

EN*Engineering*



**Comprehensive and Dependable
Design Technology Innovations**



ABOUT US

What We Do and Who We Serve

EN Engineering is a leading national engineering services firm providing comprehensive design, engineering, and consulting services to gas and electric utilities as well as other energy and industrial end-markets. With over **1,800 professionals** in over **35 offices** nationwide and Canada, EN Engineering offers customers an unparalleled spectrum of services with expertise in natural gas and oil pipeline infrastructure, gas distribution, electric power transmission, distribution and generation, automation systems, integrity management, and industrial and refinery solutions.





OUR AGENDA FOR TODAY

1. Brief Intro/About Us
2. Value of a Design Package
3. Standard or "Simple" Design Steps/Tools
4. Complex Design Steps/Tools
5. Scanning & 3-D Modeling
6. Data Driven Design
7. Data Systems
8. Risk Modeling
9. Machine Learning

*Excellence...
from start to finish*

Value of Drawing Packages

Projects that expand or improve natural gas distribution or transmission assets involve risks that are partially mitigated or managed through careful documentation. Engineered design drawing sets are a key part of this documentation. Having a fully developed design package can help with:

- Record keeping including change management
- Regulatory compliance
- Constructability
- Budget
- Public Relations

Key steps in developing a set of drawings include:

- Data Collection
- Basemap Development
- Detailed Design
- Final Construction Drawings



Standard “Simple” Design - Data Collection



The first step to creating an accurate distribution construction drawing package is to identify the project scope and **collect data of the existing conditions** to develop a base map. Many times a Professionally Licensed Surveyor (PLS) is not necessary. Instead the following provides sufficient information:

- **Aerial imagery**

- Google Maps
- Government Sites like USGS
- AZEO – Autodesk & Bing
- Microsoft Maps
- ARC GIS Software

- **Geospatial Information System (GIS) Data**

- Right of way information
- Existing utilities maps

- **Site Visit**

- Above ground features with GPS survey equipment
- Field measurements with measuring wheel
- High quality detailed photos

Standard “Simple” Design - Base Map Development & Detailed Design

COMPUTER AIDED DESIGN SOFTWARE:



The next step is to **geo-reference** and combine all of the collected data into a CAD software to develop a base map of the existing conditions which will ensure an accurate and **reliable design**. The CAD software used is typically dependent the customer preference and the Customer’s CAD standards if the have any.

▪ **Base Map Development**

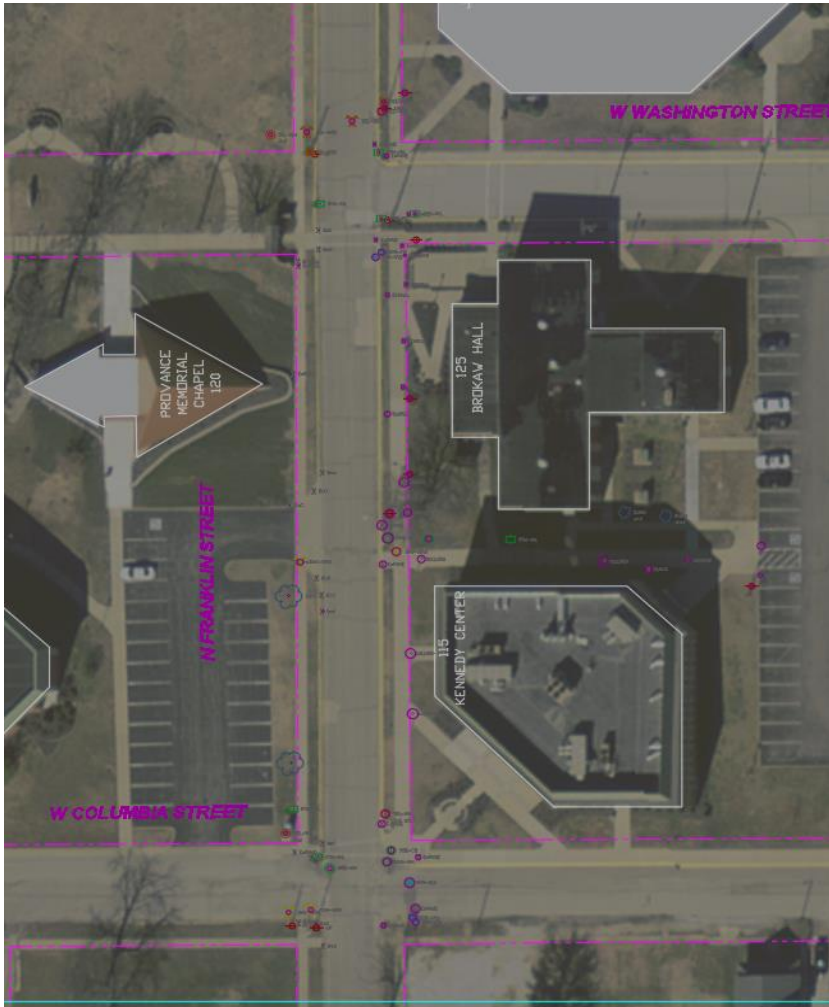
- Modify line types to correct CAD standard
- Label & Dimension existing utilities
- Label roadways and addresses

▪ **Detailed Design**

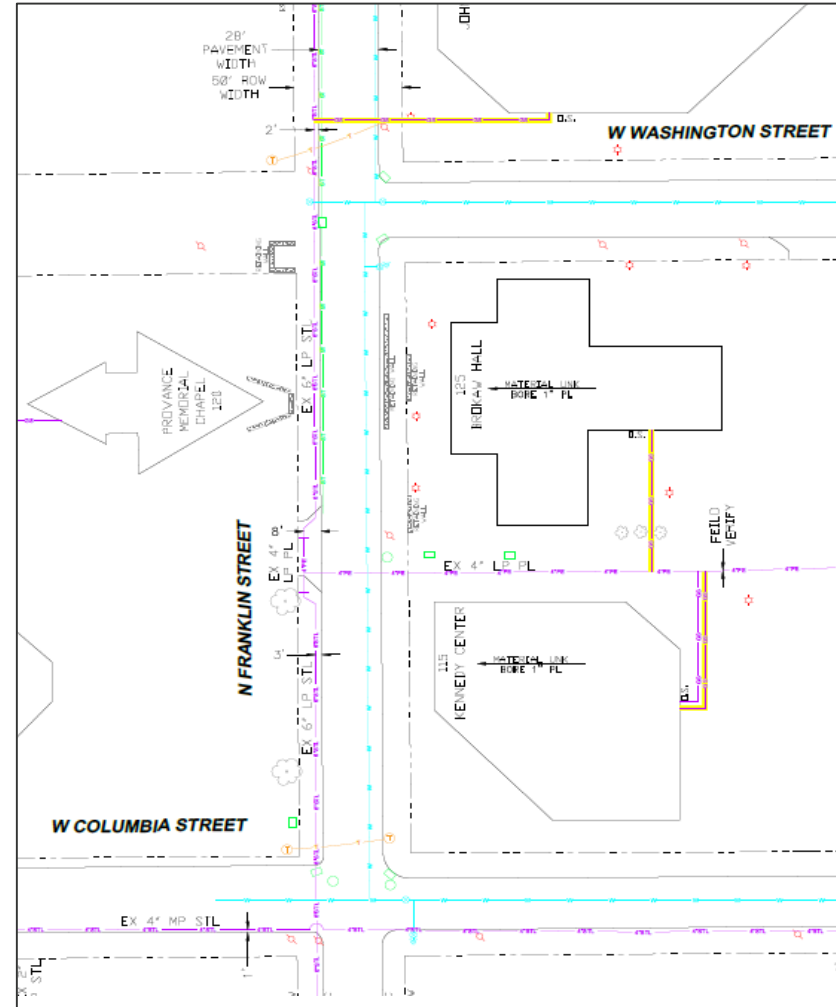
- Add proposed utility design
- Label & Dimension proposed utility
- Generate bill of material
- Create tie-in and retirement details

Standard "Simple" Design - Base Map Progression

Aerial, GIS & Field Data



Base Map



Complex Design - Large Pipeline & Facility Design

Large diameter pipeline networks and facilities transport oil & gas from producing areas to market areas. Often times these projects involve additional steps to ensure project scope is further defined and sufficient detail is provided to manage risks as previously outlined:

Pipeline

- Route selection & PLS survey
- Construction Drawing Package
- Alignment sheets of the piping route

Facility

- Data Capture
- 3D Modeling & Design
- Construction Drawing Package



Complex Design - Pipeline Route Selection & Survey



The first step to a successful pipeline project is to select the optimum route with consideration of **public safety, environmental impact, constructability, land ownership and cost**. Once the pipeline corridor is identified then land & subsurface surveys are conducted to **obtain data of the existing conditions** to develop alignment sheets.

- **Land Survey**

- Location of all above ground features
- Ground elevations
- Parcel boundaries

- **Subsurface Survey**

- Soil conditions
- Existing underground utility depths

Pipeline Alignment Sheets

COMPUTER AIDED DESIGN SOFTWARE:



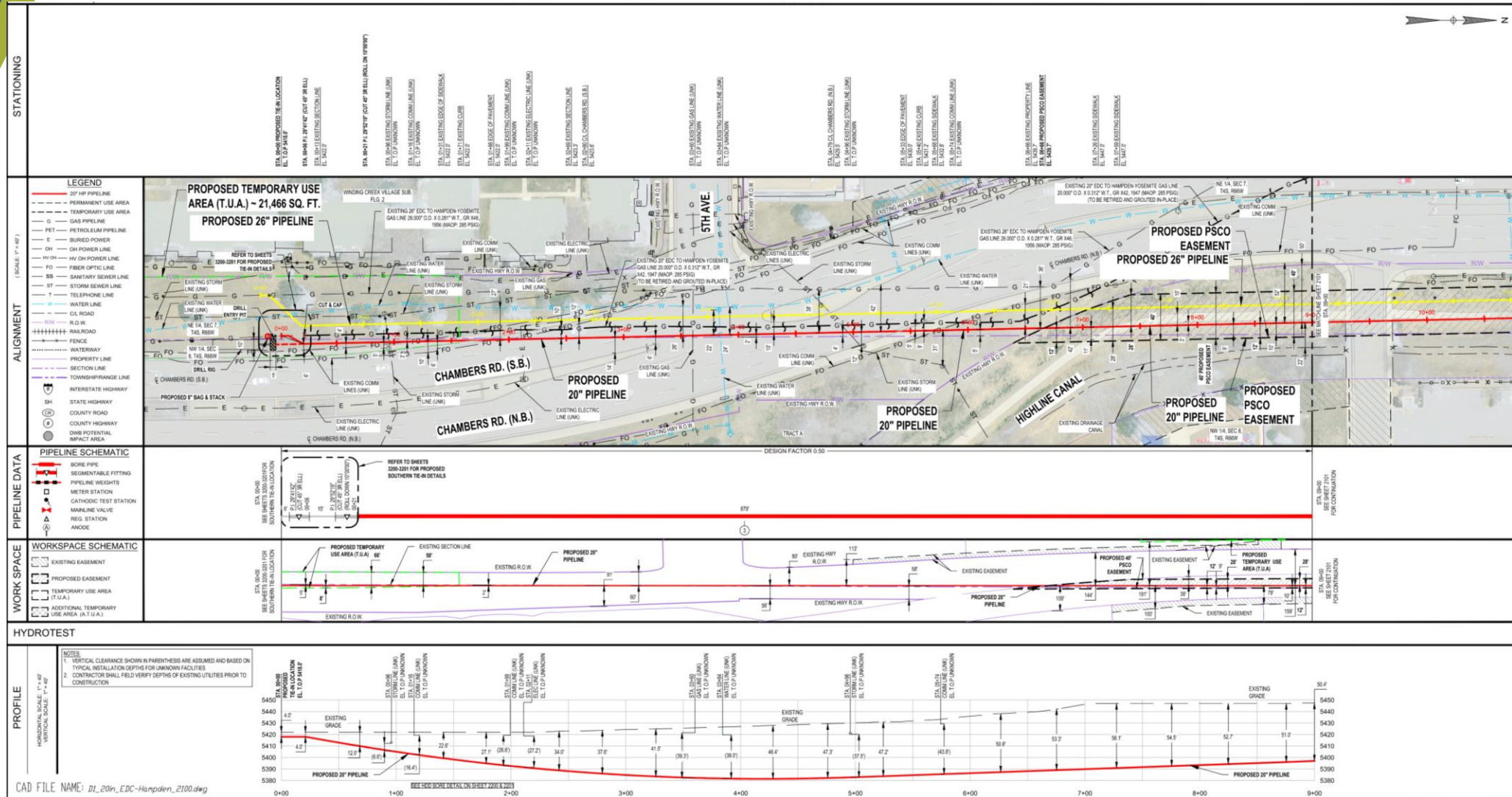
Civil 3D

**Civil 3D
Piping Networks**

Alignment sheets graphically show the **exact route and depth** of the pipeline and fittings. These construction drawings illustrate the following information to allow the contractor to install the pipeline suitably for the client:

- **Construction installation method**
- **Subsurface conditions**
- **Top of pipe elevations**
- **Pipeline utility crossing information**
- **Pipeline stationing**
- **Pipe specifications and bill of material**
- **Staging areas**
- **Environmental extents**
- **Land ownership data**

Pipeline Alignment Sheet - Example



Facility Data Capture

The first step to creating an accurate facility construction drawing package is to outline the project objectives and **capture data of the existing conditions** to develop a 3D model.

- **3D Laser Scanning Equipment**
- **Unmanned Aerial Vehicles (UAV)**



3D SCANNER DATA CAPTURE

FARO

Key Features

- +/- 2mm accuracy (better than 1/12")
- 60m/165m radius range
- Collect 976,000 points per second

Faster, More Accurate, Compelling & Usable Data



3D SCANNER DATA CAPTURE

FARO

Background

The goal of a 3D scanning is to create a digital representation of the existing conditions and to give designers and engineers virtual access to the site after the field visit.

Benefits

- 360-degree, non-contact measurement
- Easy-to-use equipment
- Guaranteed measurement accuracy
- Reduce costs

Output

- Point cloud/mesh data
- 2D & 3D Models
- Site plans & Elevation views



UAV DATA CAPTURE

Photogrammetric Mapping & Modeling



Background

UAV to capture aerial data at low altitude with downward facing sensors. During flight the ground is photographed several times from different angles and each image is tagged with coordinates. From this data, the photogrammetry combines images to create geo-referenced maps & models.

Benefits

- Provide high resolution & accurate data
- Reduce field time and overall surveying time
- Quick deliverable turn-around time

Output

- 2D & 3D Orthomosaic Maps
- 3D Models

Facility Data Capture

DESIGN SOFTWARE:



The next step is to process images & laser scans by using **ReCAP**, a scanning software with an output of a point cloud or mesh. A designer will then create a 3D model for further **analysis and design**.



Facility 3D Modeling & Design

COMPUTER AIDED DESIGN SOFTWARE:

 AutoCAD Plant 3D

 AUTODESK®
REVIT®

 CADWORX®

 Bentley® OpenPlant Modeler

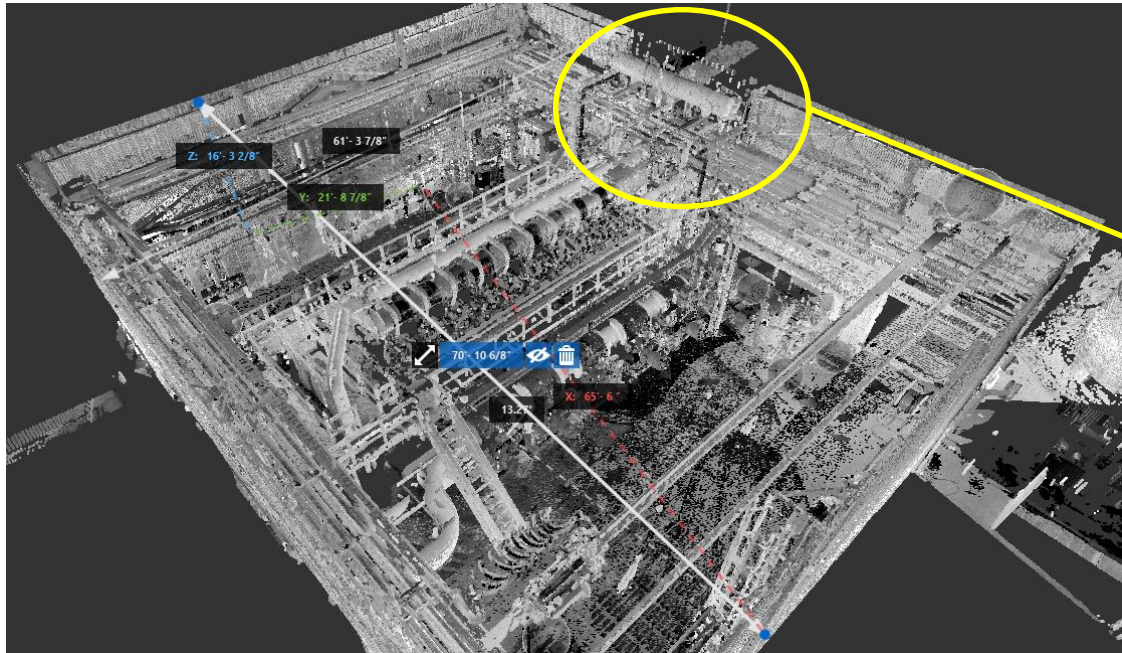
Designers create a model by placing piping, equipment, support structures and other plant components together to formulate the piping/facility design for the customer. The different modeling techniques and software provide the following capabilities:

- **Create catalogs & specifications**
- **Avoid errors by conducting clash detection**
- **Manage design data & produce construction drawings**
 - Automate piping isometrics
 - Extract Orthographic Drawings
 - Plan & Elevation Views
 - Piping & Instrumentation Diagrams
 - Bill of Material

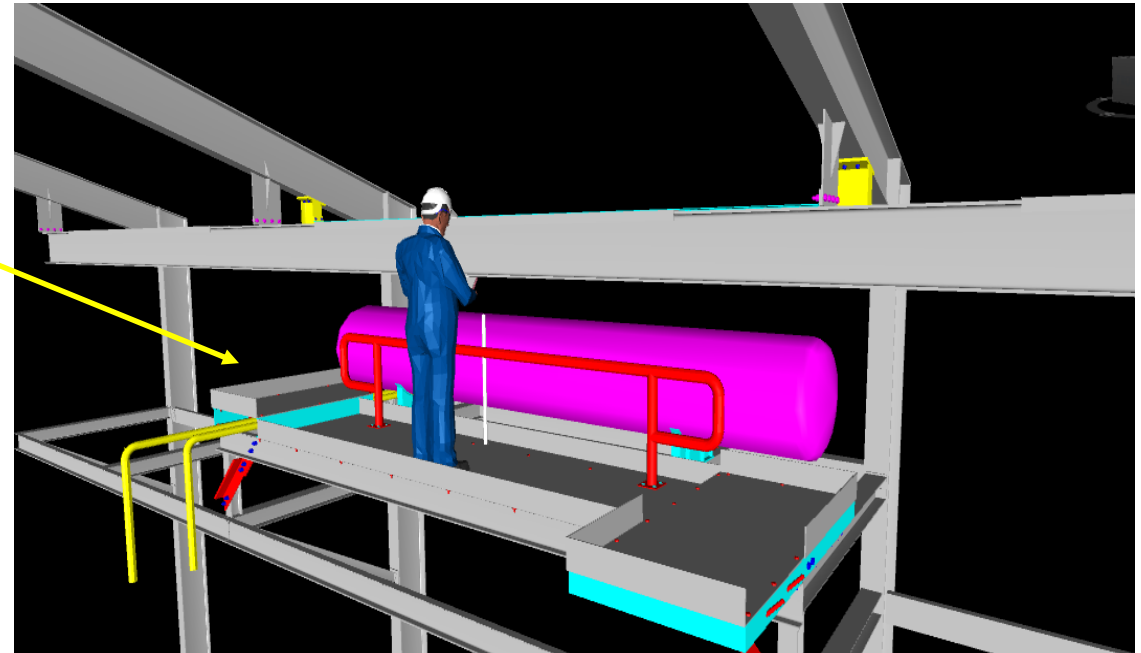
Facility 3D Model - Example

The project scope included a **design of a new platform** to have access to an existing tank which is located over an existing compressor engine. The new platform included a railing for workers to clip on with a safety harness.

ReCAP Software – Point Cloud



AutoCAD Plant 3D - Model

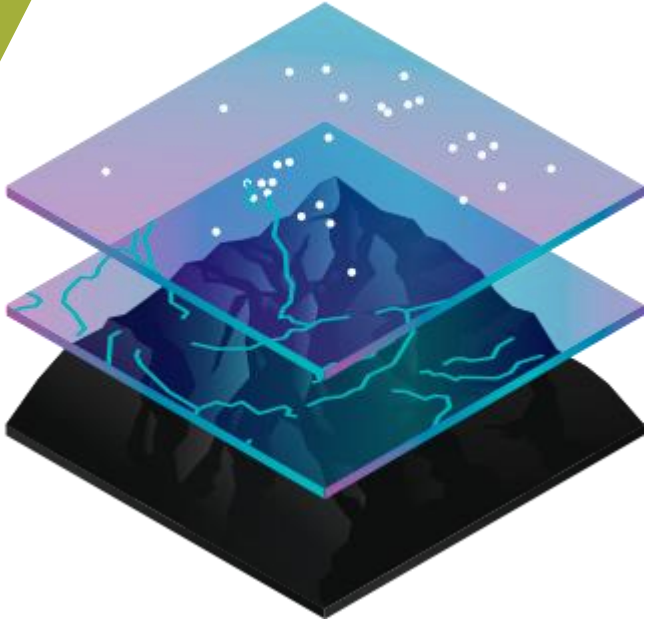


GIS & Data Analytics

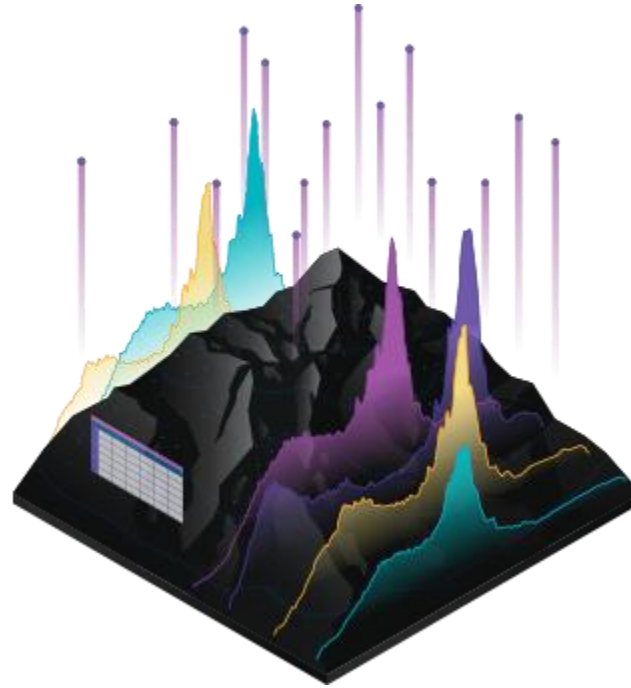
- **What is GIS?**
- **How can we use GIS and Data to immediately aid in Engineering Design?**
- **What is the value of Data Analytics, and how can we use it to help make informative Engineering Decisions?**

GIS & Data Analytics

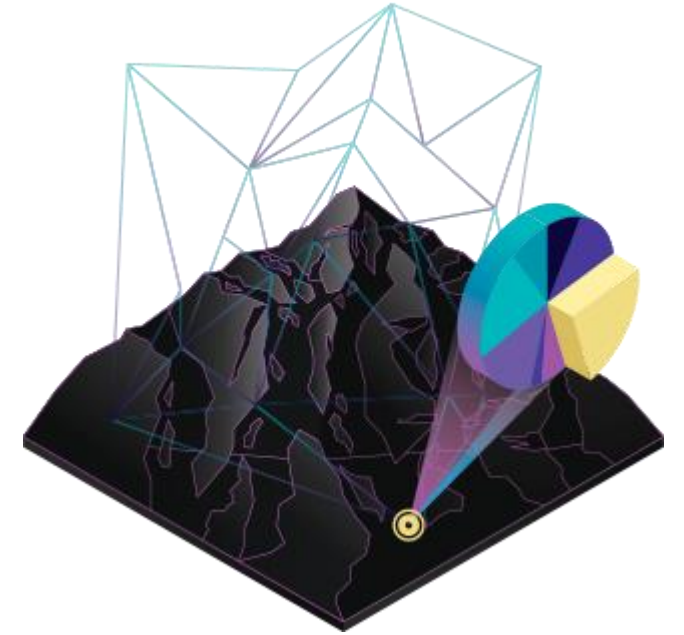
What is Geographic Information Systems?



Mapping
& Visualization



Data Integration



Analysis

GIS & Data Analytics

Data Driven Designs – 2D

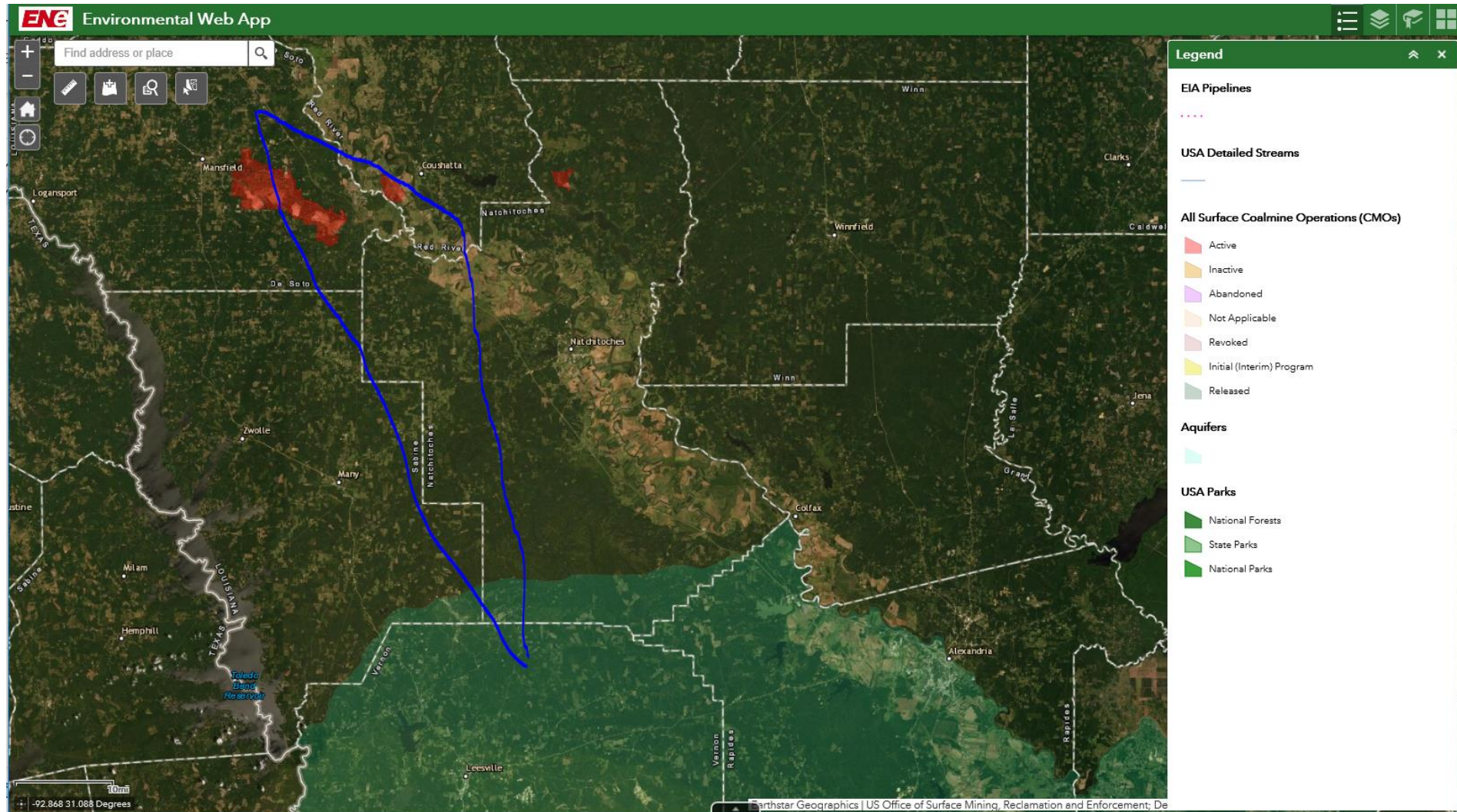
The screenshot displays the EN Engineering web application interface. At the top left, the logo "EN Engineering" is visible. The main area is a map showing a network of utility lines (pipes) overlaid on a street grid. The map includes labels for streets such as "WESTMORELAND AVE", "BLAIR RD NW", "NEW HAMPSHIRE AVE", "EASTERN AVE", "SHERIDAN ST", and "RITTENHOUSE ST". A search bar at the top left contains the text "Find address or place". On the right side, a panel titled "Export to CAD" is open, showing two sections: "Export to CAD by BCA Number" and "Clip and Ship". The "Export to CAD by BCA Number" section has an "Input" tab selected, with a text field containing "12345" and an "Execute" button. The "Clip and Ship" section has an "Output" tab selected, with a dropdown menu for "SDE or Query Layer*" and an "Execute" button. The bottom of the map shows a scale bar for 600 feet and coordinates: -77.004 38.972 Degrees. The EN Engineering logo is also present in the bottom right corner of the interface.

Clip-n-Ship



GIS & Data Analytics

Data Driven Designs – 2D



GIS & Data Analytics

Data Driven Designs – Raster Processing and Aerial Imagery Analysis



Original Raster



Segmented Raster



After Classification



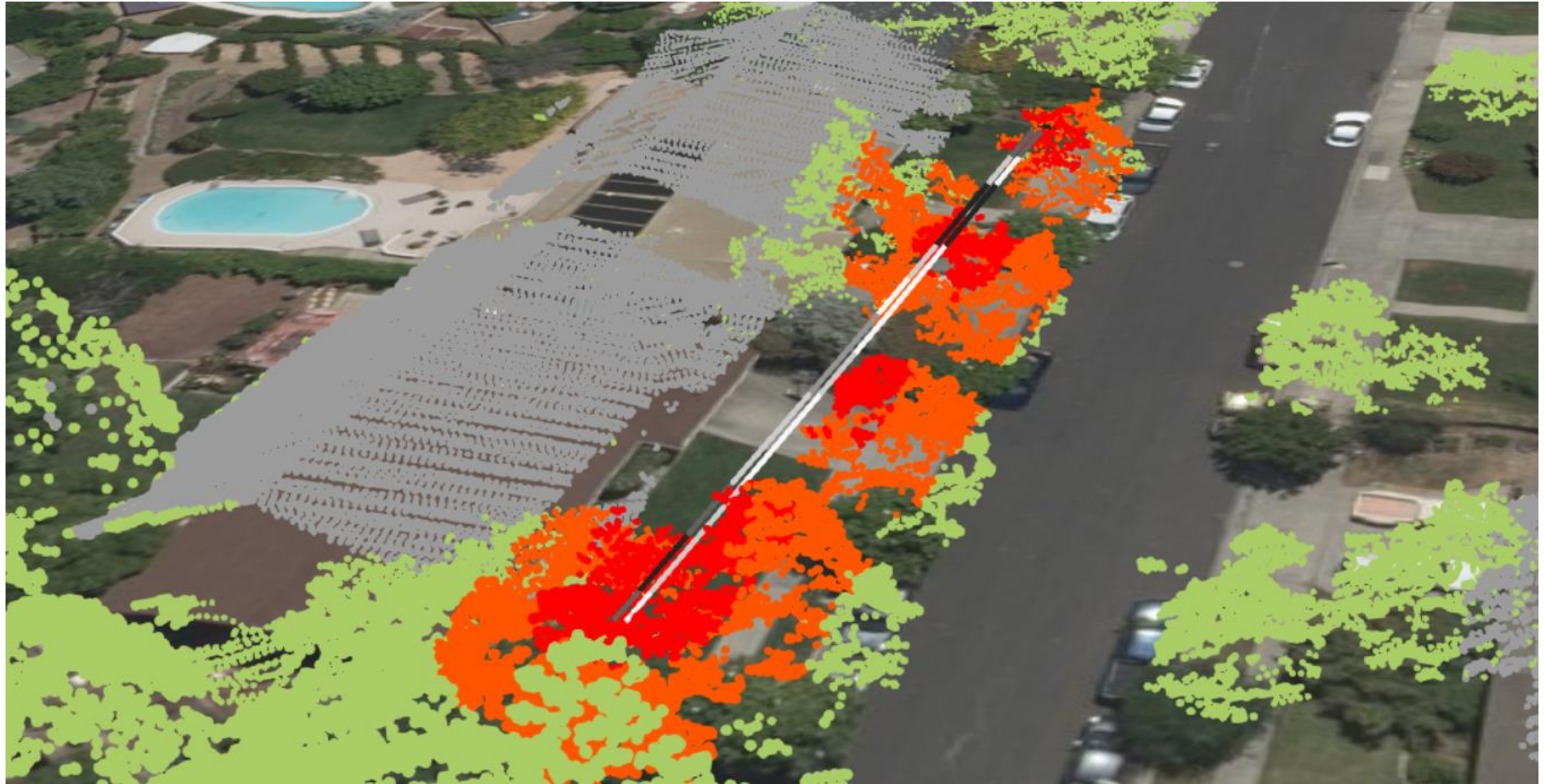
Before Classification

Impervious Surface Analysis



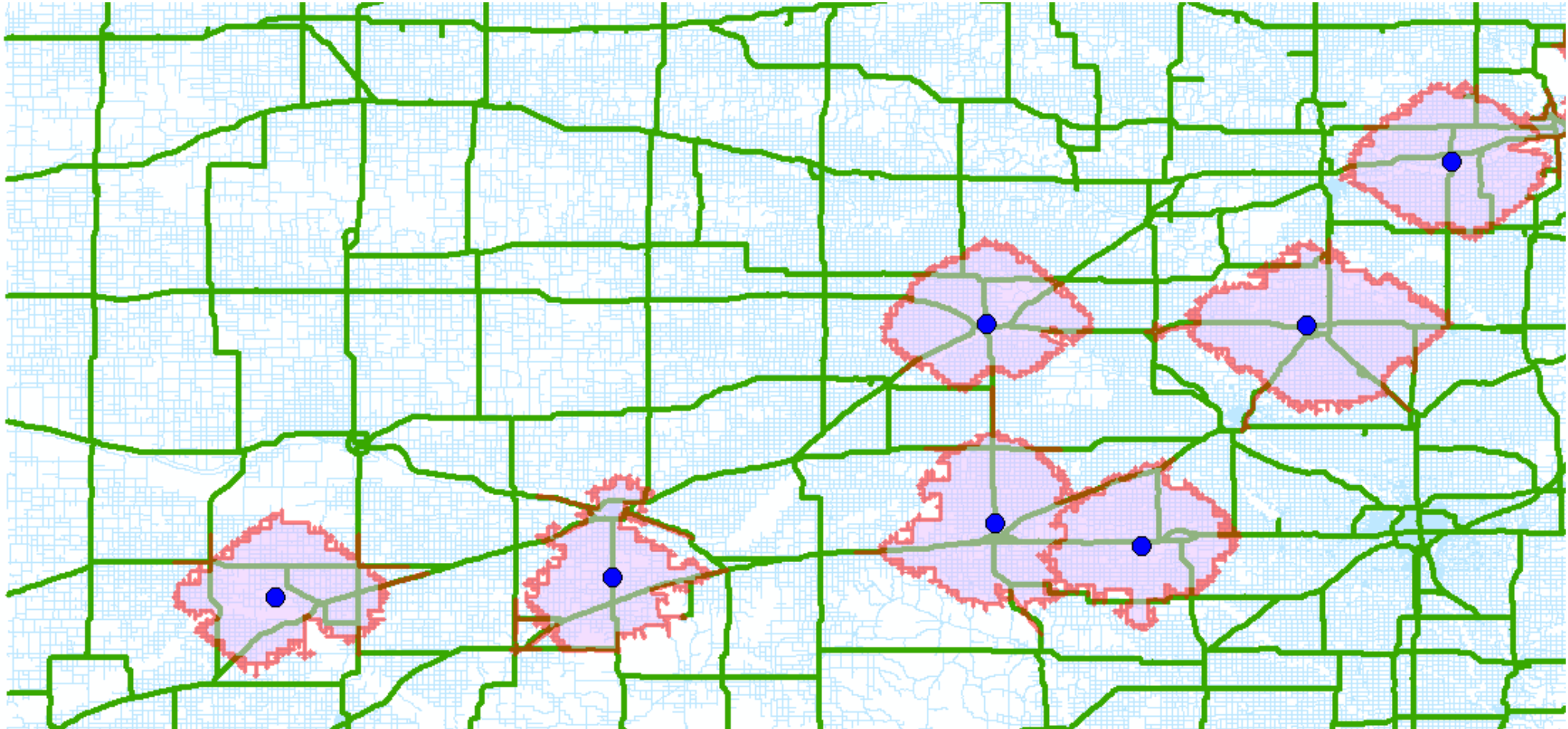
GIS & Data Analytics

Data Driven Designs – 3D Spatial Modeling



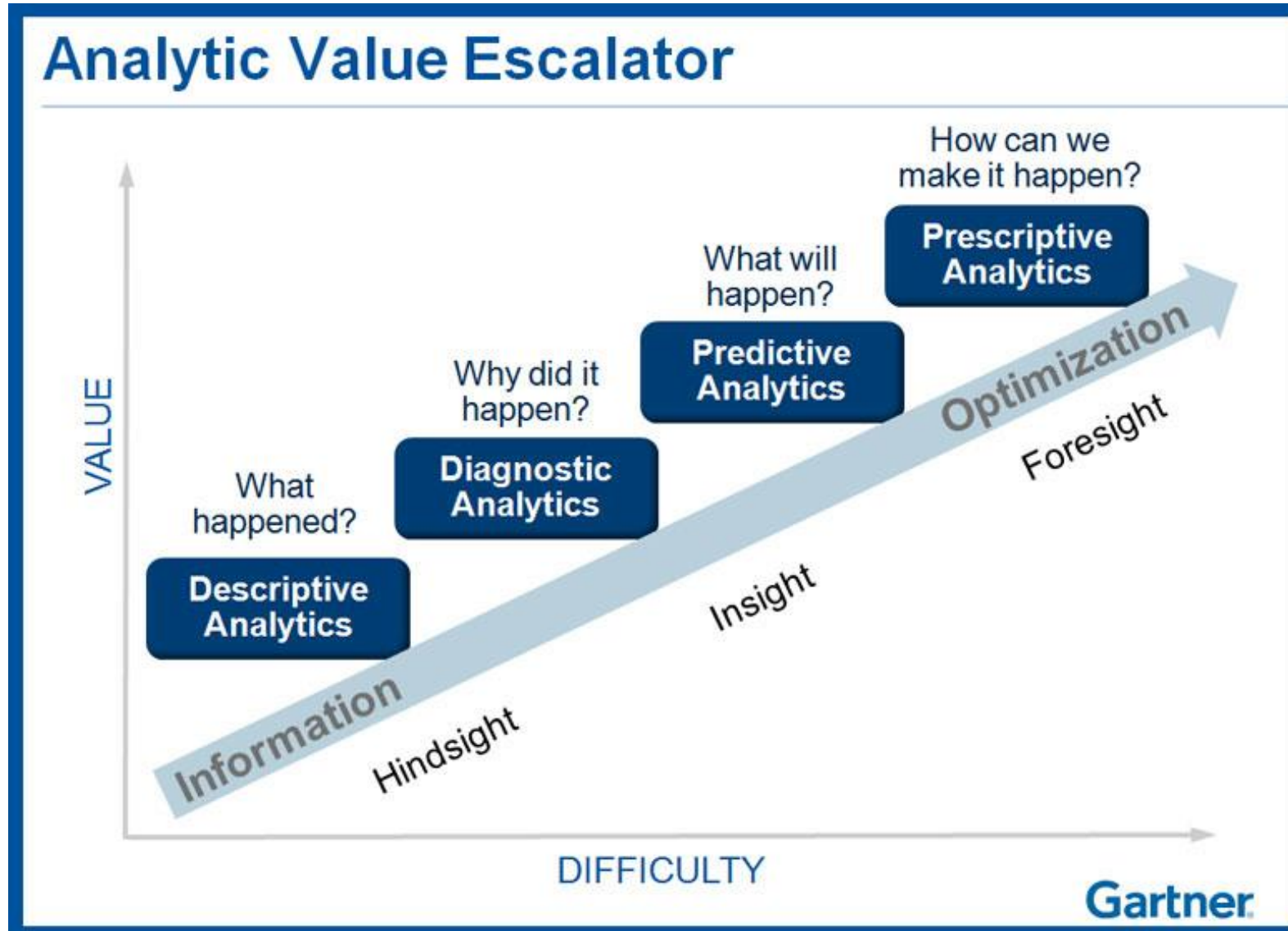
GIS & Data Analytics

Data Driven Designs – Route Network Planning



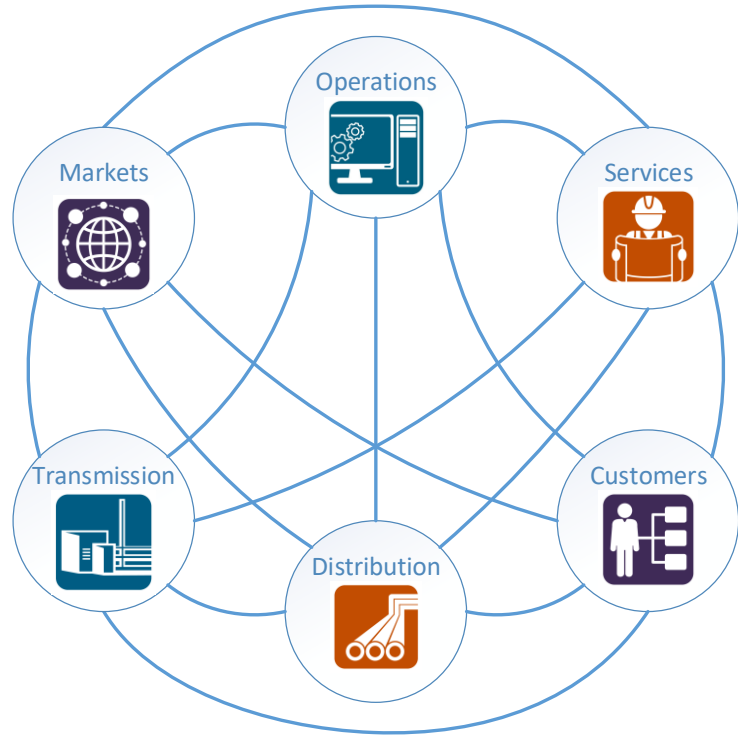
GIS & Data Analytics

Value of Data

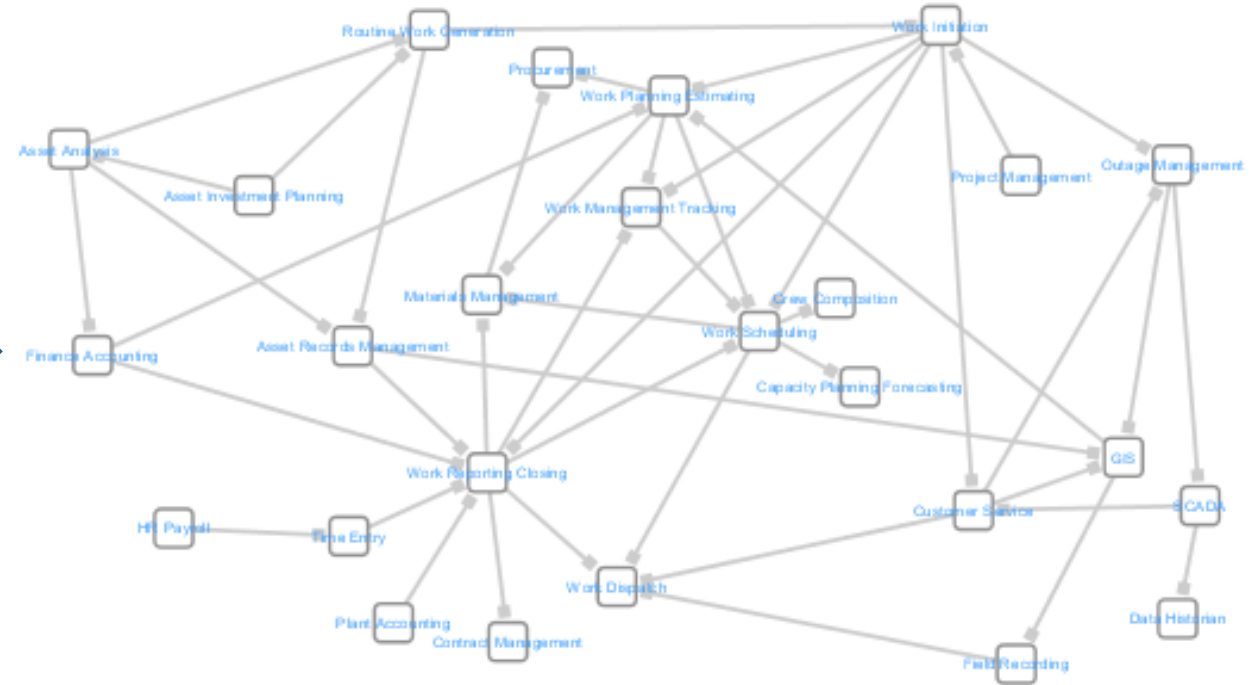


GIS & Data Analytics

Data Systems



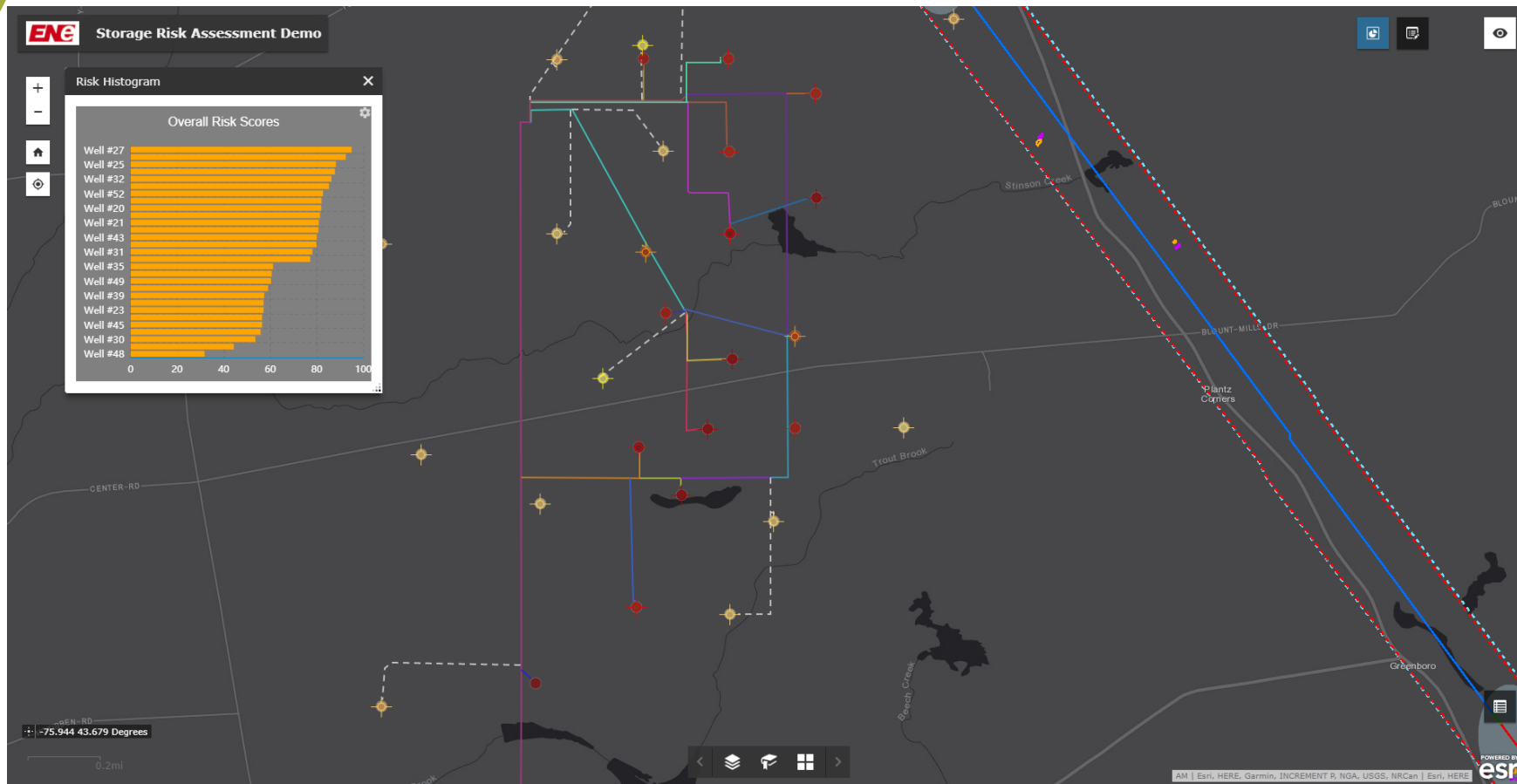
Utility Organization Structure



Enterprise Data System
Functions and Interactions

GIS & Data Analytics

Advanced Analytics – System Risk Modeling

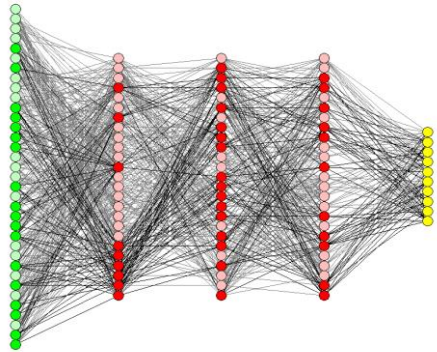


Risk Assessment Modules:

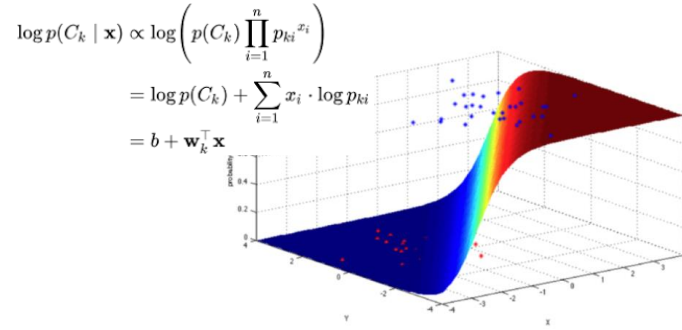
- Gas Transmission/Distribution/Storage Integrity Risk Assessments
- Hazardous Liquid Integrity Risk Assessment
- Internal Corrosion Threat Assessment and Prioritization
- AC Corrosion Threat screening and Risk Model
- Atmospheric Corrosion Risk Model
- Population expansion and consequence of failure

GIS & Data Analytics

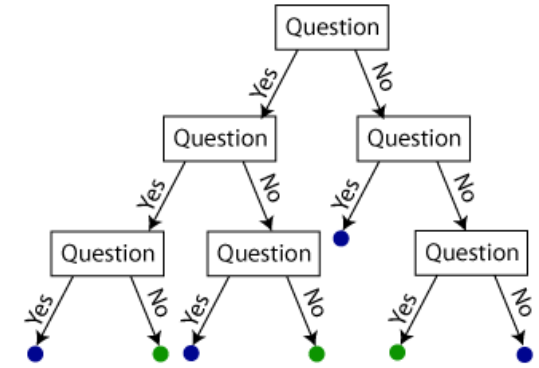
Advanced Analytics - Machine Learning



Neural Network
"Deep Learning"

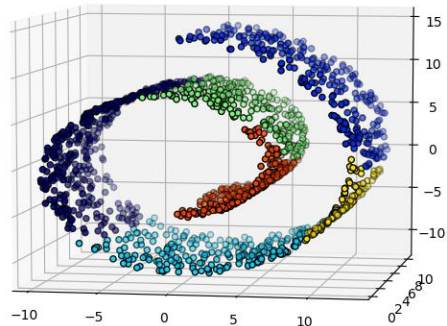


Linear & Logistic Regression

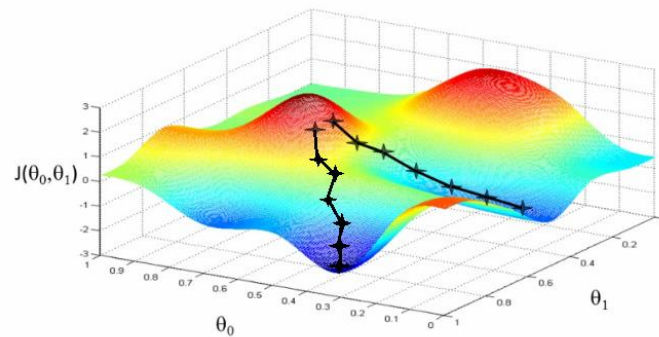


Decision Trees

With connectivity constraints (time 0.12s)

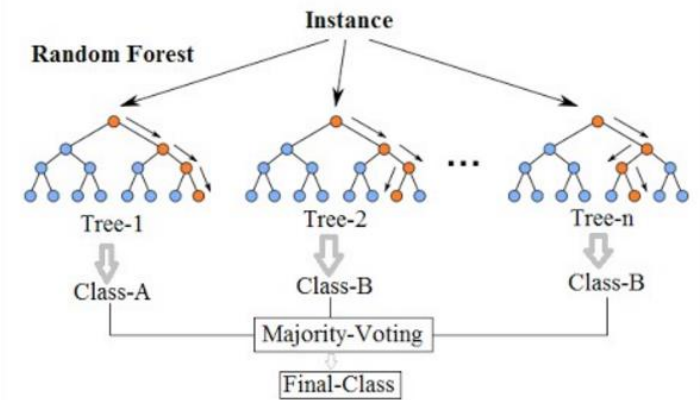


Clustering Analysis



Gradient
Descent

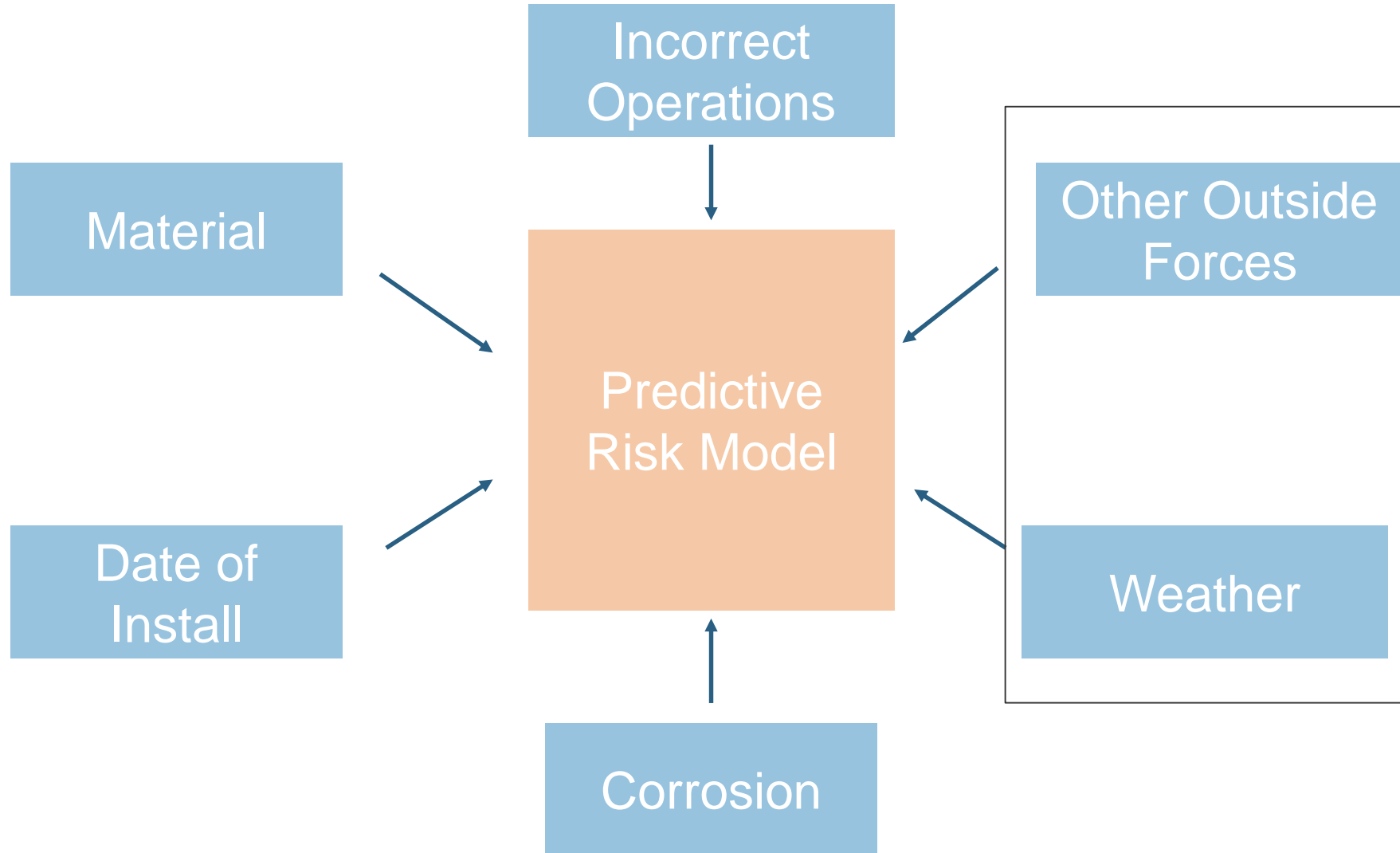
Random Forest Simplified



Random Forests

GIS & Data Analytics

Machine Learning – Applications





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Thank You!