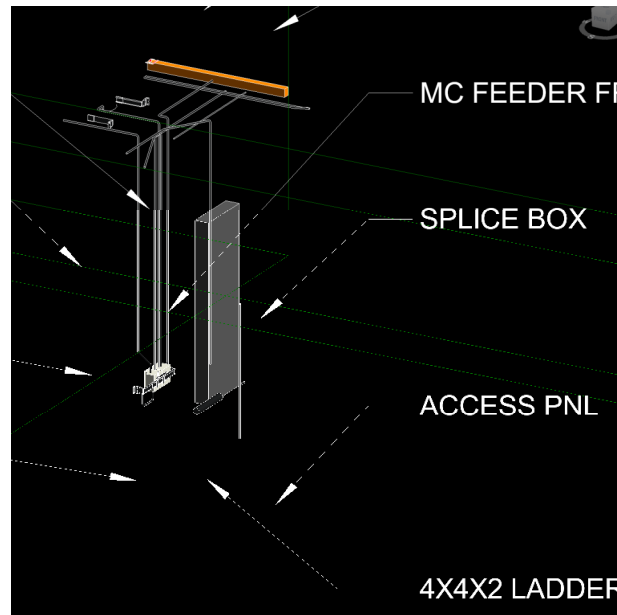
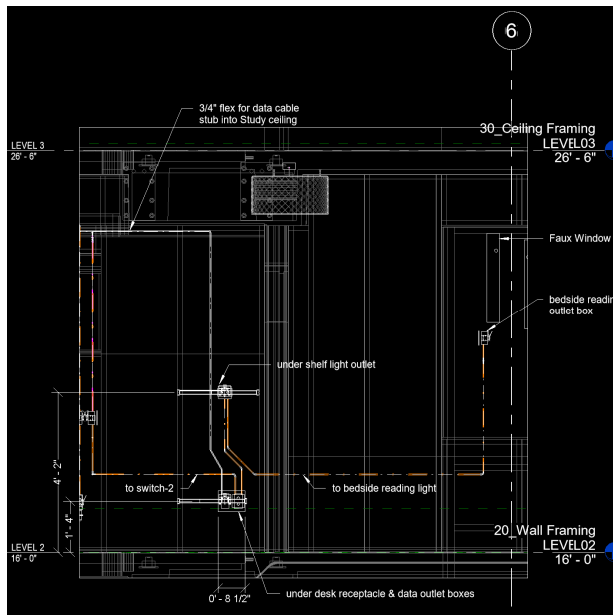
# Information Flow (Design)

Designer Creates 2D Package in Revit



# Information Flow (Construction)

BIM Developer Creates 3D Installation Drawings

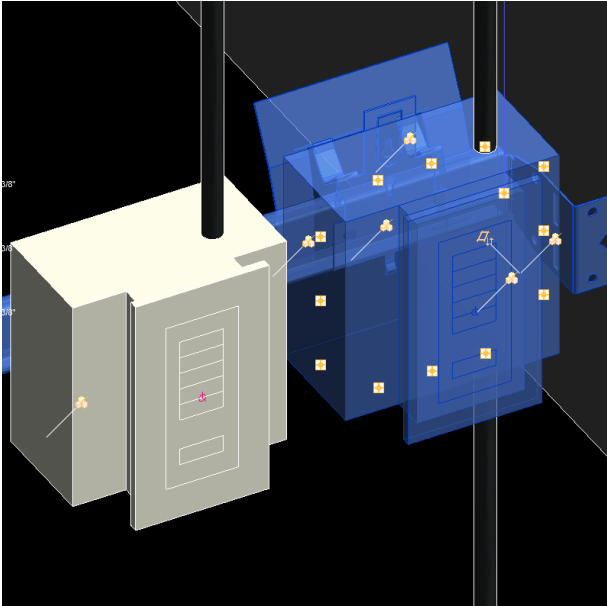


# Demain Software

Bridging the Gaps and Creating a New Process



Zone Mapping



Advanced Assemblies

| der<br>rs | Feeder ID | Feeder  | Conduit<br>Status (Beta) |
|-----------|-----------|---|--------------------------|
| ▼ Edit    |           |   |                          |
| ▼ Edit    |           |   |                          |
| ▼ Edit    | IU4000-4A | (11) SETS OF (4) #750 KCMIL AL IN 4" CONDUIT EACH                 | Not Modellec             |
| om ▼ Edit | C-MANUAL  | CONNECT VIA SWITCHBOARD BUS                                       | Not Modellec             |
| ▼ Edit    | *300-3A   | (3) #500 KCMIL AL, (1) #1/0 AWG AL GND. IN 3" CONDUIT             | Not Modellec             |
| ▼ Edit    | 300-3A    | (3) #500 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modellec             |
| ▼ Edit    | 250-3A    | (3) #350 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modellec             |
| ▼ Edit    | 600-3A    | (2) SETS OF (3) #500 KCMIL AL, (1) #2/0 AWG AL GND. IN 3" CONDUIT | Not Modellec             |
| ▼ Edit    | 700-4A    | (3) SETS OF (4) #350 KCMIL AL, (1) #3/0 AWG AL GND. IN 3" CONDUIT | Not Modellec             |
| ▼ Edit    | 600-4A    | (2) SETS OF (4) #500 KCMIL AL, (1) #2/0 AWG AL GND. IN 4" CONDUIT | Not Modellec             |
| ▼ Edit    | 600-4A    | (2) SETS OF (4) #500 KCMIL AL, (1) #2/0 AWG AL GND. IN 4" CONDUIT | Not Modellec             |
| ▼ Edit    | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modellec             |
| ▼ Edit    | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modellec             |
| ▼ Edit    | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modellec             |
| ▼ Edit    | 175-3A    | (3) #4/0 AWG AL, (1) #4 AWG AL GND. IN 2" CONDUIT                 | Not Modellec             |
| ▼ Edit    | T225-4A   | (4) #300 KCMIL AL, (1) #1/0 AWG AL GND. IN 3" CONDUIT             | Not Modellec             |
| ▼ Edit    | 225-4A    | (4) #300 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modellec             |
| ▼ Edit    | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modellec             |
| ▼ Edit    | *150-4A   | (4) #3/0 AWG AL, (1) #3 AWG AL GND. IN 3" CONDUIT                 | Not Modellec             |
| ▼ Edit    | 20-2C     | (2) #12 AWG CU, (1) #12 AWG CU GND. IN 3/4" CONDUIT               | Not Modellec             |
| ▼ Edit    | 175-3A    | (3) #4/0 AWG AL, (1) #4 AWG AL GND. IN 2" CONDUIT                 | Not Modellec             |
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| ▼ Edit    | 225-4A    | (4) #300 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modellec             |

Feeder Calculator

# Zone Mapping

Creates electrical zones for distribution analysis

Zone Mapping | 90027.00-20-Electric-Avesta Concord - Concord, CA\_bjohnson

Zones: Power

- Power - 1 - N
  - Power - 1.1 - N-48034
    - Power - 1.1.1 - N-48034-MCH**
      - Power - 1.1.1.1 - N-48034-MCH - Level 1
      - Power - 1.1.1.2 - N-48034-MCH - Level 3
      - Power - 1.1.1.3 - N-48034-MCH - Level 4
      - Power - 1.1.1.4 - N-48034-MCH - Level 5
      - Power - 1.1.1.5 - N-48034-MCH - Level 6
      - Power - 1.1.1.6 - N-48034-MCH - Level 7
      - Power - 1.1.1.7 - N-48034-MCH - Level 2
    - Power - 1.1.2 - N-48034-L
    - Power - 1.1.3 - N-48034-RCKN
    - Power - 1.1.7 - N-48034
  - Power - 1.2 - N-20834
  - Power - 2 - E
  - Power - 2 - O

Selected Electric Zone - Power - 1.1.1 - N-48034-MCH

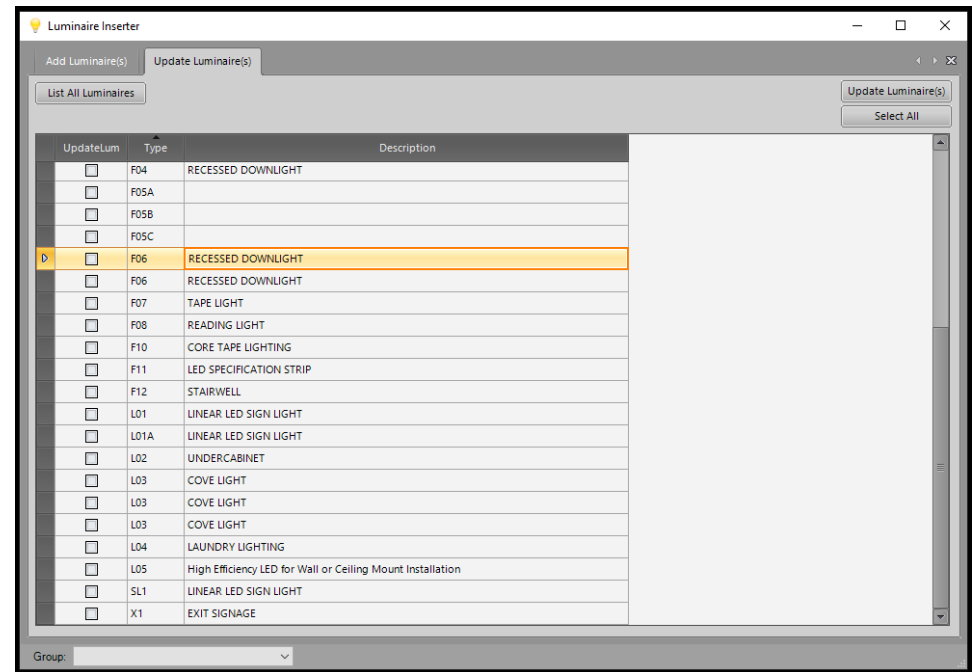
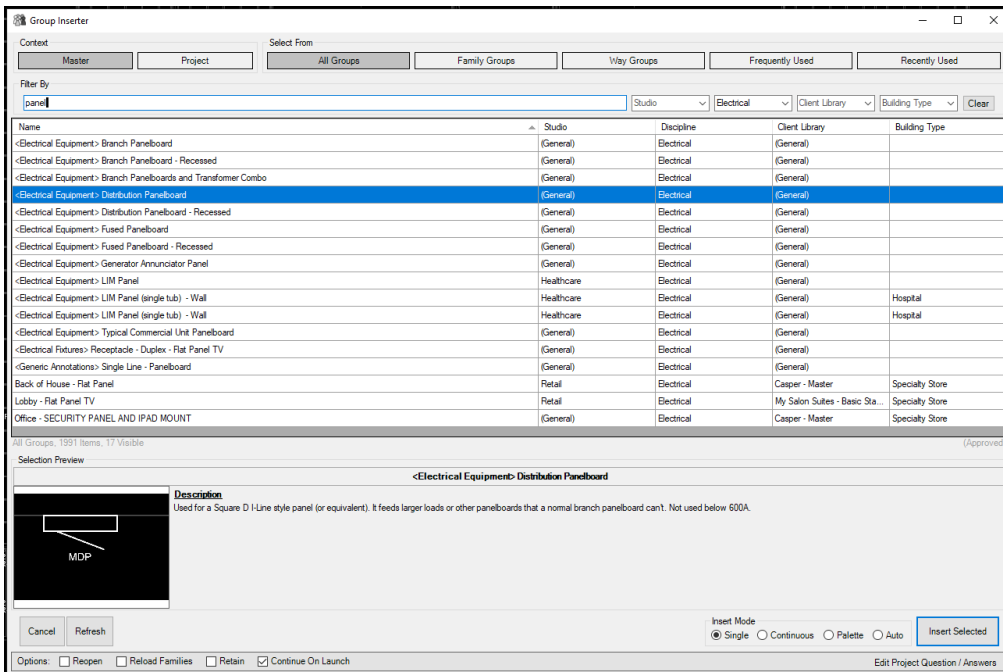
Dist. System: 480/277V 3PH 4W    W/SqFt: 0.00    Levels    Power Branches: NORMAL    Load Classifications: Motor, Cooling, Heating    Panels

Show Zone Extents    Update Spaces    Temp Loads: + Add - Remove

Selection: 1 Total 1 Zones 0 Zones Elements    Additional Selection Totals

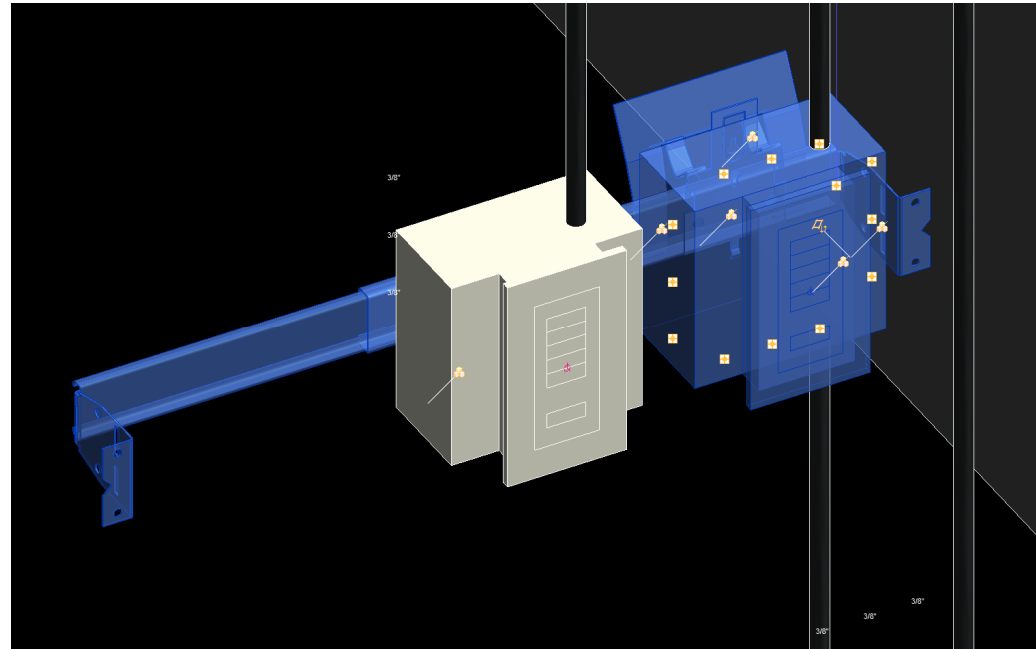
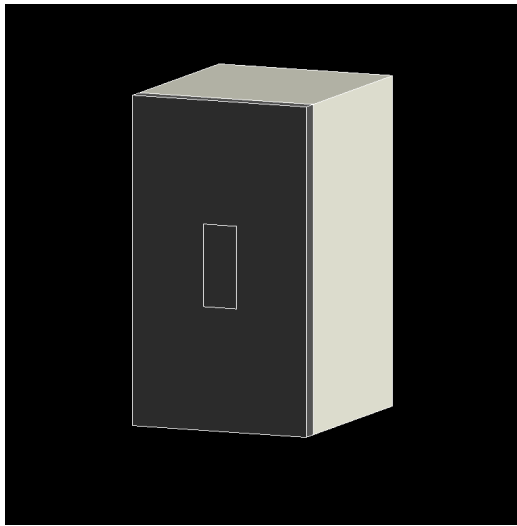
# Advanced Assemblies

Databasing assembly information for consistent modeling and easy data extraction



# Advanced Assemblies

Databasing assembly information for consistent modeling and easy data extraction



# Feeder Calculator

Leverage model data for fast, accurate and code compliant engineering calculations

| Equipment   | Family Type                                   | Rating (A) | Demand (A) | UG                       | Feeder Length (ft) | Voltage | Poles | Wires | Existing                 | 200% Neutral             | Ground Type | Feeder Type | Feeder Amps | Feeder ID | Feeder  | Conduit Status (Beta) | Fault Current | Auto                                | Short Circuit Rating | Total Voltage Drop % |
|-------------|---|------------|------------|--------------------------|--------------------|---------|-------|-------|--------------------------|--------------------------|-------------|-------------|-------------|-----------|---|-----------------------|---------------|-------------------------------------|----------------------|----------------------|
| MSB(N)      | Switchboard                                   | 0          | 0          | <input type="checkbox"/> | 0                  | 0       | 0     | 0     | <input type="checkbox"/> | <input type="checkbox"/> |             |             |             |           |   |                       | 73998         | <input type="checkbox"/>            | 0                    | 0.251                |
| (E) UTILITY | Oil Filled Transformer - Pad Mounted          | 0          | 0          | <input type="checkbox"/> | 0                  | 0       | 0     | 0     | <input type="checkbox"/> | <input type="checkbox"/> |             |             |             |           |   |                       | 68084         | <input type="checkbox"/>            | 0                    |                      |
| MSB(E)      | Switchboard                                   | 4,000      | 4,112.4    | <input type="checkbox"/> | 127.40             | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> | UTILITY     | Auto        | Auto        | U4000-4A  | (1) SETS OF (4) #750 KCMIL AL IN 4" CONDUIT EACH                  | Not Modelled          | 73354         | <input checked="" type="checkbox"/> | 100000               | 0.79                 |
| MSB(N)      | Switchboard                                   | 2,000      | 2,067.6    | <input type="checkbox"/> | 2.00               | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Custom      | C-MANUAL  | CONNECT VIA SWITCHBOARD BUS                                       | Not Modelled          | 73352         | <input checked="" type="checkbox"/> | 100000               | 0.79                 |
| MCP-10      | Switchboard                                   | 175        | 53.9       | <input type="checkbox"/> | 798.70             | 480     | 3     | 3     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | *300-3A   | (3) #500 KCMIL AL, (1) #1/0 AWG AL GND. IN 3" CONDUIT             | Not Modelled          | 6415          | <input checked="" type="checkbox"/> | 14000                | 1.72                 |
| MCP-6       | Switchboard                                   | 300        | 176.9      | <input type="checkbox"/> | 22.70              | 480     | 3     | 3     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 300-3A    | (3) #500 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modelled          | 56593         | <input checked="" type="checkbox"/> | 65000                | 0.87                 |
| MCP-7       | Switchboard                                   | 250        | 25.1       | <input type="checkbox"/> | 387.70             | 480     | 3     | 3     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 250-3A    | (3) #350 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modelled          | 9613          | <input checked="" type="checkbox"/> | 14000                | 1.06                 |
| MCP-8       | Switchboard                                   | 600        | 140.6      | <input type="checkbox"/> | 571.40             | 480     | 3     | 3     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 600-3A    | (2) SETS OF (3) #500 KCMIL AL, (1) #2/0 AWG AL GND. IN 3" CONDUIT | Not Modelled          | 15498         | <input checked="" type="checkbox"/> | 18000                | 1.66                 |
| MCP-9       | Switchboard                                   | 700        | 93.5       | <input type="checkbox"/> | 743.30             | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 700-4A    | (3) SETS OF (4) #350 KCMIL AL, (1) #3/0 AWG AL GND. IN 3" CONDUIT | Not Modelled          | 14004         | <input checked="" type="checkbox"/> | 18000                | 1.45                 |
| SSS-M-1     | Disconnect and Starters - Combination Starter | 600        | 415.0      | <input type="checkbox"/> | 93.40              | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 600-4A    | (2) SETS OF (4) #500 KCMIL AL, (1) #2/0 AWG AL GND. IN 4" CONDUIT | Not Modelled          | 45548         | <input type="checkbox"/>            | 65000                | 1.21                 |
| SSS-M-2     | Disconnect and Starters - Combination Starter | 600        | 415.0      | <input type="checkbox"/> | 102.90             | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 600-4A    | (2) SETS OF (4) #500 KCMIL AL, (1) #2/0 AWG AL GND. IN 4" CONDUIT | Not Modelled          | 43868         | <input type="checkbox"/>            | 65000                | 1.25                 |
| SSS-M-3     | Disconnect and Starters - Combination Starter | 400        | 240.6      | <input type="checkbox"/> | 25.90              | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modelled          | 56832         | <input type="checkbox"/>            | 65000                | 0.90                 |
| SSS-M-4     | Disconnect and Starters - Combination Starter | 400        | 240.6      | <input type="checkbox"/> | 34.90              | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modelled          | 52705         | <input type="checkbox"/>            | 65000                | 0.94                 |
| HFR1        | Panelboard - Distribution Panelboard          | 400        | 75.2       | <input type="checkbox"/> | 482.30             | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modelled          | 11433         | <input checked="" type="checkbox"/> | 14000                | 1.47                 |
| T-F1        | Dry Type Transformers - 112.5 kVA             | 175        | 22.9       | <input type="checkbox"/> | 7.60               | 480     | 3     | 3     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 175-3A    | (3) #4/0 AWG AL, (1) #4 AWG AL GND. IN 2" CONDUIT                 | Not Modelled          | 8454          | <input checked="" type="checkbox"/> | 14000                | 1.47                 |
| LFR1A       | Panelboard - Branch Panelboard                | 225        | 52.8       | <input type="checkbox"/> | 7.40               | 208     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> | TRANSF...   | Auto        | Auto        | T225-4A   | (4) #300 KCMIL AL, (1) #1/0 AWG AL GND. IN 3" CONDUIT             | Not Modelled          | 8141          | <input checked="" type="checkbox"/> | 22000                | 1.51                 |
| LFR1B       | Panelboard - Branch Panelboard                | 225        | 13.8       | <input type="checkbox"/> | 1.90               | 208     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 225-4A    | (4) #300 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modelled          | 8065          | <input checked="" type="checkbox"/> | 22000                | 1.52                 |
| HFR2        | Panelboard - Distribution Panelboard          | 400        | 131.1      | <input type="checkbox"/> | 314.50             | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 400-4A    | (2) SETS OF (4) #250 KCMIL AL, (1) #1 AWG AL GND. IN 3" CONDUIT   | Not Modelled          | 16190         | <input checked="" type="checkbox"/> | 25000                | 1.56                 |
| FR-LCP      | LCP - Branch Panel - Lighting Control Panel   | 100        | 64.1       | <input type="checkbox"/> | 111.40             | 480     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | *150-4A   | (4) #3/0 AWG AL, (1) #3 AWG AL GND. IN 3" CONDUIT                 | Not Modelled          | 9008          | <input checked="" type="checkbox"/> | 14000                | 1.94                 |
| INV         | LCP - Branch Panel - INV                      | 20         | 2.8        | <input type="checkbox"/> | 2.60               | 277     | 1     | 2     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 20-2C     | (2) #12 AWG CU, (1) #12 AWG CU GND. IN 3/4" CONDUIT               | Not Modelled          | 7907          | <input checked="" type="checkbox"/> | 18000                | 1.98                 |
| T-F2        | Dry Type Transformers - 112.5 kVA             | 175        | 4.6        | <input type="checkbox"/> | 9.80               | 480     | 3     | 3     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 175-3A    | (3) #4/0 AWG AL, (1) #4 AWG AL GND. IN 2" CONDUIT                 | Not Modelled          | 9333          | <input checked="" type="checkbox"/> | 14000                | 1.56                 |
| LFR2A       | Panelboard - Branch Panelboard                | 225        | 10.7       | <input type="checkbox"/> | 6.80               | 208     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> | TRANSF...   | Auto        | Auto        | T225-4A   | (4) #300 KCMIL AL, (1) #1/0 AWG AL GND. IN 3" CONDUIT             | Not Modelled          | 8986          | <input checked="" type="checkbox"/> | 22000                | 1.57                 |
| LFR2B       | Panelboard - Branch Panelboard                | 225        | 6.3        | <input type="checkbox"/> | 2.90               | 208     | 3     | 4     | <input type="checkbox"/> | <input type="checkbox"/> |             | Auto        | Auto        | 225-4A    | (4) #300 KCMIL AL, (1) #2 AWG AL GND. IN 3" CONDUIT               | Not Modelled          | 8846          | <input checked="" type="checkbox"/> | 22000                | 1.57                 |

Auto Type:  Copper Only  Aluminum, 100 A and over

Max Feeder VD %:  ASHRAE  Custom 2 %

Options:  Auto Calculate  Show Additional Feeder Fields

VD Amps = 80% Feeder Rating

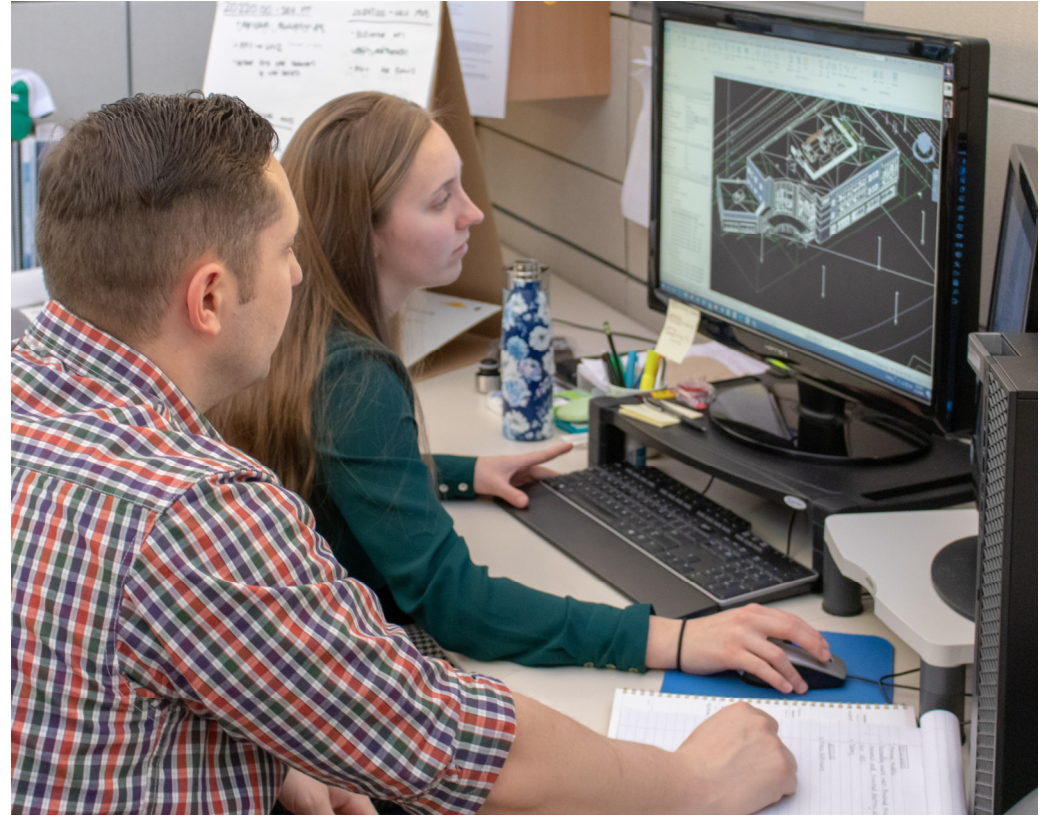
[Calculate](#) [Refresh](#) [Update Revit](#)



# Realizing Benefits

## Software

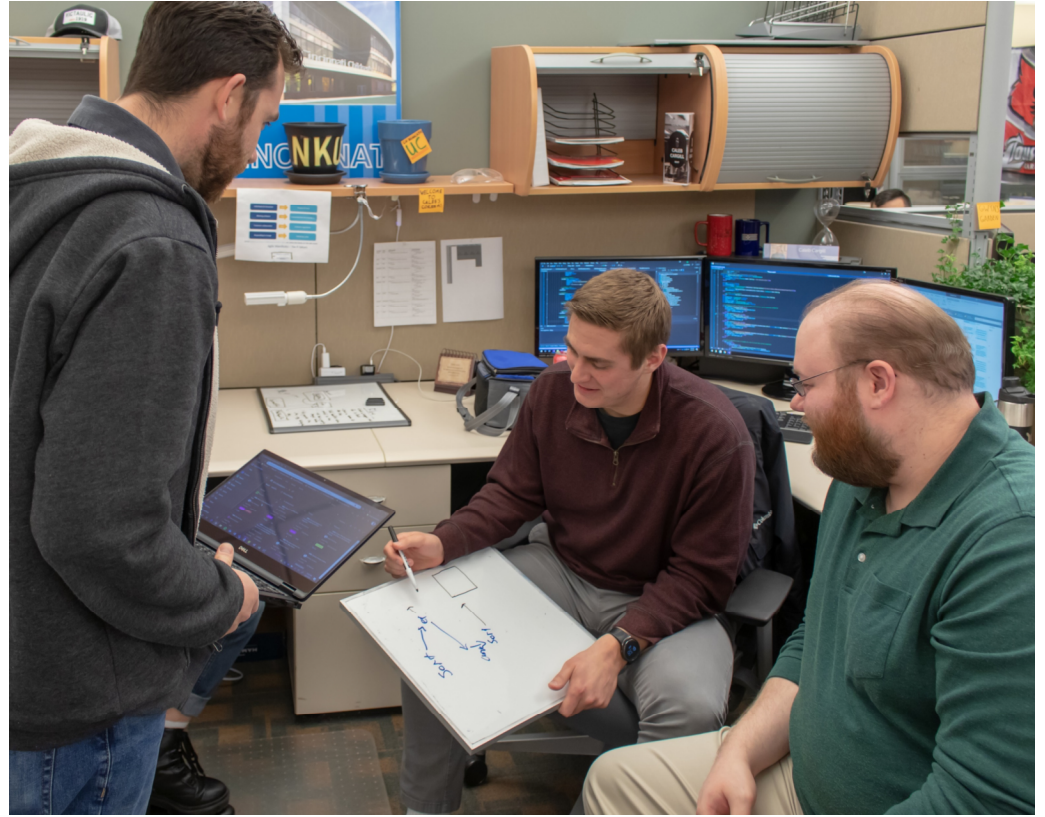
- Only 1 platform – Revit
- Migrated to the cloud
- Existing tools improved with combined experience
- New tools created collaboratively



# Realizing Benefits

## Team

- Rex Moore software team created and partnered with KLH
- KLH fire alarm team created, learning from Rex Moore
- Overflow work picked up by the other team



# Evaluate How Data Can Drive Beyond Prefabrication Into Manufacturing for Utility Scale Solar Projects



**Adam Perales**

Business Development Manager  
Construction Innovations



**Mark Hans, CTS**

Lead Technology Designer  
Software Engineer  
KLH Engineers

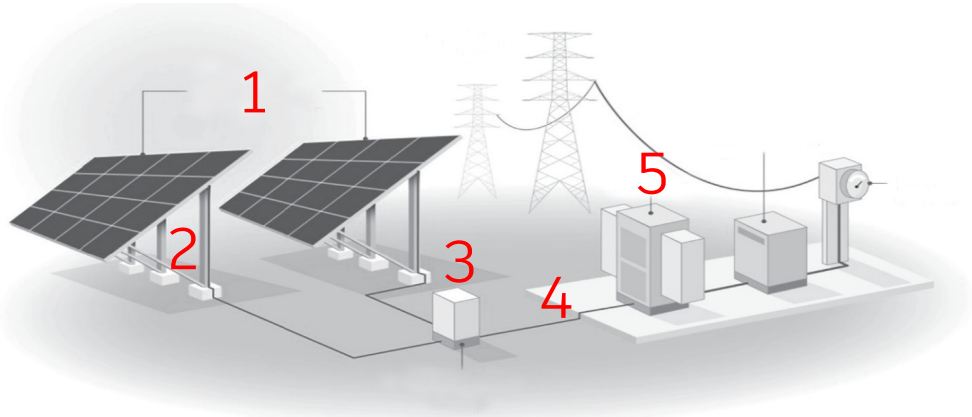
# Data-Driven Manufacturing

The U.S. has roughly 88.9 gigawatts of total installed photovoltaic capacity, enough to power 16.4 million American homes.

Total installed U.S. photovoltaic capacity is expected to more than double over the next five years.



# Basics of Photovoltaic



1

## Module

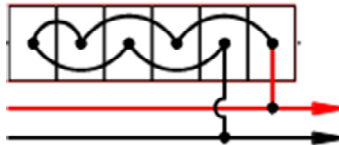
~400 watts DC  
6'-3" x 3'-4"



2

## String

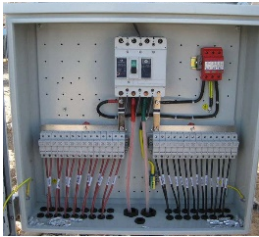
Typically 6-30  
modules in series  
make up a string



3

## Combiner Box

Typically combine  
6-25 strings for  
a DC Feeder



4

## DC Feeder

Common Trench  
from Combiner  
Boxes to Inverter



5

## Inverter

20-30 DC Feeders  
per Inverter for  
conversion  
to AC Power



# Data-Driven Manufacturing

Utility Scale Solar Project: 10MW – 400MW+

## Typical Numbers for 250MW Project:

- Covers 5 square miles
- 1.6 million modules
- 60,000 strings
- 1,800 combiner boxes
- 100 inverters



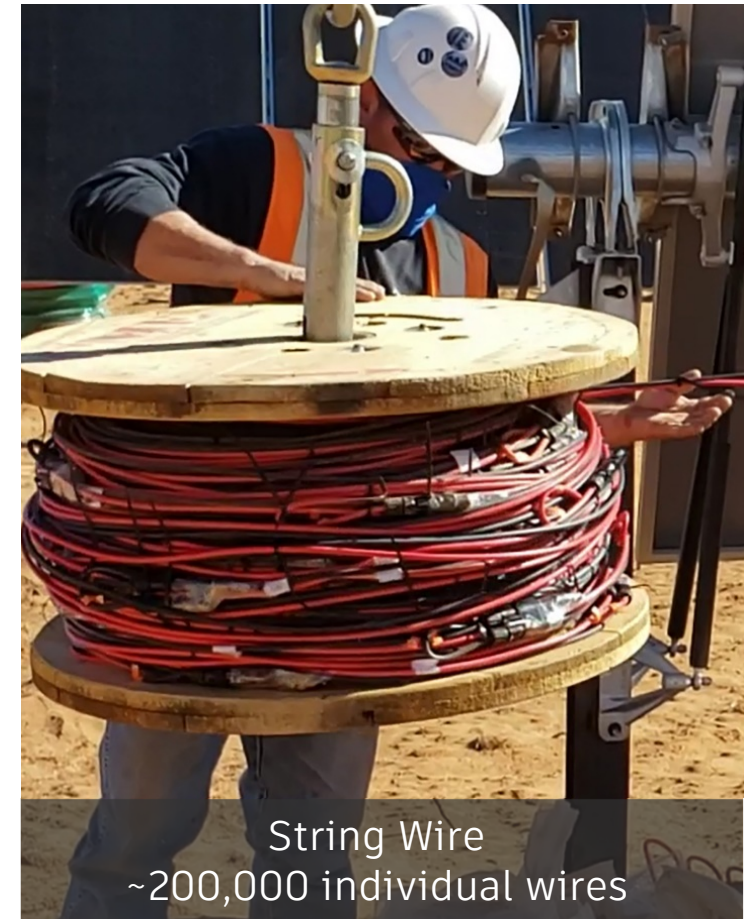
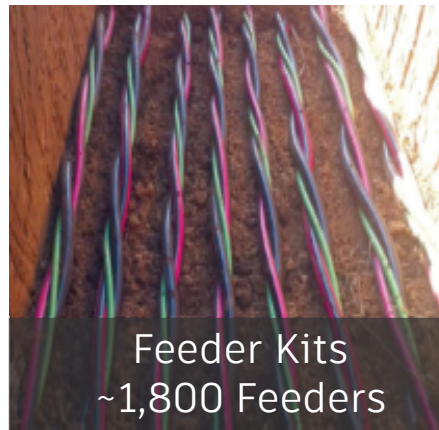
# Data-Driven Manufacturing

## Opportunities

- String wire harnesses
- Feeder harnesses
- Combiner box assemblies
- Loose material kitting

## Benefits of Manufacturing

- Factory inspection and testing
- Unique identification + sequencing
- Just-in-time shipping supports project flow



# Data-Driven Manufacturing

## String Wire

- ~200,000 individual wires

## String Wire Properties

- Wire color
- Wire size
- Wire length
- Connector type
- Conductor quantity





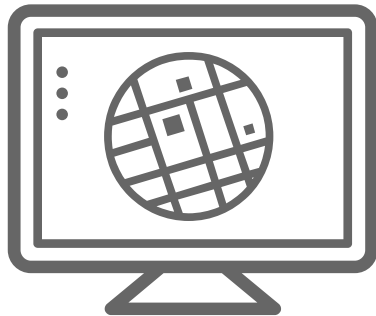
# Data-Driven Manufacturing

## Loose Material Kitting

- Fuses ~40,000
- ZipRing™ ~800,000
- Zip Ties ~150,000
- Wire Management Hangers ~750,000
- Ground Jumper Wires ~10,000
- Splitters ~25,000



# Data-Driven Manufacturing



Solar design  
provided in  
AutoCAD (2D)



## Design Criteria Based on Manufacturing Standards

- Row/module settings
- String wiring design
- Hardware requirements



Solar design  
translated into  
Revit (3D)

# Data-Driven Manufacturing



**Design Validation  
and Optimization**



**Development through the Revit API can  
analyze the model providing full bills of  
material, aiding the manufacturing process**





# DEMAIN

Building Tomorrow



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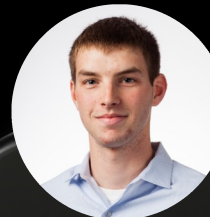
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The background of the slide is black with several large, dark grey, 3D-rendered geometric shapes (cubes and rectangular prisms) scattered around. The shapes are lit from the side, creating bright highlights and deep shadows, giving them a metallic or polished appearance. The text 'AUTODESK UNIVERSITY' is centered in a large, white, bold, sans-serif font.

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