Autocad® Utility Design(AUD) 2014 Work Flow and Systems Integration at Colorado Springs Utilities

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Summary

Colorado Springs Utilities (CSU) discusses implementation strategies of Autocad® Utility Design (AUD) 2014

- Colorado Springs Utilities is…
- CSU AUD Electric Projects: Past and Present
- Key Learning Objectives
  1. Identify Standards
  2. Workflow Configuration
  3. Conceptual Model
  4. Integration with other systems
- Benefits
- Questions

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Colorado Springs Utilities is:

- Colorado Springs Utilities is a 4-service municipal utility located at the foot of Pikes Peak in Colorado between Pueblo and Denver. Its 1800 employees supply natural gas, electricity, water, and wastewater services to a community of approximately 350,000 customers/owners.

- Service Agreements include:
  - Electric   213,433
  - Gas   189,498
  - Wastewater   132,470
  - Water   136,231
  - Non Service*   171,968
    - i.e. Carbon Monoxide monitor sales, temporary contract assistance, etc.

Colorado Springs Utilities

It's how we're all connected

Colorado Springs Utilities is (cont):

- The CSU electric system provides retail service to metropolitan Colorado Springs and Manitou Springs and delivers special contract power to the Air Force Academy (USAFA), Peterson Air Force Base, Fort Carson, and Cheyenne Mountain Air Station.

- Colorado Springs Utilities has an electric franchise to serve Manitou Springs through 2025.

- Colorado Springs Utilities electric service area is approximately 470 square miles serving 212,966 electric meter accounts as of Dec, 2011 which has been our largest operating year to date. Annual budget of 1.154 billion dollars in 2014.

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CSU Gas and Electric Service Areas Extending Beyond Colorado Springs

City Boundary
Gas Boundary
Electric Service Boundary

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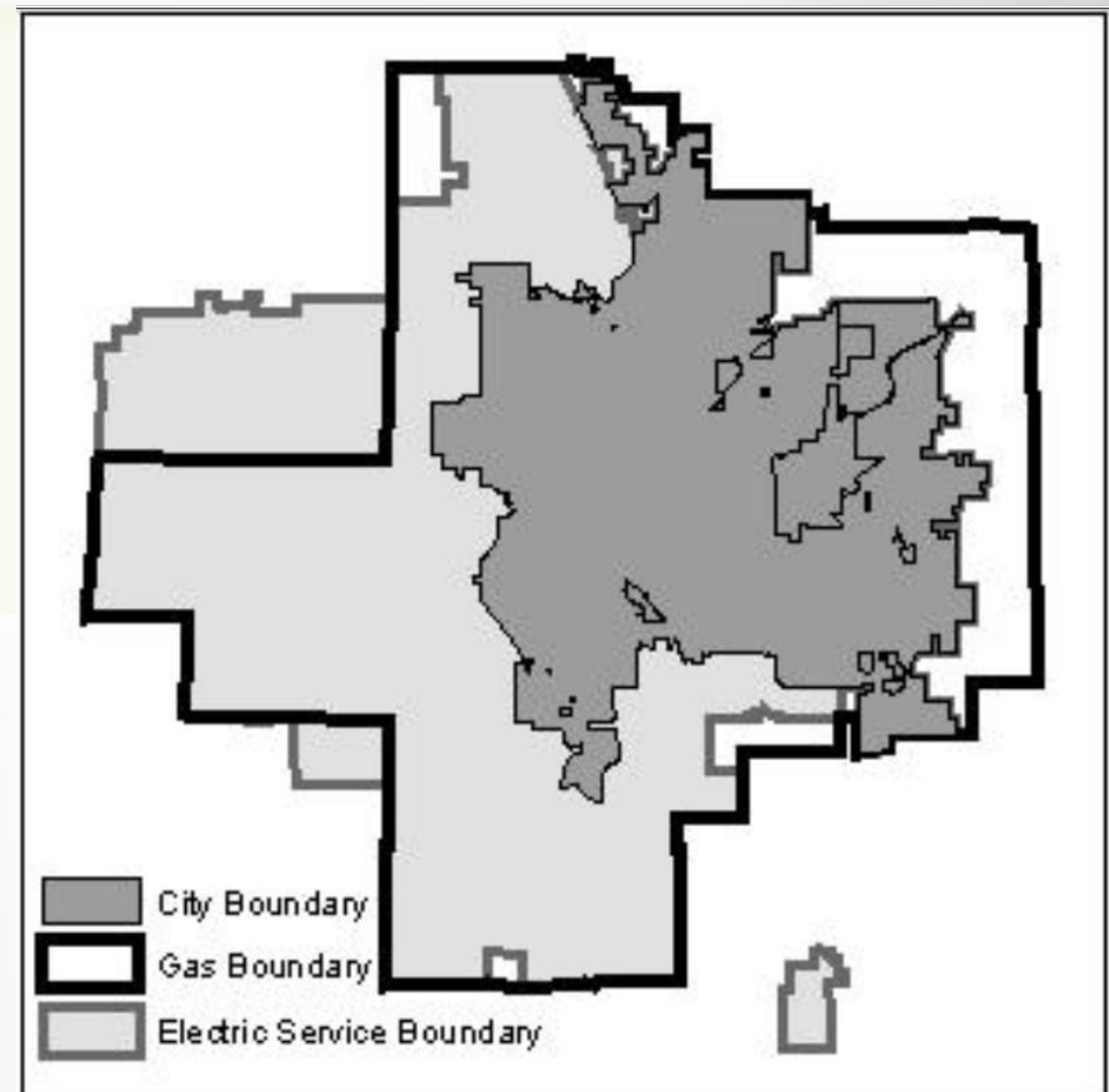
AUD Projects: Past and Present

- Original AUD 2009 implementation
  - Put in production in 2010
  - 95% customized, feature rich, difficult to build, not possible to upgrade and expensive

- Current AUD 2014 Electric Project
  - Rebuilds with new technology
  - Configured internally with some custom plug-in work contracted out
  - Managed internally
  - Configured with 90% out of the box industry model (database) and rules (windows workflow foundation configuration exposed in AUD)
  - 12% of the cost of original project
  - Improved upgrade path

Key learning objectives

At the end of this class, you will be able to:

1. Identify standards needed to support and implement AUD Electric Design.

2. Walk through an existing work flow of a utility implementing AUD 2014 Electric.

3. Design a conceptual model to support integration with work and asset management, field inventory, Geographical Information System (GIS) and billing systems.

4. Construct and utilize engineering information through downstream and upstream system integration.

Examples are based on CSU Pole Heads and Streetlights.

CSU Pole Heads and Streetlight Examples

- CSU Pole Heads/Crossarms
    - Best example of matching models and many attributes to AUD (Section 1)

- Streetlights
    - Best example of AUD Information Model Design to Many Systems (Sections 3 and 4)

Learning Objective 1 –

Identify standards needed to support and implement AUD Electric Design

- **_Standards Dilemma - When No Standards Exist_**

  - If you do not have standards, strongly consider using an existing standard template

  - Can Use RUS standard

  - Template contains a base line of models, rules and structures to get an organization started

- ***Most Organizations Have Standards in Some Form***

  - An approach is needed to identify standards to work with AUD

  - Identify and use a mechanism to systematically achieve standardization and improved workflow (discussed in sections 2-4)

  - Find differences in the template, start with base style/symbol and model and slightly change as needed (attributes, style, ports)

- ***Compare the Electric Feature Standards Pole Head Example: (Your standards vs AUD standard)***

  - Model Standards example - 3D overhead model with ports, levels and various attributes
  - Comparison of attributes includes
    - Primary Voltage
    - Connected phase – Three Phase vs. Single Phase
    - Arm Length
    - Pin (insulator) configuration
    - Neutral Location
  - Once a suitable RUS design was determined the 3D model was then associated to Colorado Springs CU's

- **The construction detail and Colorado Model and AUD standard model name in our example:**

Colorado Springs CU	Description	RUS Associated Construction Specification
E.AR-15KV-3PH-SGL-8	3-Phase Crossarm Framing, 15 kV, single 8'	C1.11

CSU Construction Standard

Steps to Perform Comparisons to AUD Standard Template

- When standard is not available, created new 3D models from scratch (example: alley arms).

- Most attributes are in industry model.

- When using standard model we can query attributes through the AUD Rules.

- Use most likely match, limit variables needed to update including:
    - Symbols, Engineering Calculations, type, KVA, etc.

- No standard, then use most similar standard template. This standard template will have basics of what you need.

- Meeting AUD standard will provide a higher confidence of compatibility with rules and engineering calculations with AUD out of the box.

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CSU Standards Background as an Example

- CSU has approximately 1900 CUs for electric, with more than 50% of electric equipment having some form of customization

- How standards of Models/CUs is represented, with minimal changes of AUD out of the box, is key

- When mapping your electric features to the standard, even if nomenclature is different, keep "Categories" grouping (i.e. Model Group) and use models similar to standard template

- Strongly consider keeping base attributes of components that exist in the AUD out of the box template and adding your own

- This helps with applying rules through filtering and sorting

- **_Examples of What Can be Leveraged Out of the Box with Slight Adjustments_**

    - Our slight adjustments initially included:

        - Pole Heads = Cross Arm Framing, but we kept the pole head category
        - Kept Jboxes, but used as a Handhole structure
        - LBU = Load Break Unit is used as a Fuse Feature Class

    - It may be necessary to sort out some of the names through filter and sorting

- **Functionality We Gained Out of the Box**

  - AUD can select appropriate pole heads/cross arms for conductor

  - AUD can select appropriate pole size for conductor selected

  - AUD can tie specific equipment to appropriate level

  - AUD can size transformers

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- ***Use Structures Where Possible***

  - Use AUD built-in relationships

  - Generate identifiers on structure first, if necessary use device

  - Structure and device impact hierarchy to be used in API and other system

  - Can have structure and devices in same model (i.e. transformers and pad in same model)

Model/CU Comparison: Our Approach

- Least Common Denominator approach is taken

- Find out what is needed and make sure it has all the necessary storage for attributes and compare models

Sample of Alley Arms not having Compatible AUD RUS Standard CU

- Here we have a 3D Model from AUD out of the box and a corresponding CU
- We match the attributes and migrate them over to the new AUD standard
- Where attributes do not exist we add them and populate them

AUD 3D Model Name	CSU CUID	DESCRIPTION	RUS COMPATABLE CU
10' Double Alley Arm 3D(3)	E.ALLEY-15KV-3PH-DBL-10	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 15 kV insulators, double 10 foot wood arms & double insulators.	
10' Double Alley Arm 3D(3)	E.ALLEY-15KV-3PH-DBL10FG	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 15 kV insulators, double 10 foot fiberglass arms & double insulators.	
8' Double Alley Arm 3D(2)	E.ALLEY-15KV-3PH-DBL-8	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 15 kV insulators, double 8 foot wood arms & double insulators.	

Sample of No AUD 3D Model to match CSU Model/CU

| AUD 3D Model Name	CSU CUID	DESCRIPTION	RUS COMPATABLE CU
	E.ALLEY-35KV-3PH-DBL-10	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, double 10 foot wood arms & double insulators.	
	E.ALLEY-35KV-3PH-DBL10FG	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, double 10 foot fiberglass arms & double insulators.	
	E.ALLEY-35KV-3PH-DBL-8	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, double 8 foot wood arms & double insulators.	
	E.ALLEY-35KV-3PH-DBL8FG	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, double 8 foot fiberglass arms & double insulators.	
	E.ALLEY-35KV-3PH-SGL-10	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, single 10 foot wood arm.	
	E.ALLEY-35KV-3PH-SGL10FG	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, single 10 foot fiberglass arm.	
	E.ALLEY-35KV-3PH-SGL-8	3-Phase Alleyarm Framing (Tangent & Small Angle Structures), 35 kV insulators, single 8 foot wood arm.	

Sample of AUD standard Model that matches CSU Standard Models/CUs, but still no 3D Model

AUD 3D Model Name	CSU CUID	DESCRIPTION	RUS COMPATABLE CU
	E.AR-15KV-1PH-DBL-8	1-Phase Crossarm Framing, 15kV, double 8' arms	A2.21
	E.AR-15KV-1PH-DBL8FG	1-Phase Crossarm Framing, 15kV, double 8' fiberglass arms	A2.21
	E.AR-15KV-1PH-DDE-DBL-10	1-Phase Crossarm Framing, 15kV insulators, double deadend on double 10 foot arms.	A6.21
	E.AR-15KV-1PH-DDE-DBL10FG	1-Phase Crossarm Framing, 15kV insulators, double deadend on double 10 foot fiberglass arms.	A6.21

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AUD Requirements and Technical References for Pole Head Example

- Each of the last two cases, we could not identify a model to use as we found differences comparing CSU standards to AUD template standards.

- When Model is not found, we will then need to create one.

- In this case since it refers to an Overhead Pole Head (Alley Arm); refer to "Autodesk® AutoCAD® Utility Design 2014 – 3D Model Creation for Pole Head" from subscription center White Paper.

- This White Paper refers to the settings and adjustments required to setup the 3D model for the Pole Head Feature which includes: Block Origin, Radius of the Pole, Ports and lastly, Pole Head.

- How do we reconcile when no 3D Model/CU exists for our standard in AUD 2014?
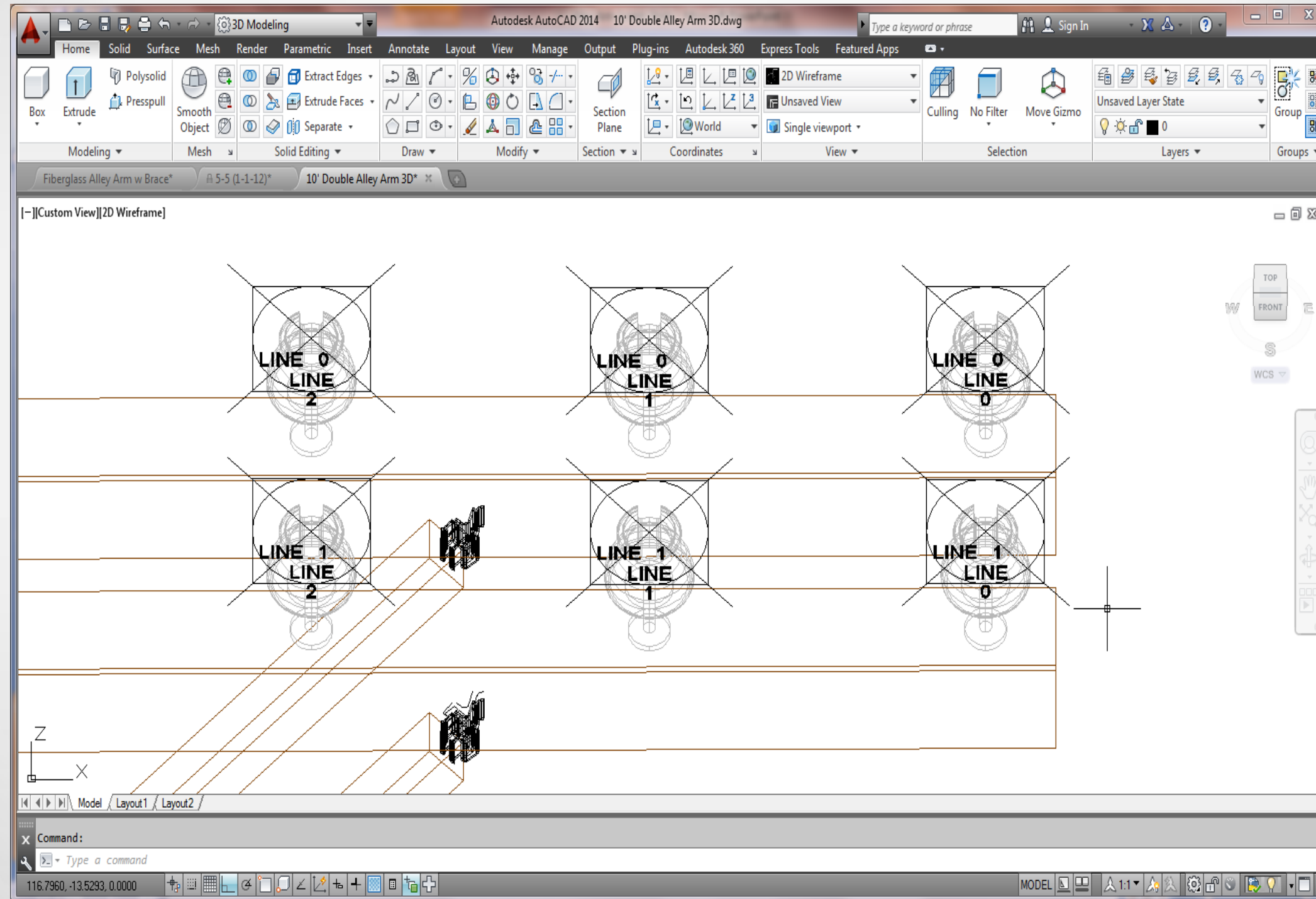
Acquire construction standard for Pole Head
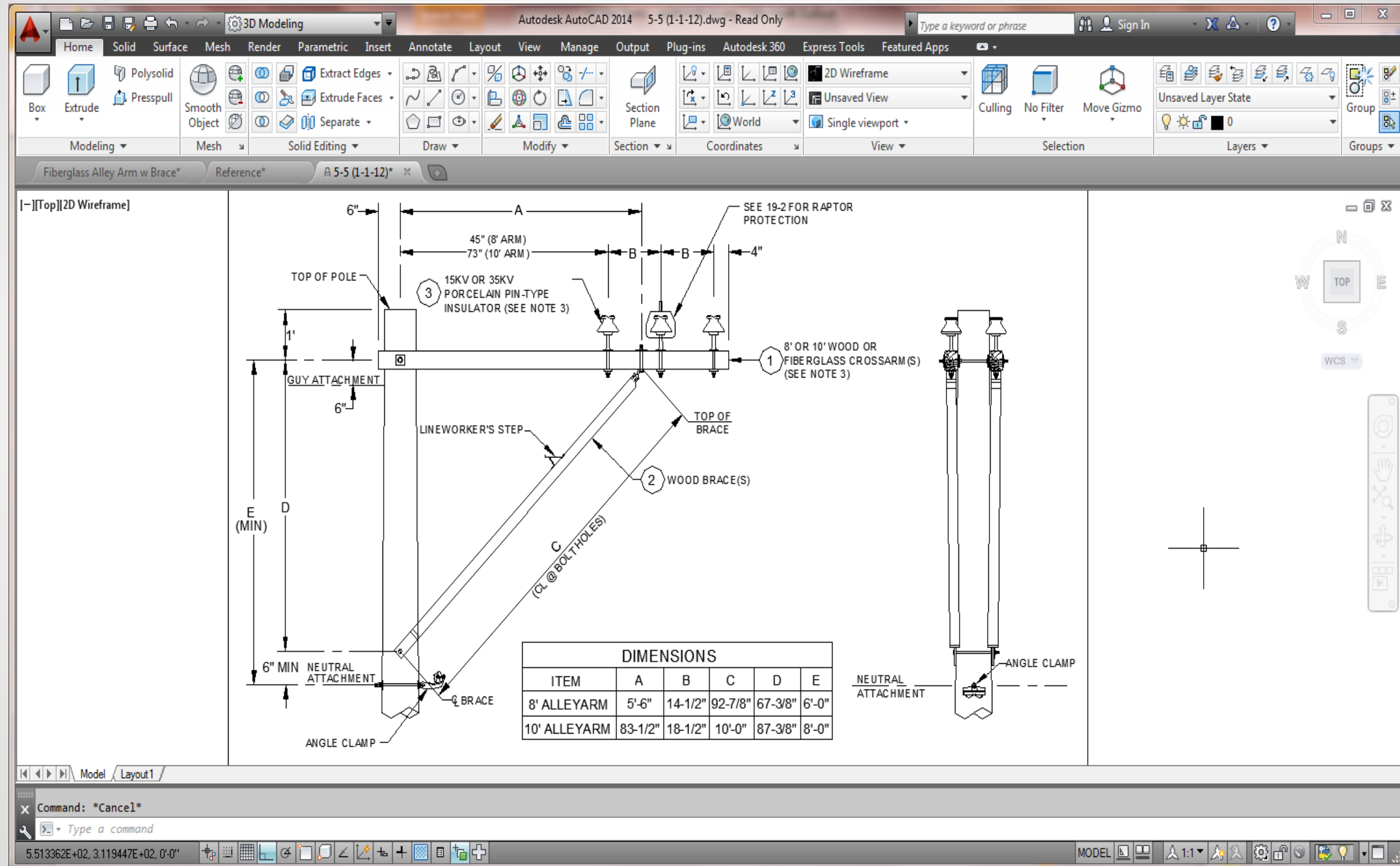
- *Draw Pole Head to scale (Start with copy of an existing RUS 3D model)*
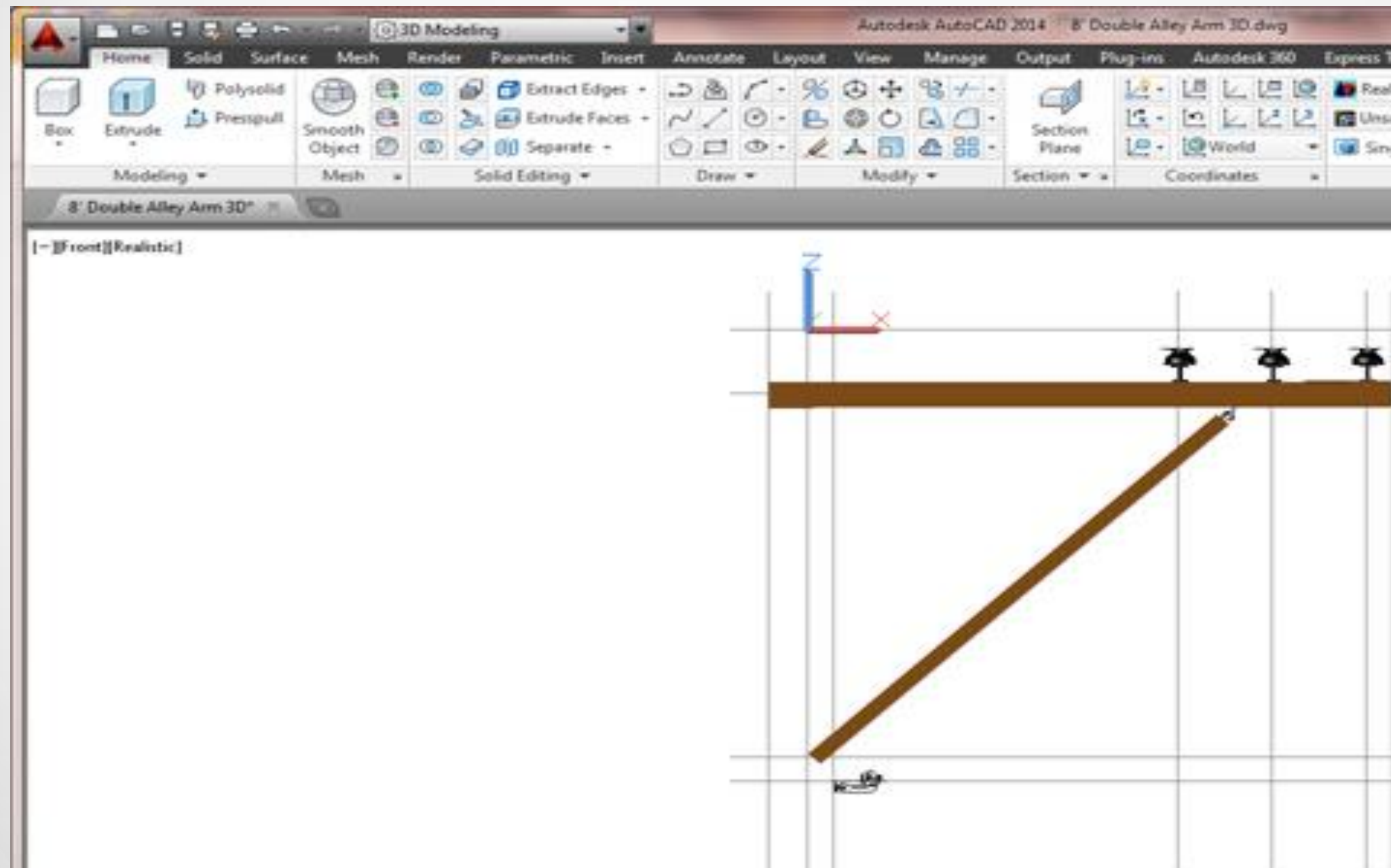
Orient Pole Head in space per Utility Design 2014 - 3D Model Creation for Pole Head white paper (i.e. top of pole at location (0,0,0))
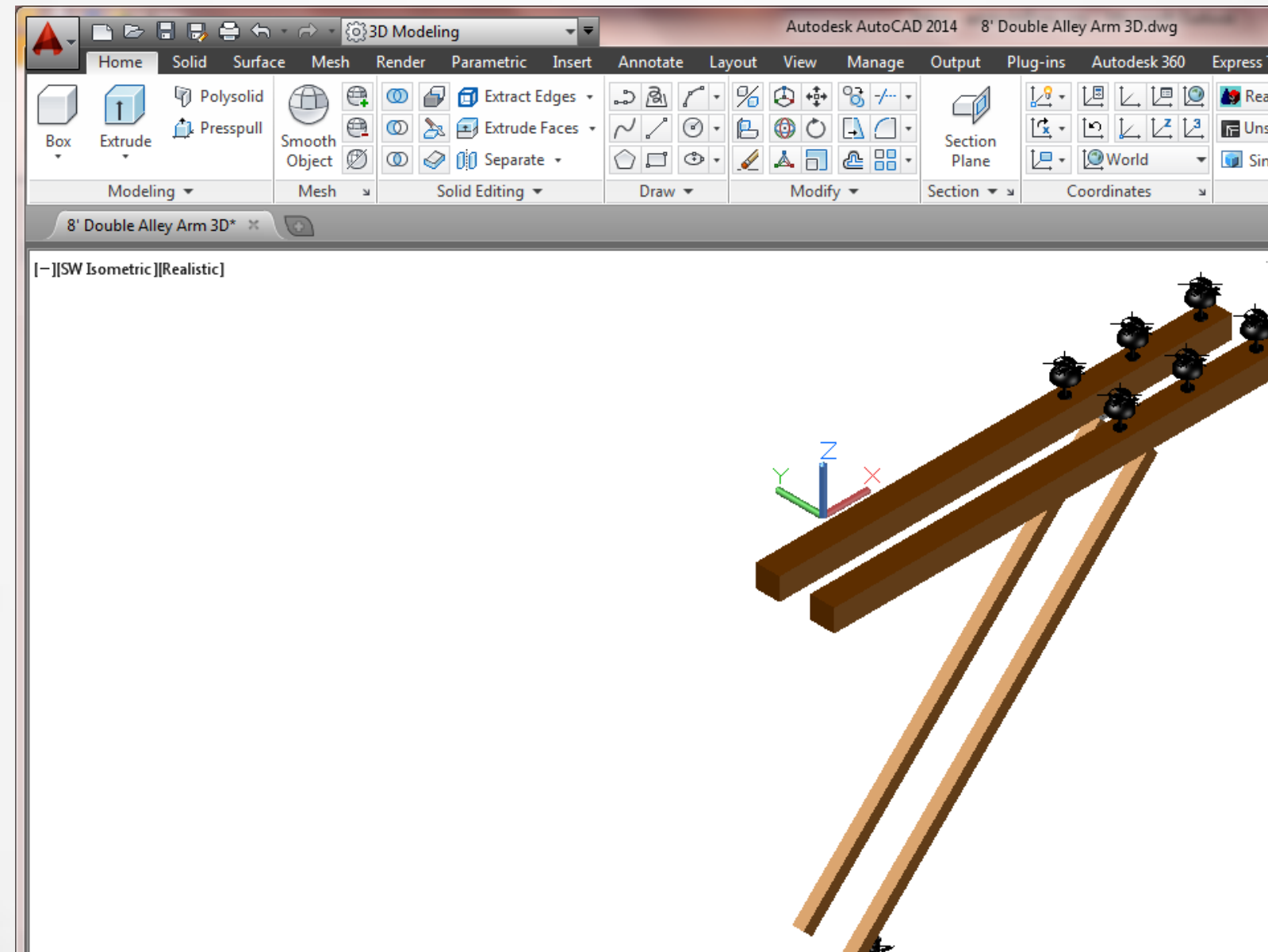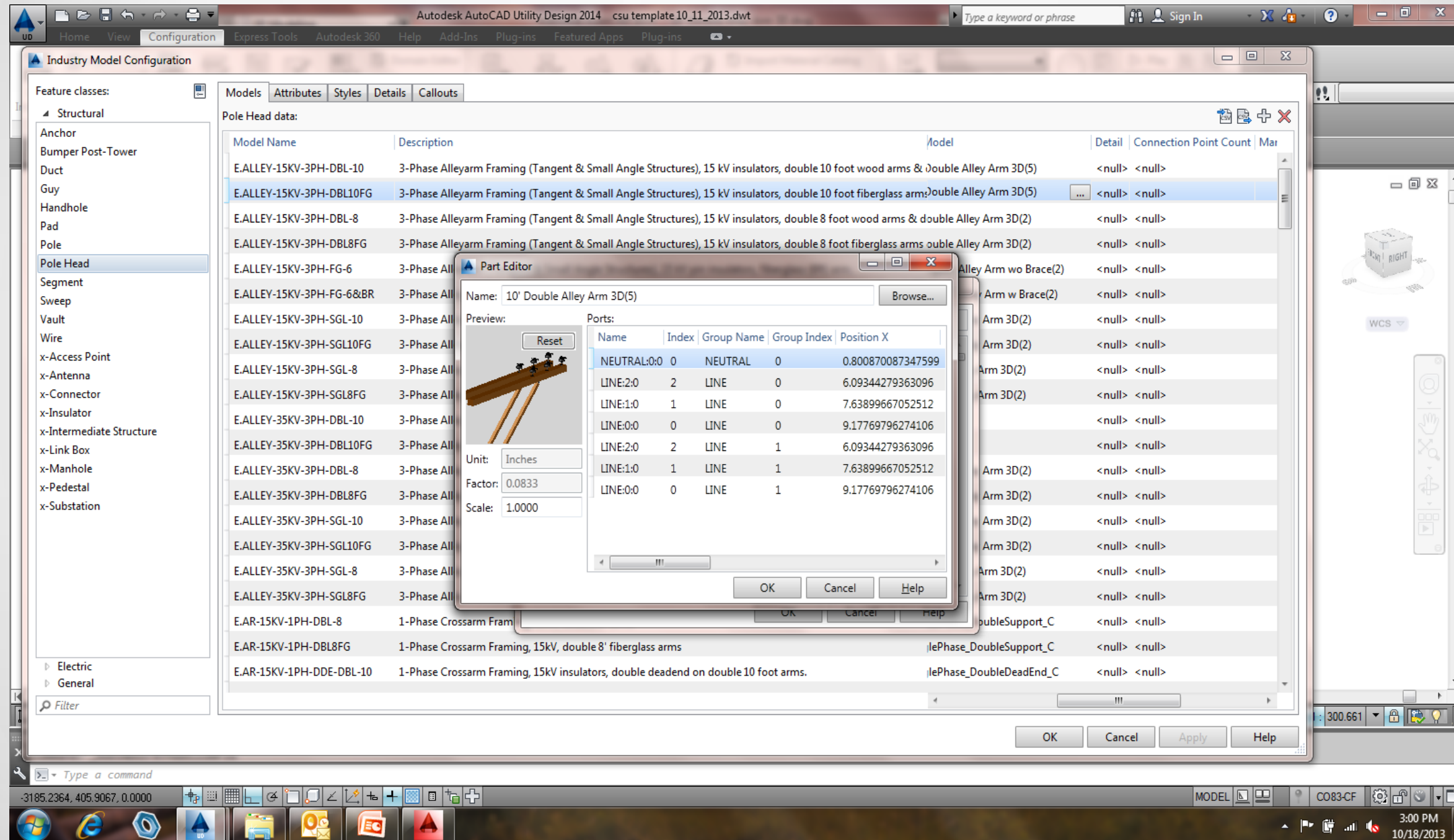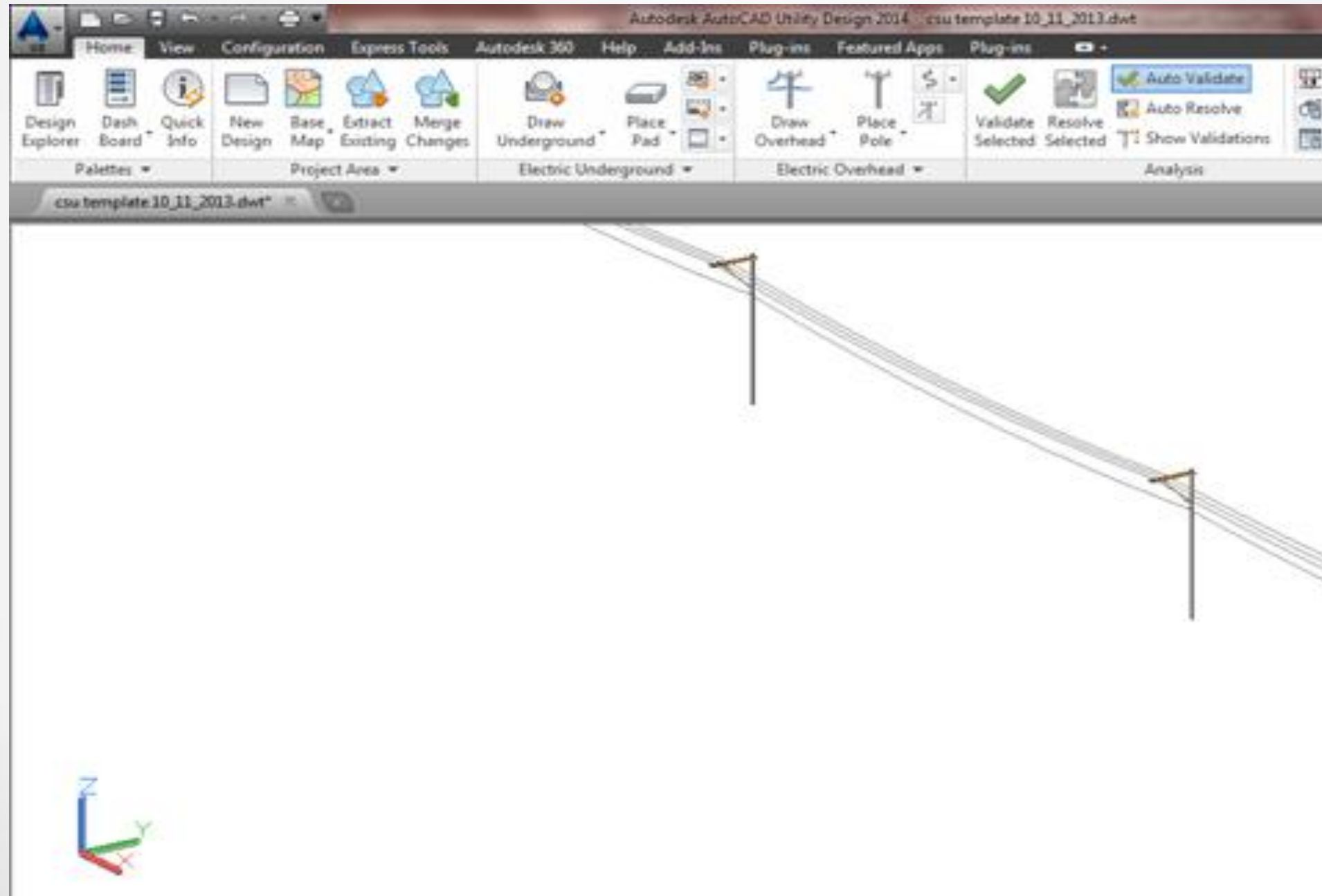
Assign Ports (Copy from an existing RUS model)
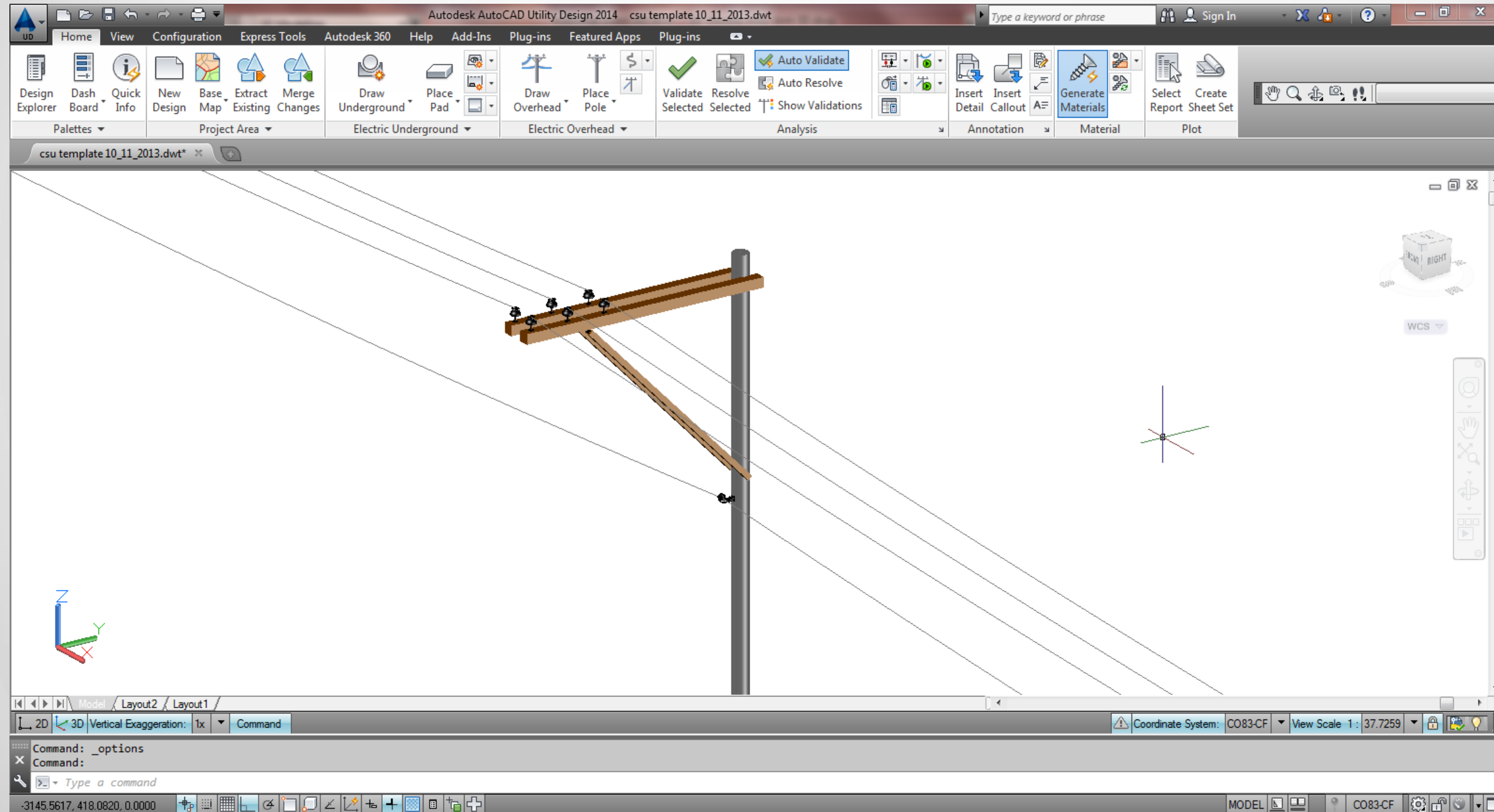
Load into Industry Model and assign to a Pole Head Model

- *Draw Pole line to test and observe at different scales and views to verify*

Individual Pole View or Layout and Ports Assignment

- We iterate through this process for each feature we need to standardize. Most are simpler than the pole with polehead/crossarm.

Learning Objective 2 –

Walk through an existing workflow of a utility implementing AUD 2014 Electric

Consider Looking at Business Processes Critically

- We need to identify where inception of business information occurs and events that trigger it

- There are existing systems and processes in place, but require business analysis to review workflow

- This will tighten our work processes through simplifying workflow and leveraging various systems' strengths for the utility

High Level Information and Flow by Systems We Know Internally

- **Billing** needs information to bill depending on accounts, services and agreements

- **Field Inventory** needs ways to categorically group equipment and identify assets

- **Work and Asset Management System** (Maximo) manages work management, supply chain, and warehouse materials

- **Asset Management** needs a means to document installed assets to show in digital map books

- **GIS** provides map books of macro information, mostly structures and higher valued assets (transformers), key access points (vaults, poles), and switching

- **Finance** needs capital outlay, job trends, and specifics about streetlights and pole attachments

- **Outage Management** uses information from GIS and Asset Management

Questions to Understand Our Workflow

We now put together some critical questions to determine our workflow from business information and records of source and management perspectives.

Record of Source Questions

- Where must information record be to support billing?
- Where must information record be to support regulatory requirements?
- Where must information record be to support field inventory?
- Does asset hierarchy of location and equipment belong in RMS when it starts in AUD?
- Where must assets be installed to document network is energized?

Relationship Questions

- How do we associate materials to physical structures (Physical)?
- How do we associate materials to network connectivity (Logical)?

Questions to Understand Our Workflow (cont)

- ## Location Questions
  - How do we want to identify location by job type?
  - What information would be most helpful to help identify area and assets?

- ## Identifier Questions
  - What identifier can we build that has intrinsic value and keeps features unique?
  - What of previous design elements do we need to carry forward for needed documentation and process that can be used for unique identifiers?

- ## Association/Grouping Questions
  - How shall we group our AUD features in general?
    - Logically?
    - Physically?
  - Map grid, subdivision name, circuit, equipment to structures?

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Learning Objective 3 –

Design a conceptual model to support Work and Asset Management, Field Inventory, GIS and Billing Systems

Our Model we Design from Requirements is focused on Data Attributes and Job Workflow

- Each requirement will apply to a streetlight AUD feature

- What attribute is needed and by which department:

	AUD Streetlight Attributes							
Department	Address	LID	SID	SPID	Rate	XY	Logical	Physical
Billing	Y			Y	Y	Y		
Field Inventory	Y	Y	Y			Y	Y	Y
RMS	Y	Y				Y	Y	Y
Asset Management/GIS	Y	Y	Y			Y	Y	Y
Operations Maintenance	Y	Y	Y			Y		
Finance		Y						Y
Outage Management	Y	Y	Y			Y	Y	Y

LID: Unique ID

SID: Logical ID with Map Grid

SPID: Account ID

Rate: Charge Code

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Our Model we Design from Requirements is focused on Data Attributes and Job Workflow (continued)

- We will add attributes of Rates and SPID and address
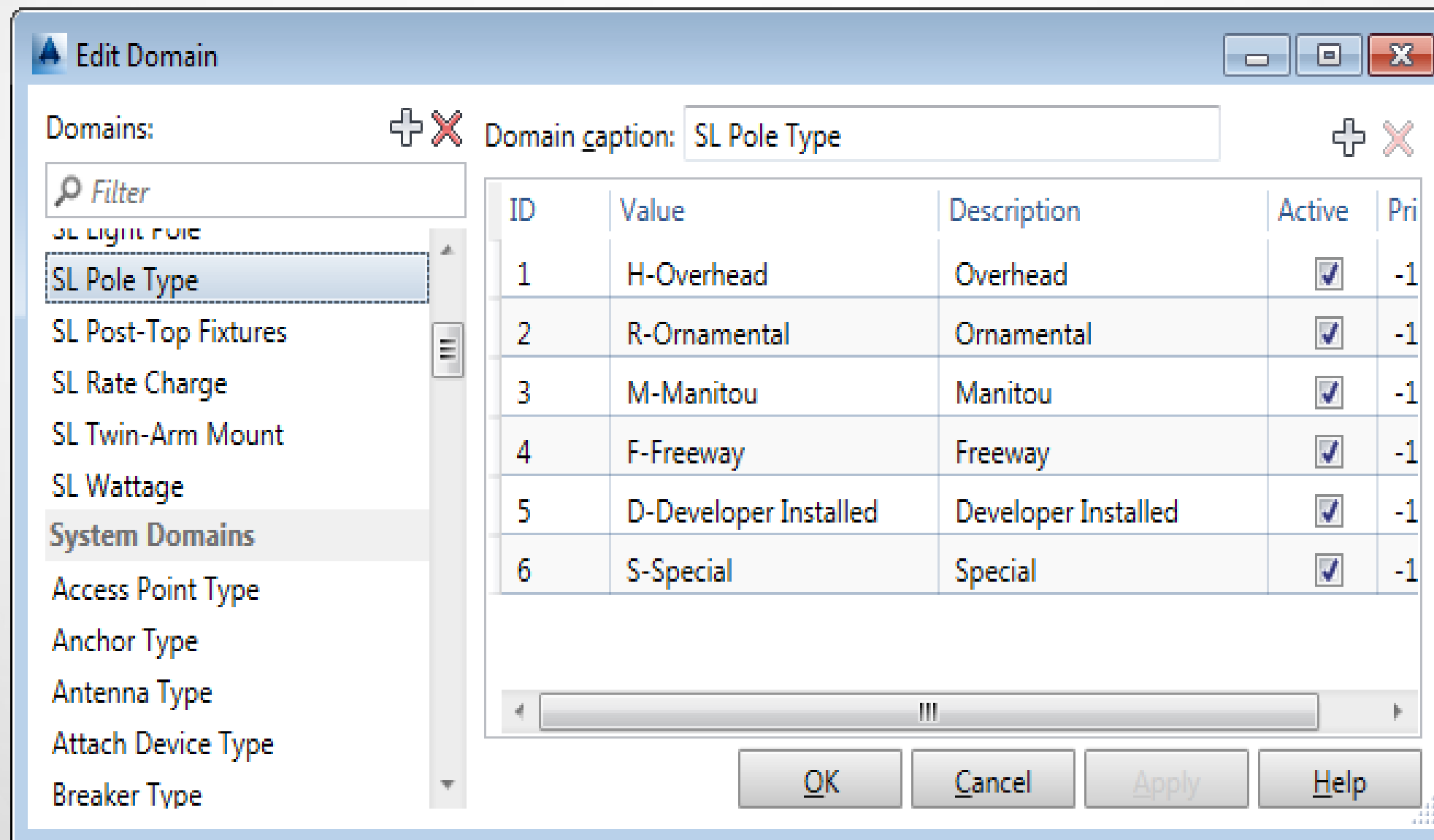
Our Model we Design from Requirements is focused on Data Attributes and Job Workflow (continued)

- This is a model adjustment using configuration and a domain
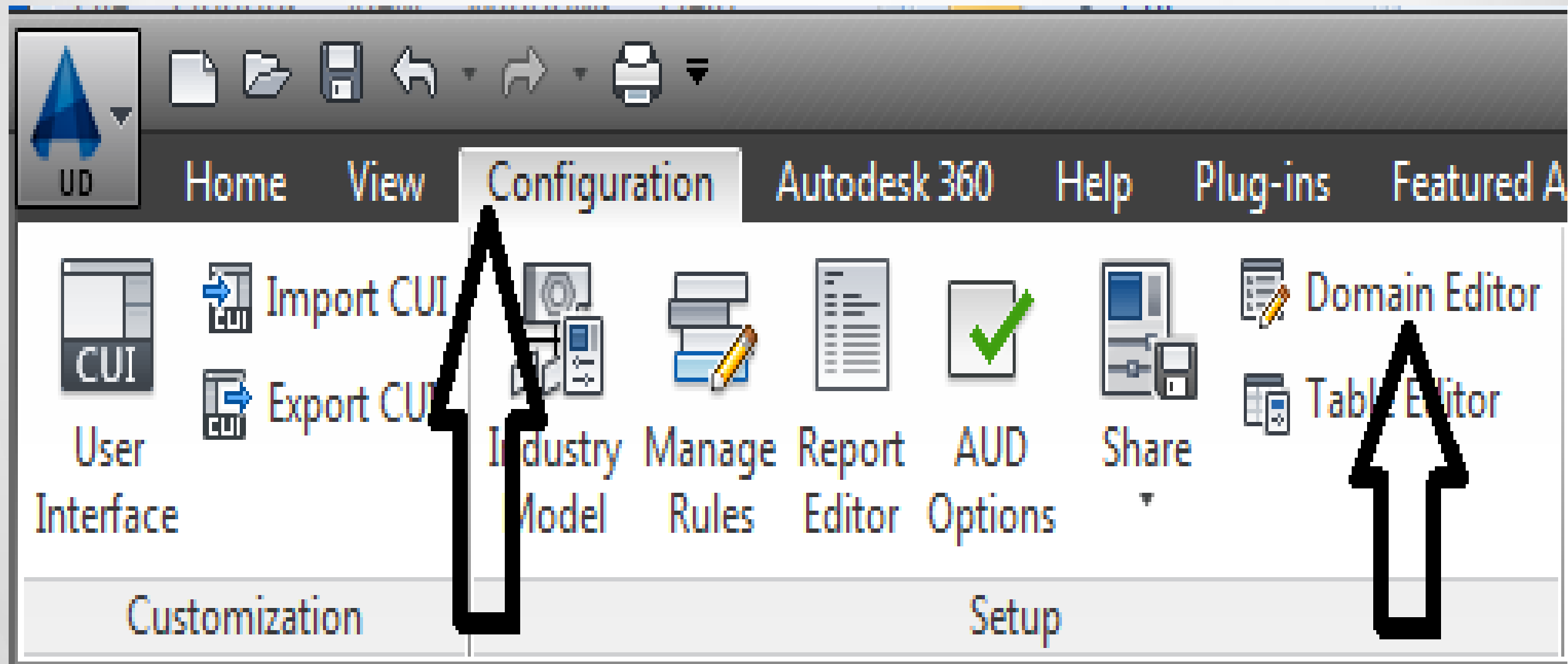
Our Model that we Design from Requirements is focused on Data Attributes and Job Workflow (cont)

- We choose the type of pole next
- Pole Type is a trigger to identify the LID, our unique identifier attribute

Our Model we Design from Requirements is focused on Data Attributes and Job Workflow (cont)

- Here we add Address Number and Street Name is required using AUD rules
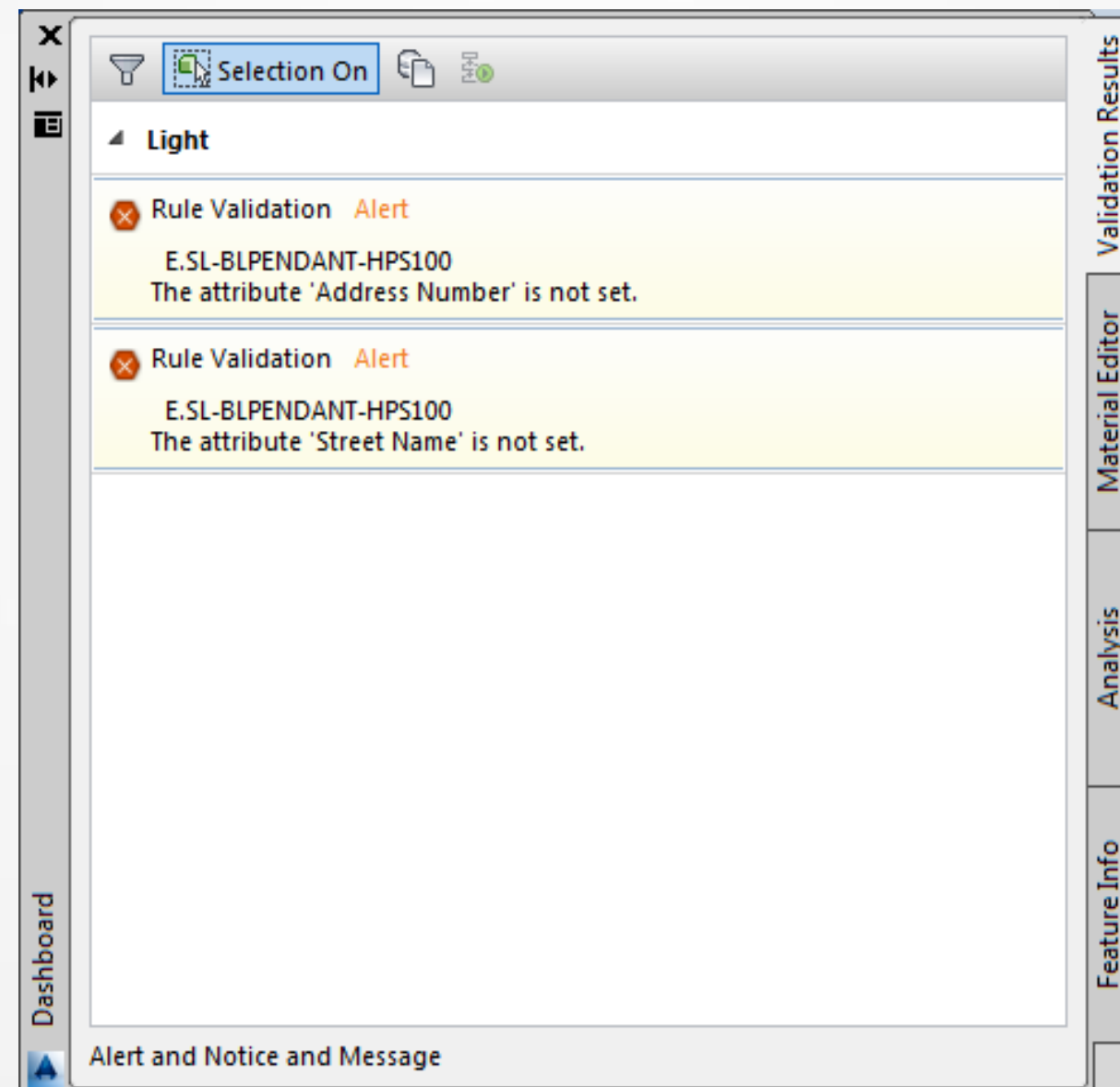
- **Conclusion: How Information Model is Used**

  - When AUD materials are exported, the streetlight address and billing information are sent to the billing system

  - The Work and Asset Management System will receive the location record

  - Field inventory will receive the billing information with asset information pre-populated for installation

  - Map information is made readily available for the GIS

Learning Objective 4 –

Construct and utilize engineering information through downstream and upstream system integration.

Functions Built to Accommodate Business Challenges

- CUIX on AUD Ribbon
- Plug-in .Net dll

Which can be seen more clearly here; specifically, we have 5 functions from left to right.

# *Get Work Order* (Get WO icon) – *how we start the design process*

- This will fill our job header information, allowing us to setup a job and work request and produce job prints in several layouts

- Each layout has the respective job information – one of the layout blocks with the work order information follows:

- **Export BOM –** This function sends our bill of materials to Maximo for costing, estimating, and installation

- **Write Material List –** Prompts the user to insert the specification list with LID identifiers
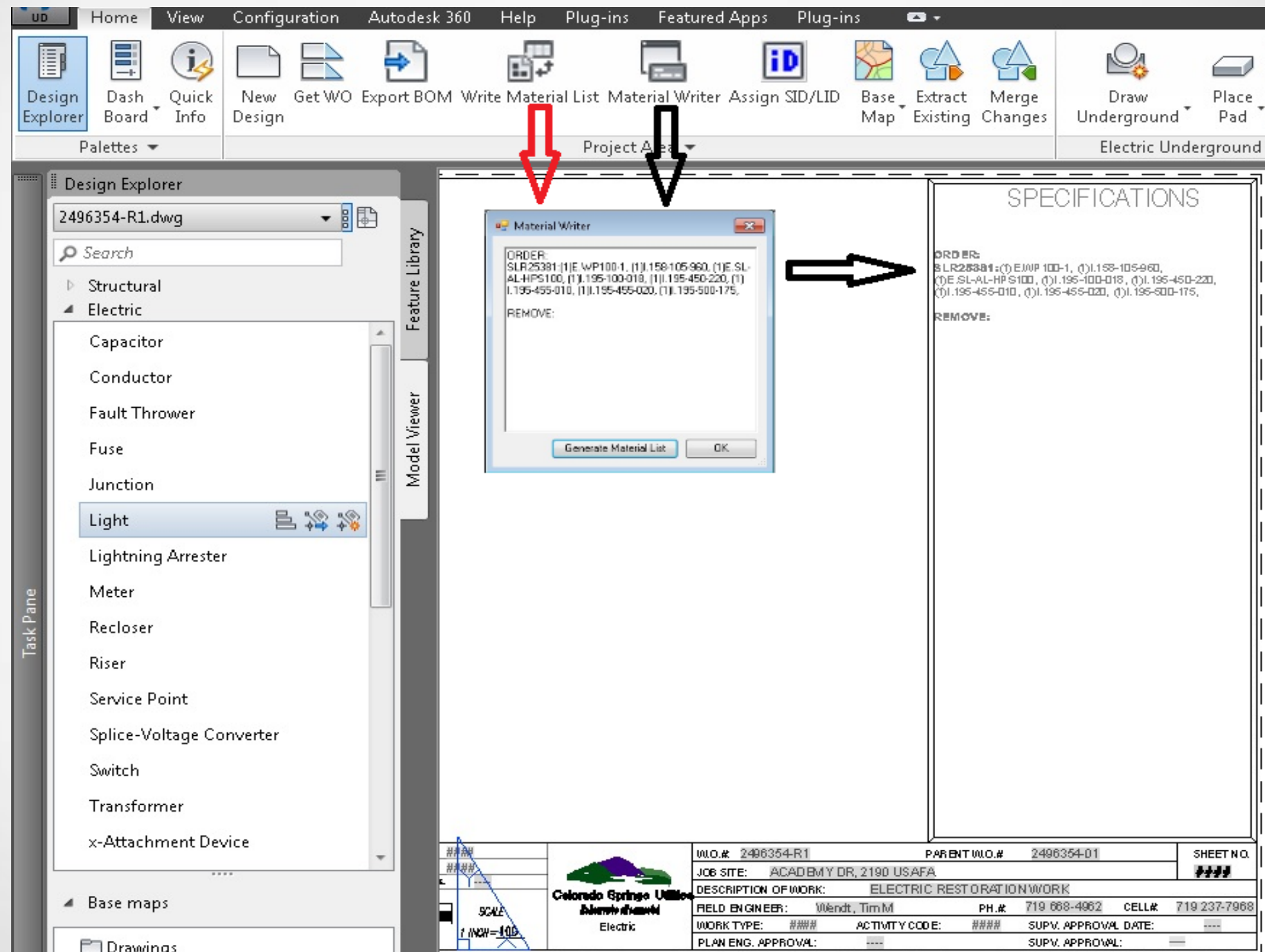
MaterialWriter

- The output of this command Equipment organized by SID and LID to Order and To Remove
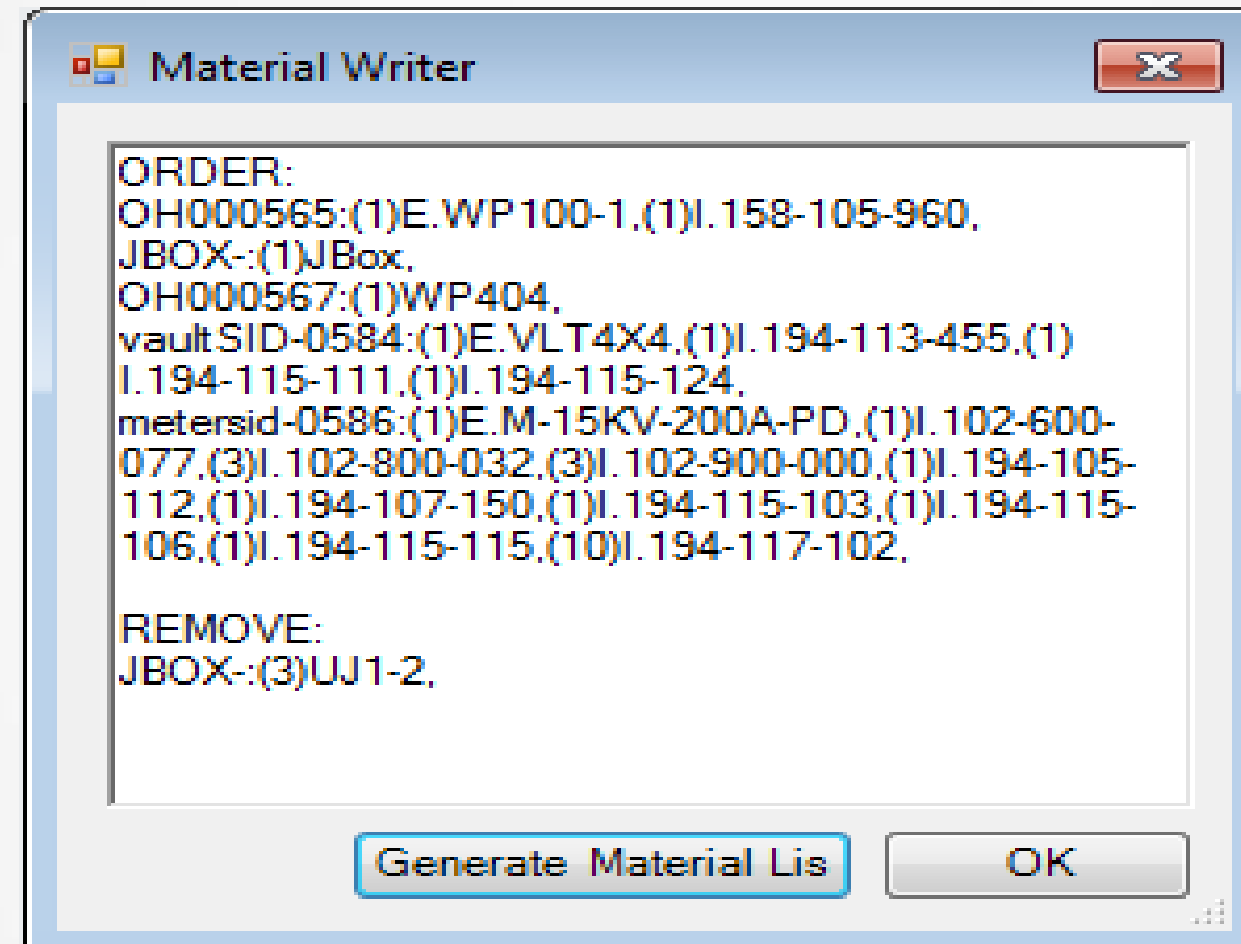
- When accepted, generate material list will place this on the page title block

- To design your job:

Assign SID/LID

- We build integration "hooks" into the other systems

- We dynamically create LIDs for Pads, Vaults, Poles and Streetlights

- We create SIDs identifiers to assist with what, where, and unique identification for schematic drawings

  - Underground design - we use subdivision or site prefix and increment
  - Overhead design - we use the voltage and a map grid (3000 x 4000 feet grids used in our mapping system in Colorado State Plane Coordinate System Central)

- When adding a work location to a structure LID and SID, values are labeled on the design

- Work location block is supplemental information used to group materials to sites

How we built interconnection between AUD and other systems mostly Out of the Box

- We connect our information from different systems together through server side views having joins between tables in different Oracle databases wherever possible

- We read and write the data through Oracle stored procedures exposed directly as stored procedures and also as REST and SOAP web services

- We use AUD "Custom Rules" (sample in AUD .Net API) when device or structure is being validated to determine if SID and LID have been set

- We access the custom rules through contexts exposed in the Rules Engine of AUD

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- .Net custom rule to access the Web Service and Oracle end points - action and setting of values occurs in AUD seamlessly.

An example of using the ActivityContext is here:

```csharp
protected override DynamicValue Execute(CodeActivityContext context)
{
    string methodName = MethodBase.GetCurrentMethod().Name;

    ErrorManager.Info(className, methodName, "Entered Method");

    string vaultCode = string.Empty;
    //The feature can be used as is or can be cast to the type of feature
    IFeatureItem featItem = this.Feature.Get(context);

            // This is the entry point to call CSU code that calls their procedures to
            //generate Vault Codes values
    //Call CSU code to generate Vault Codes...

    string sitePrefix = String.Empty;
    sitePrefix = featItem.GetAttribute("SITEPREFIX").Value.ToString();
    //note you will have to use the proper name.
    ErrorManager.Info(className, methodName, "SITEPREFIX feature attribute value = " + sitePrefix);

    CSU_IdentifierGenerate idgenerate = new CSU_IdentifierGenerate();
     //add coordinates here
     vaultCode = idgenerate.GetVaultCode(sitePrefix);
     ErrorManager.Info(className, methodName, "Vault Code value = " + vaultCode);

     idgenerate = null;
    //return value to the AUD Rules
     ErrorManager.Info(className, methodName, "Exiting Method");

     return vaultCode;
}
}
```
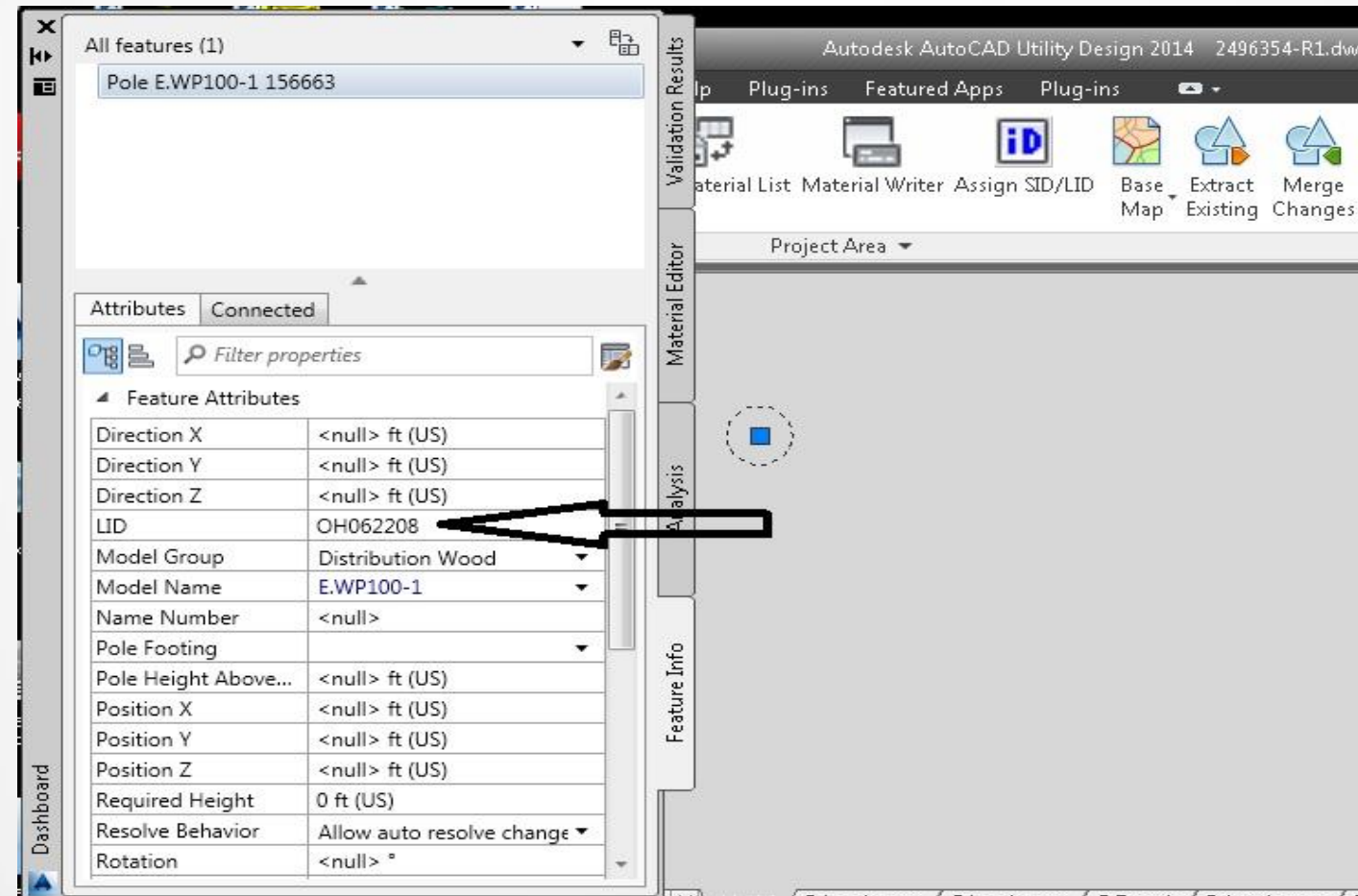
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- *Integration and Rules to Other Systems: LIDs and SIDS*

- *Example 1: Overhead Poles and Location Identifiers*

  LID = OH062207, OH062208 = OH + series(generated)

- ***Example 2: Streetlights and Location Identifiers***

  LID = SLX26001,SLM26002 = SL + Type + Series(generated)

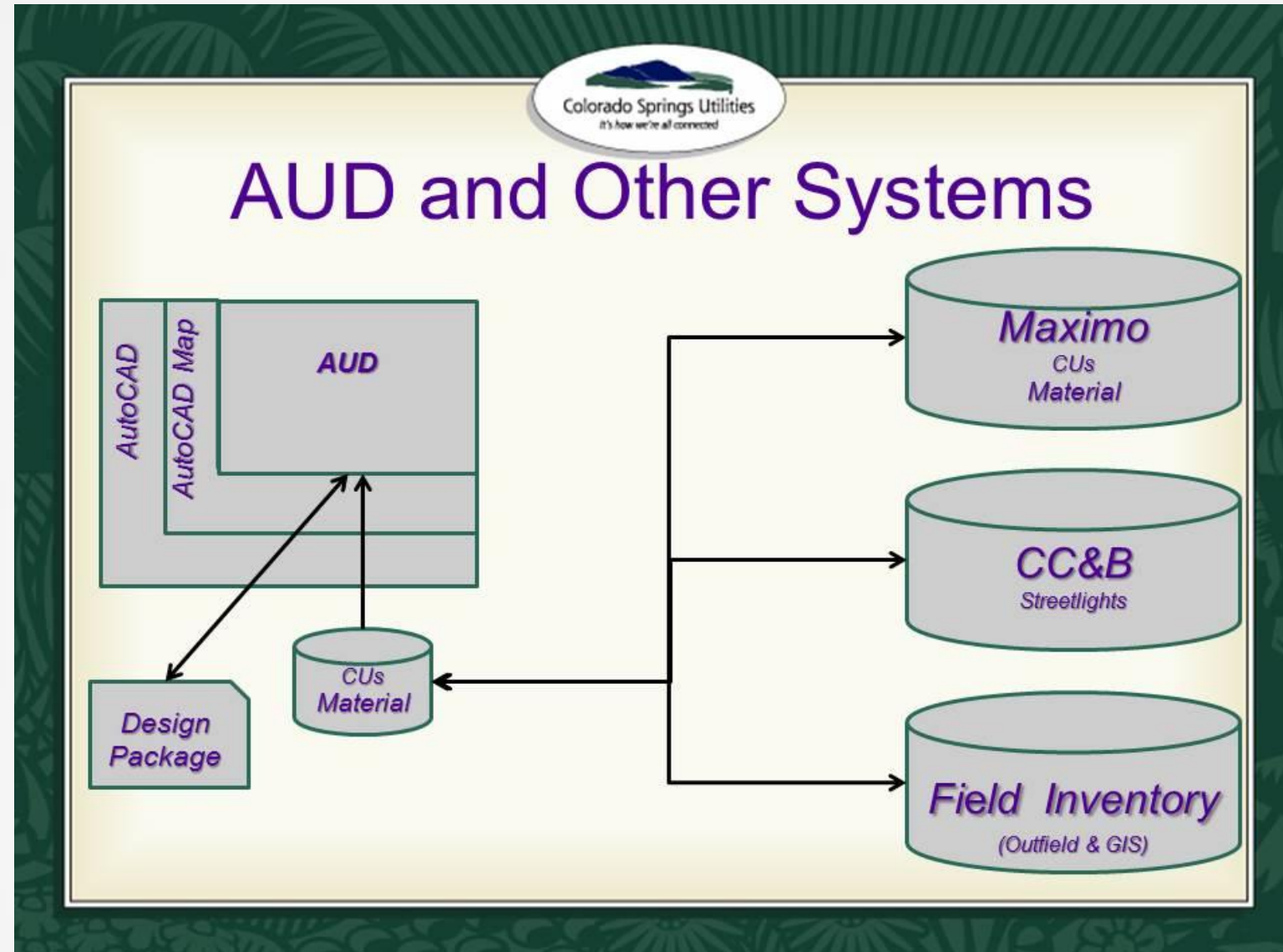- ***Example3: Underground Vaults and Site Identifiers(SIDs)***

  SID = CVR-1, CVR-2 where Siteprefix = CVR + Series(generated)

- ***Example 4: Overhead Switch Site Identifiers***

  SID = Nominal Voltage(12) + Mapgrid(from XY) + Series(generated)

Information Flow from AUD to Other Systems

- Use Features in Information Model
- Use custom rules and .Net code to send information to other systems

Implementation Parts

- Configuration of AUD Rules engine
    - Used for validation, ordering, and labeling (callouts)

- Customization
    - .Net Plug-in (plug-in model to simplify development and deployment)
        - Interacting Accessing data via Autocad Map FDO Providers (for our material list)
        - Native Oracle .Net Providers and web services
        - AUD .Net API to access our industry model with model attributes and custom attributes

- **_There can be many AUD representations for the same feature_**

  For example <u>a streetlight is</u>:

    - an asset to asset management
    - a maintenance item to work Management
    - a mapped point feature to Mapping
    - an item to Bill that must have a rate class and type associated
    - an electrical device that can be attached to a pole or unto itself
    - an item of concern that changes through maintenance and could be subject to an outage

AUD Feature Information to Other Systems
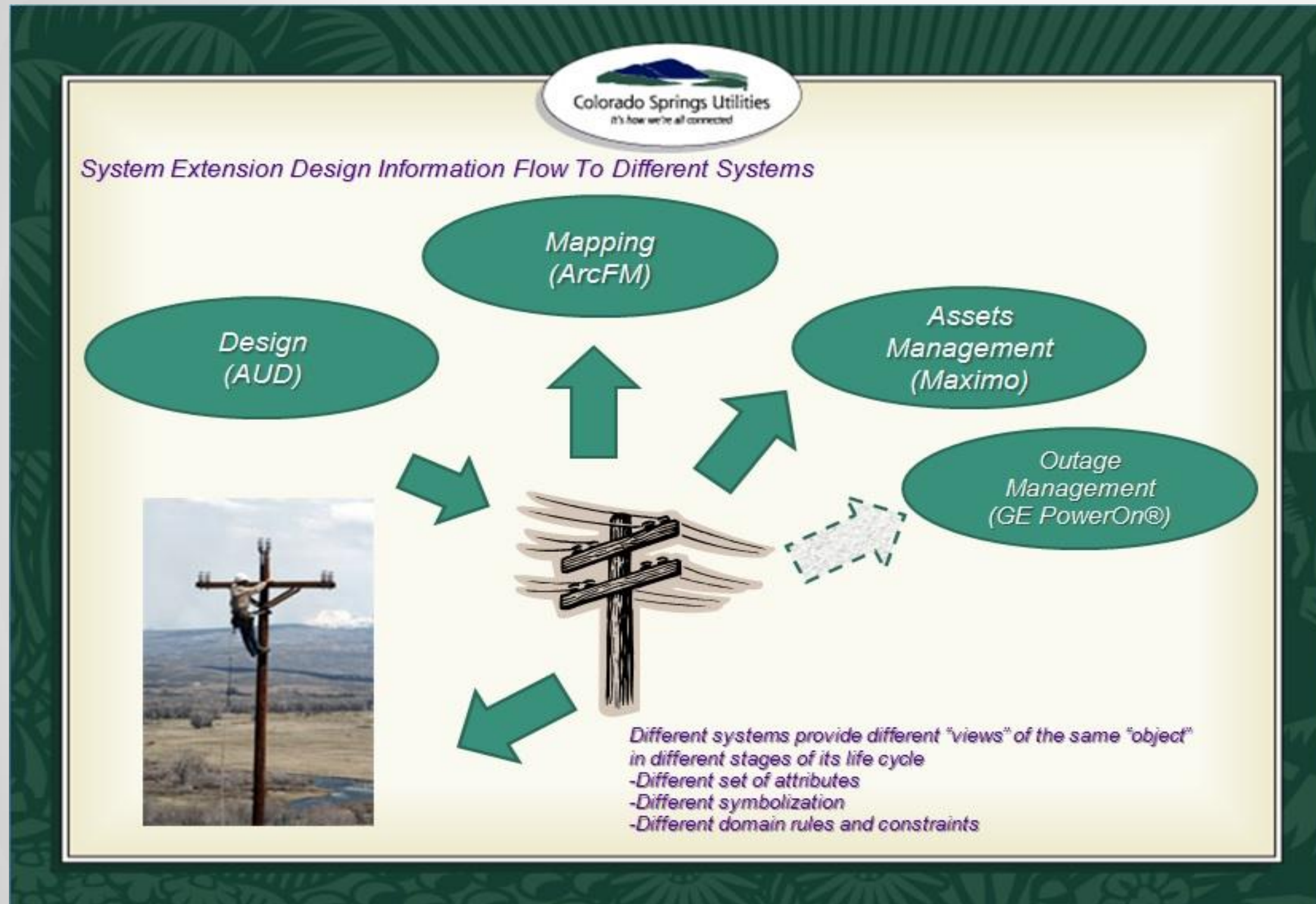
Key Benefits

- **Each system's strength is leveraged**

- **Survey and design system solution once and do it well**

- **Use core product and subscription where possible - keeping it simple and configured**

Thank You for Your Interest!

- **Questions?**

- **Contact Information**

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  http://www.csu.org

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