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The 22nd International Asset, Facility & Maintenance Management Conference

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A BIM Based Model For Road Construction & Maintenance In Saudi Arabia

Dr. Altayeb Qasem

26-28 January 2025
The Ritz-Carlton Jeddah, Kingdom of Saudi Arabia

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Motivation & Problem Statement

Motivation

- **Critical Role and Increasing Complexity of Road Infrastructure:**
  Roads are vital lifelines across Saudi Arabia, enabling efficient transportation of people and goods while linking urban areas. The growing need for improved facilities and the increasing complexities of cities have introduced significant challenges to road maintenance and rehabilitation efforts, further emphasizing their critical importance.

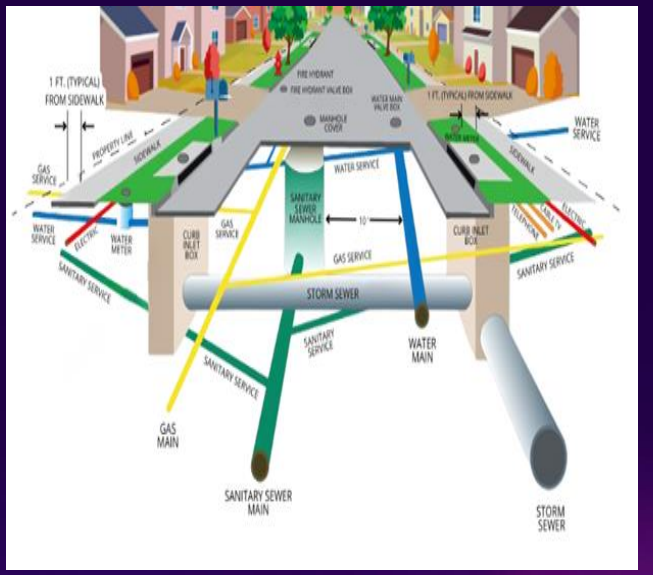
- **Significant Infrastructure Investments:**
  Saudi Arabia's infrastructure spending is projected to reach 1,251 billion SAR in 2024, with an anticipated increase to 1,368 billion SAR by 2026, reflecting the strategic importance of enhancing road maintenance and rehabilitation strategies to protect these investments.

- ***Challenges in Coordination and Project Delays:***
  Road construction and maintenance efforts face significant delays due to complex approval processes involving multiple entities and stakeholder disputes, further amplified by insufficient communication and coordination mechanisms.

Objective Statement

- The main objective of this study is to develop a BIM-based model for road construction and maintenance in Saudi Arabia.
- This model aims to streamline the approval and implementation processes by establishing a system that enhances communication and coordination among all relevant stakeholders, encompassing planning, control, and assurance processes.

BIM in Road Construction & Maintenance



•**High Complexity**: Multiple utilities (water, sewer, gas, electricity, telecom) often share the same road space.

•**Numerous Stakeholders**: Different owners require permits and coordination for any construction or maintenance work.

•**Centralized Data**: BIM provides a unified, 3D model of all assets, facilitating clear communication among parties.

•**Streamlined Coordination**: Helps avoid conflicts, reduce project delays, and minimize disruptions to traffic and surrounding communities.

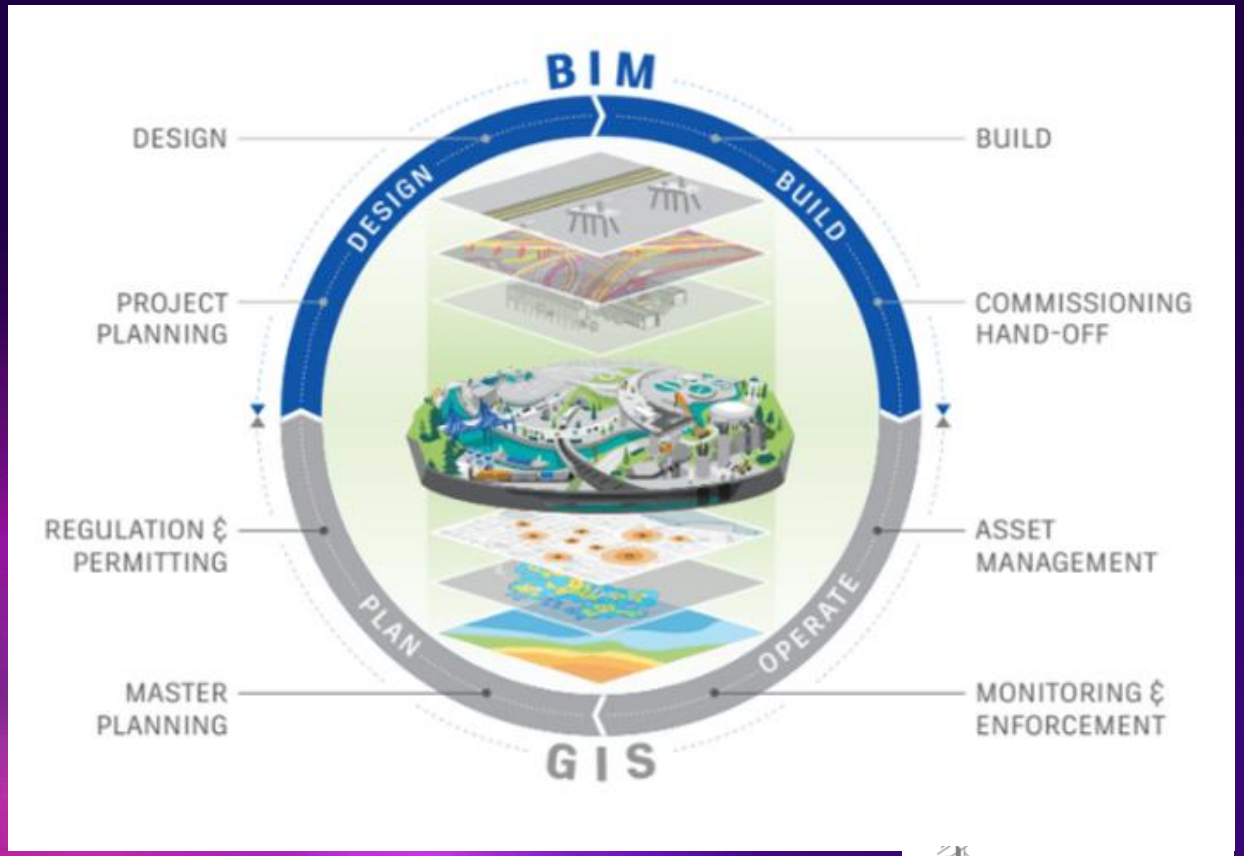
•**Improved Decision-Making**: Detailed information aids in planning, budgeting, and scheduling, resulting in more efficient and cost-effective road maintenance.

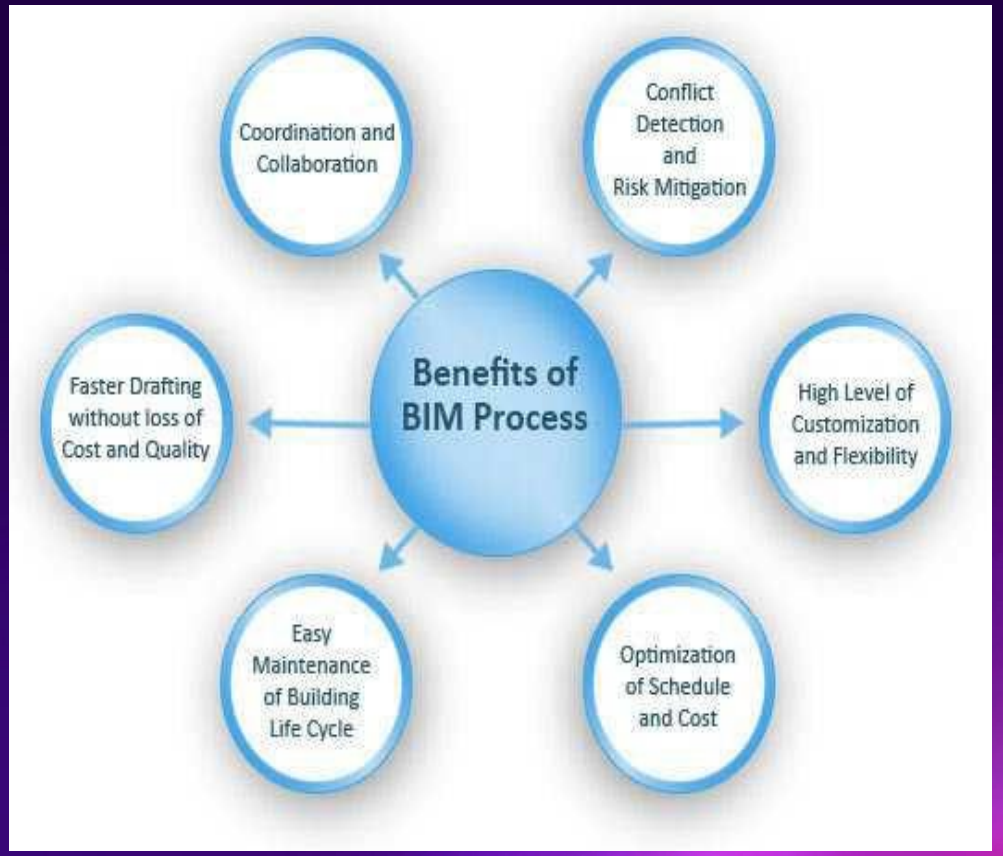
Why BIM ??

“BIM and 3D modeling of roads with their buried infrastructure enhance communication of maintenance interventions to stakeholders, ensure safety of underground facilities via spatio-temporal analysis, and streamline the process of obtaining the necessary permissions and approvals.”

BIM is all About

Communication Collaboration & Coordination





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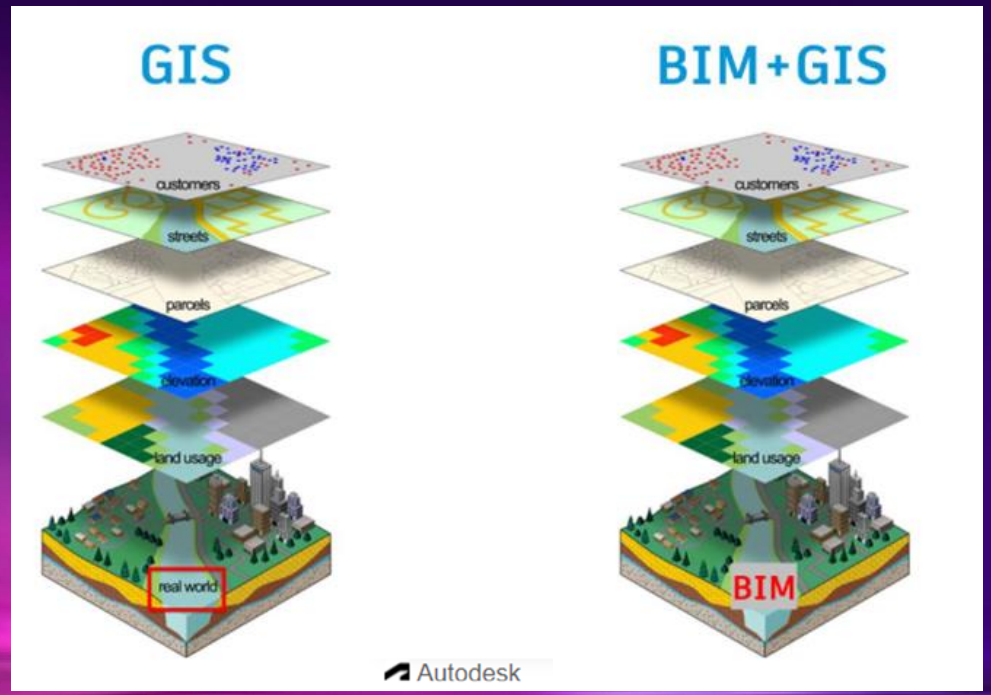
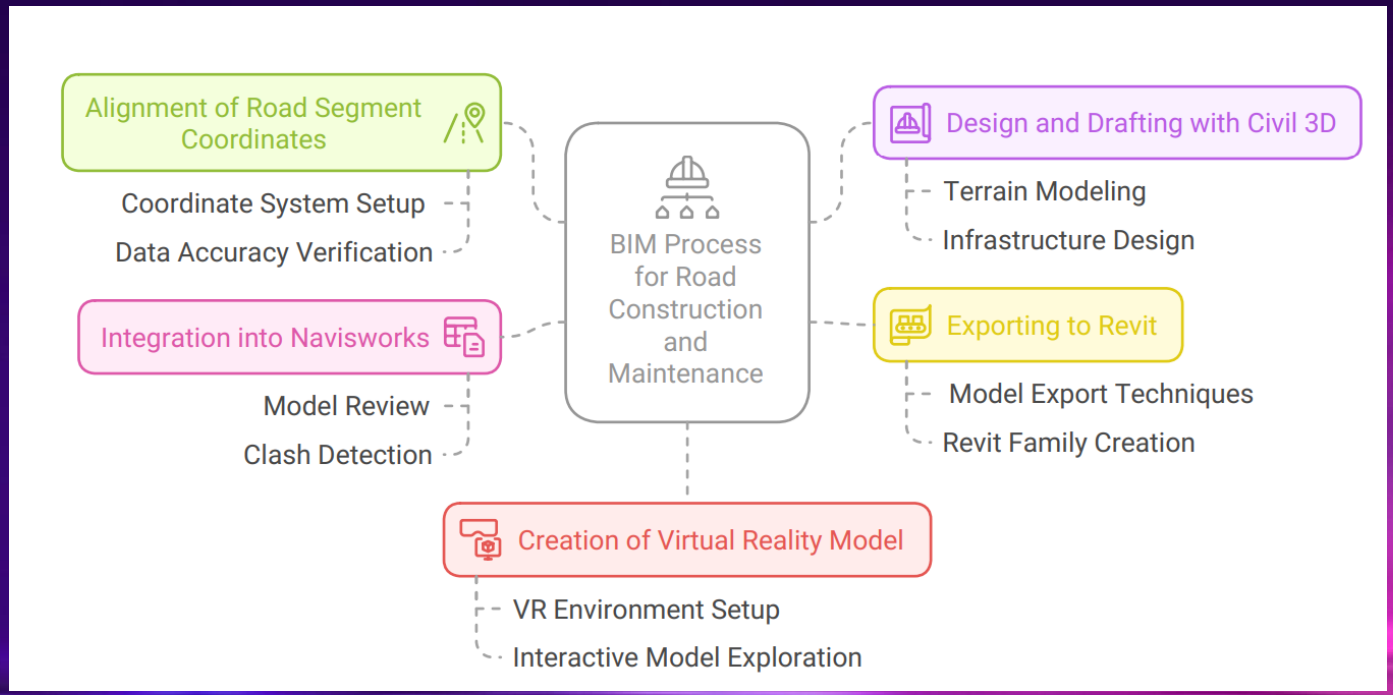
Methodology for Creating the BIM Model

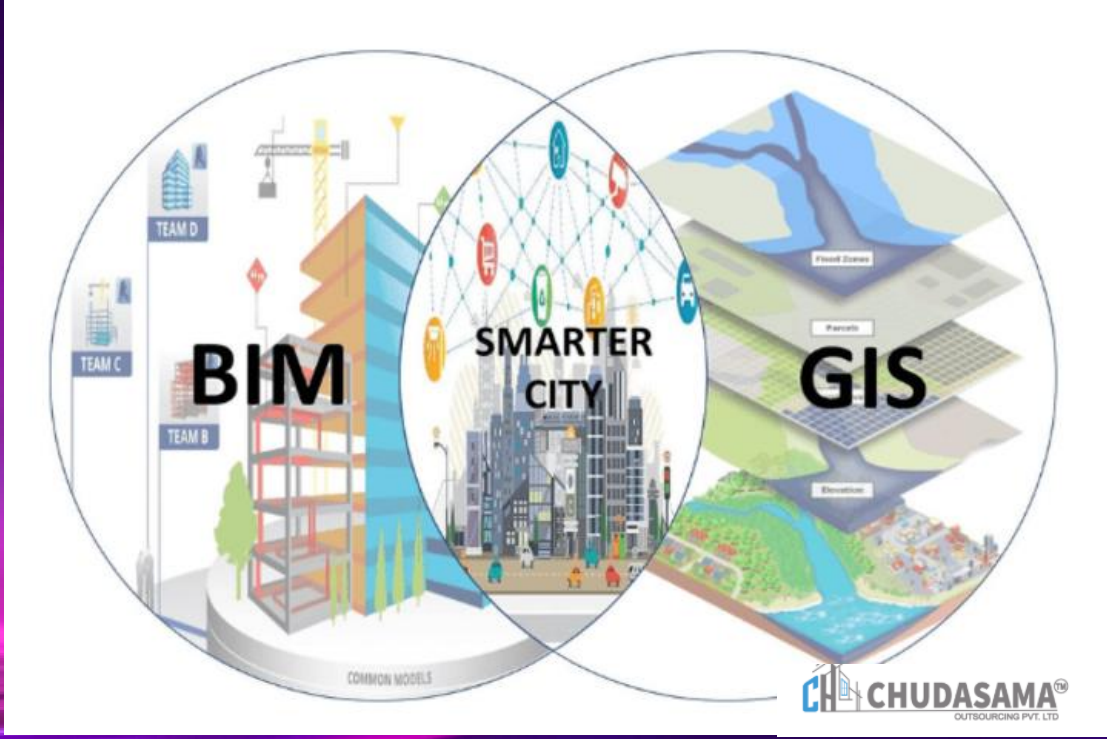
Integrating GIS-Civil 3D –Rivet- Navisworks

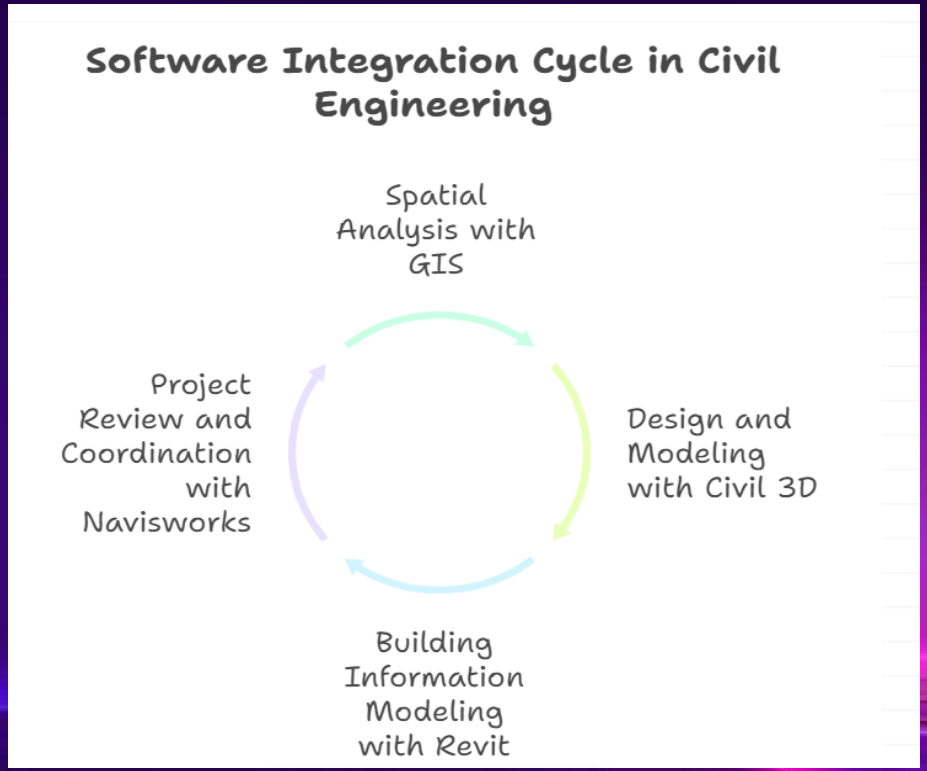




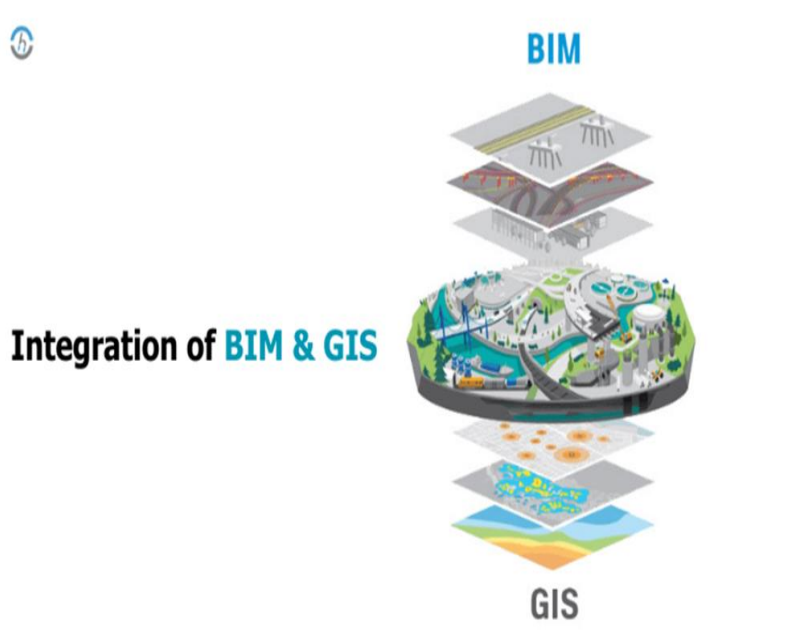
Starting Point

The methodology for developing the VR model is based on current practices using commonly used software for road design and modeling:



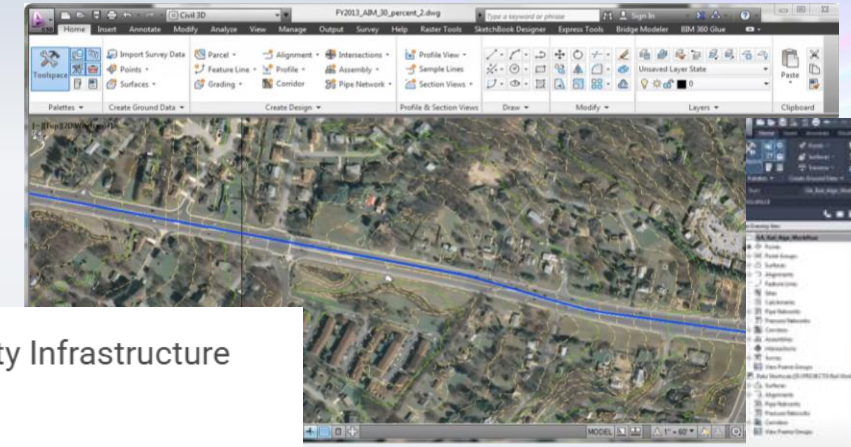


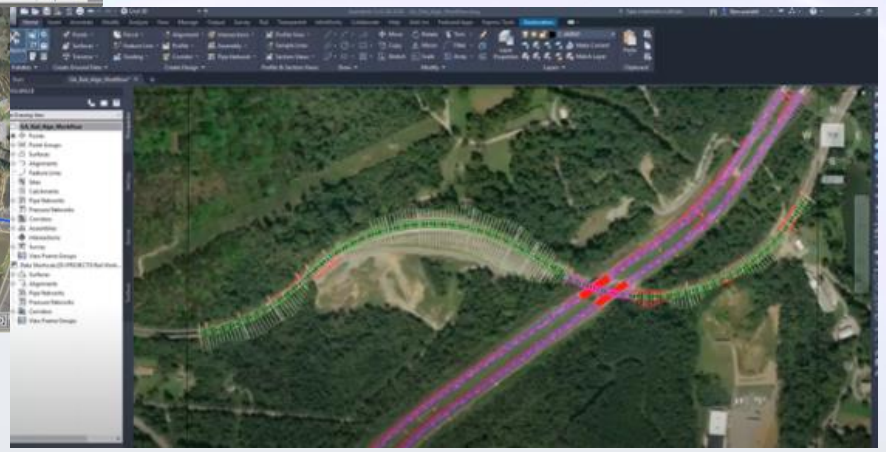
Current & Commonly Used Applications

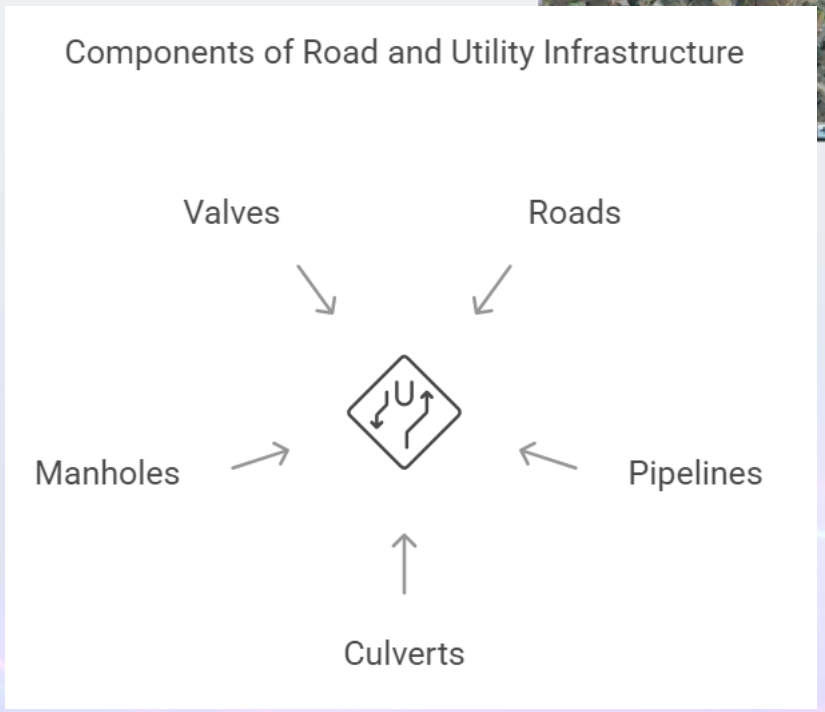


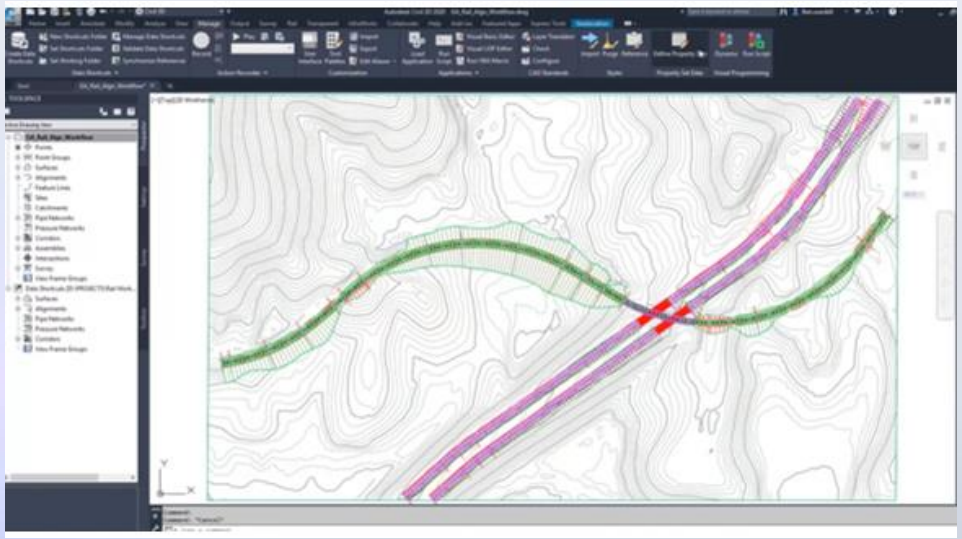
- **GIS:** Used to show the alignment and identify the location of road pavements and buried facilities.
- **Civil 3D:** Applied to design the road pavement and model all buried facilities within the same area.
- **Revit:** The developed model is exported to Revit to integrate additional utilities with the road segment.
- **Navisworks:** Animates the road segment, visualizing the proximity of utilities and the impact of rehabilitation interventions on other facilities.

Step 1 GIS How to Start ??









GIS Maps .... Google Maps ... Google Earth..

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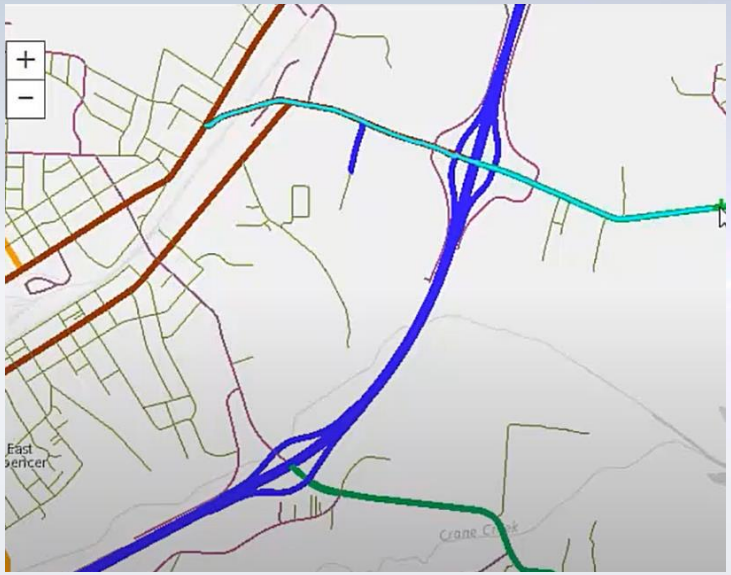
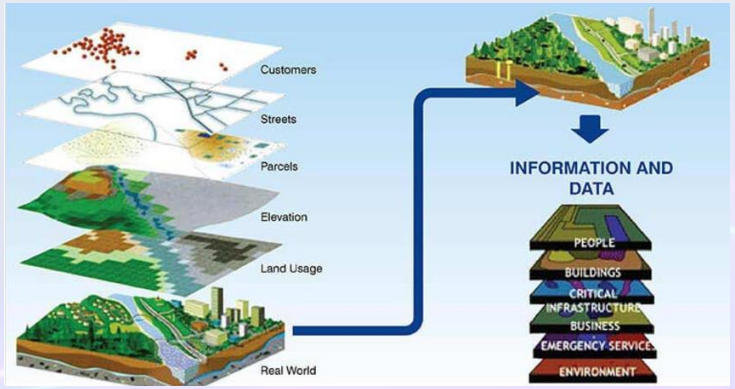
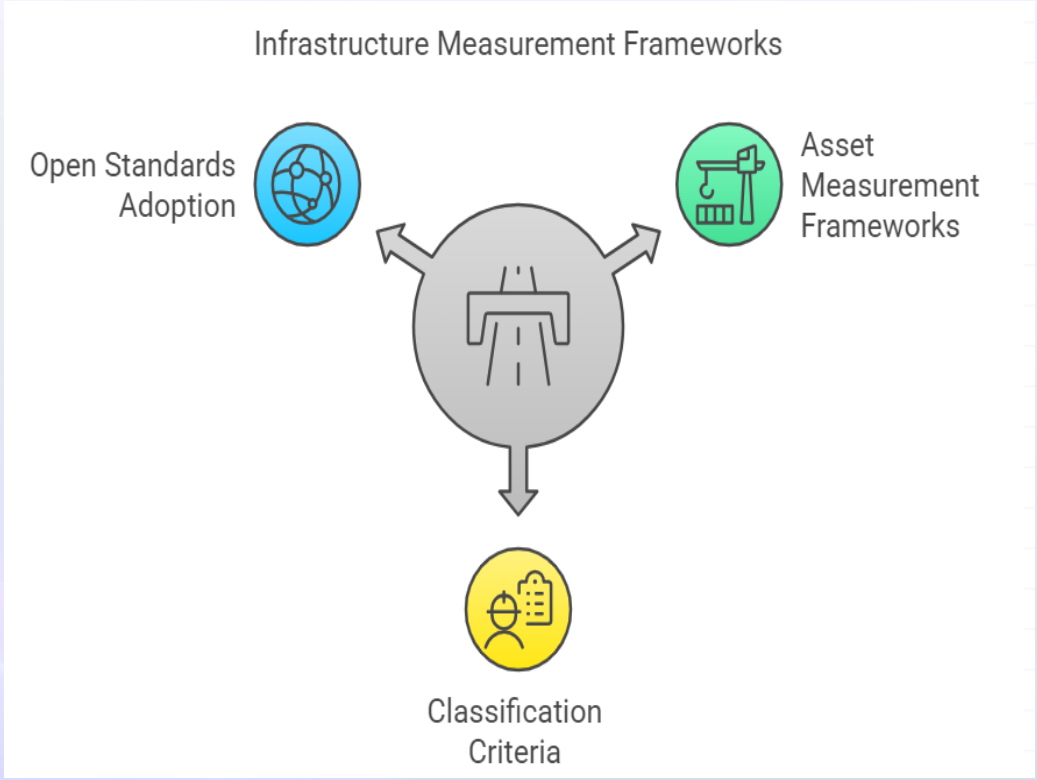
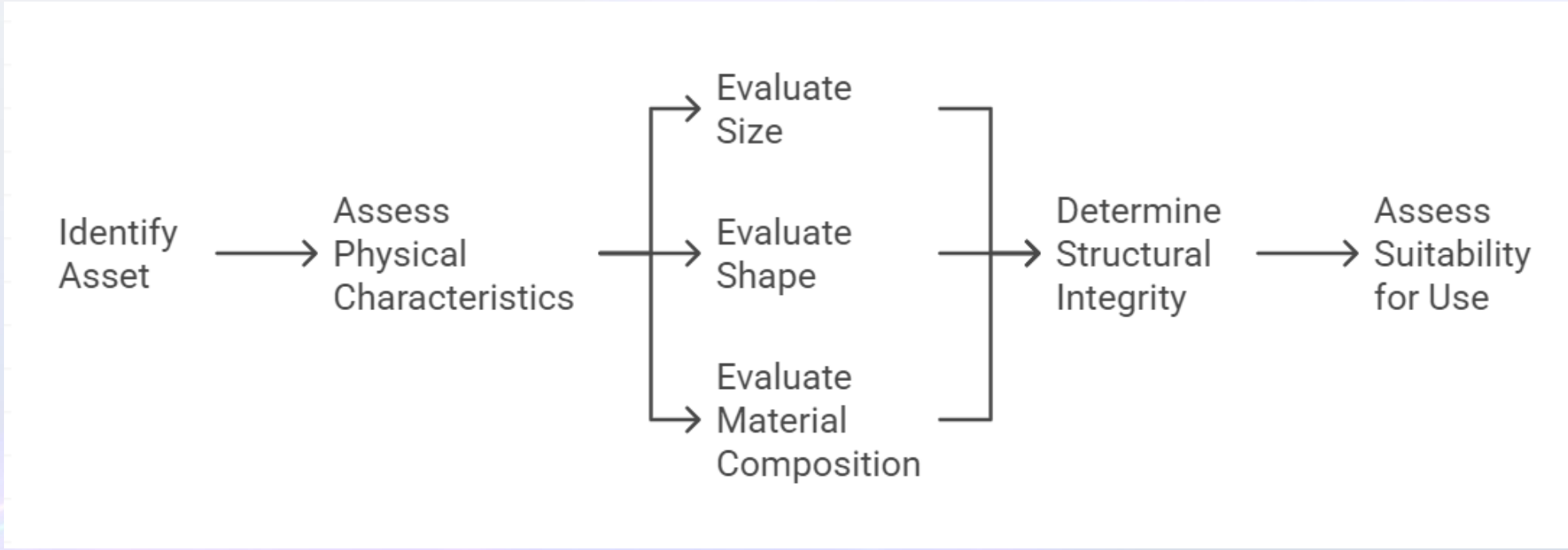
Step 2: Define the characteristics of buried Infrastructures
(within spatial proximity)







Integrating with Civil 3D Challenges



Current Challenges Infrastructure Asset Issues

- **No Clear Data Records**

As-built Roads section and other buried facilities must be extracted 3d laser scanners tech or others is needed.

- **Stand Alone Design & Executions**

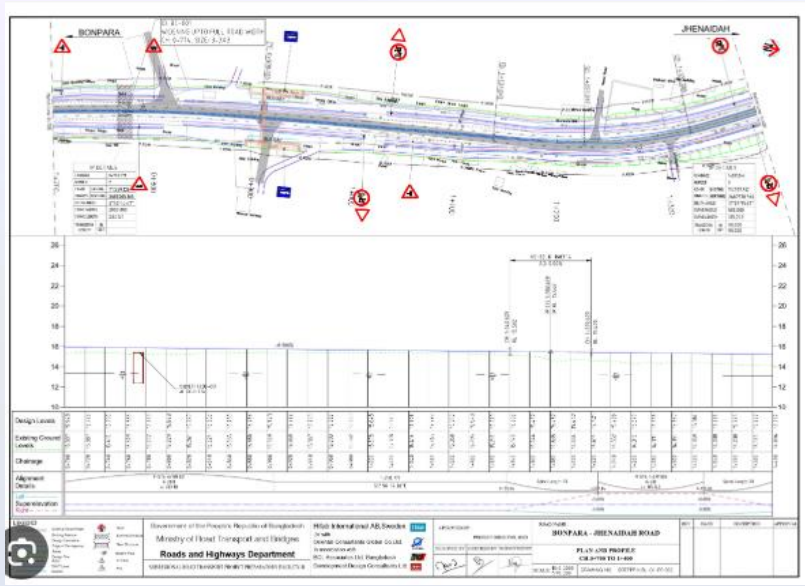
Existing As-built water , sewer, electrical and other networks MEP/data networks with space proximities needs to be developed .

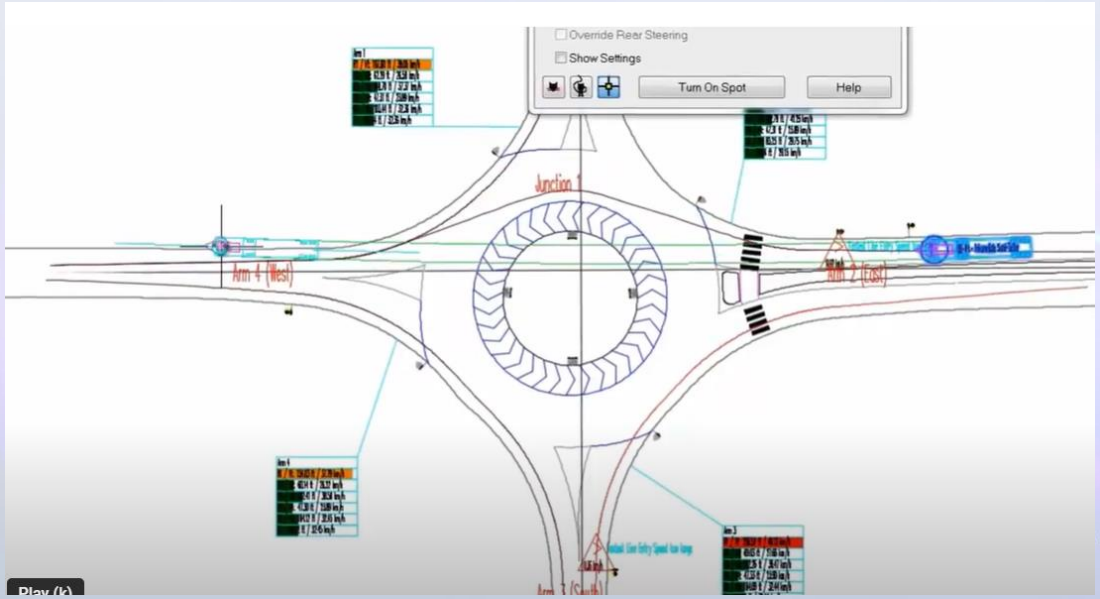
- ***No standard safety procedures***

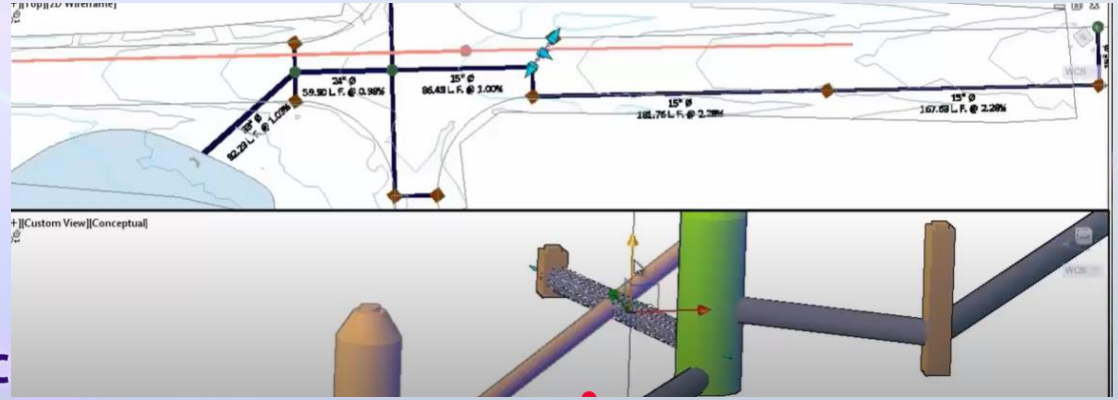
Assuring Safety & Security & standards for utility owners planning is essential for their approvals

- **No standardized Modeling for rehabilitations Interventions**

Step 3:Civil 3D Road Design







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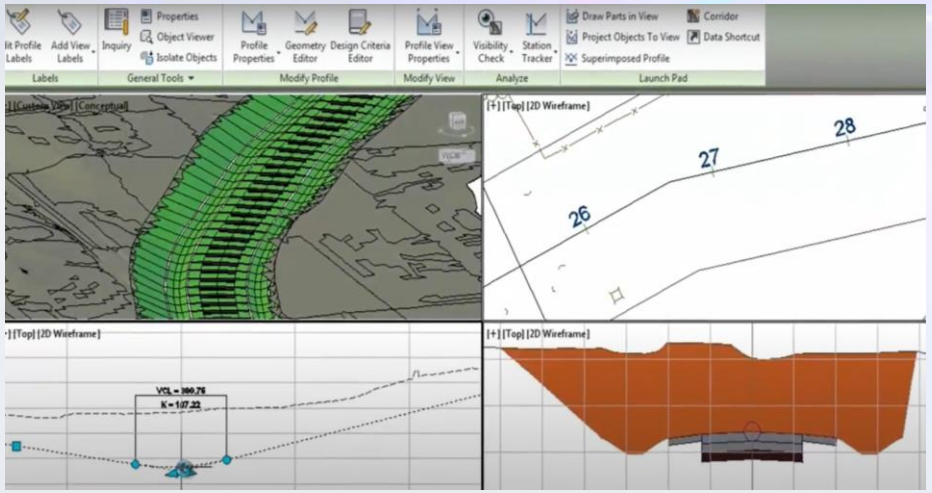
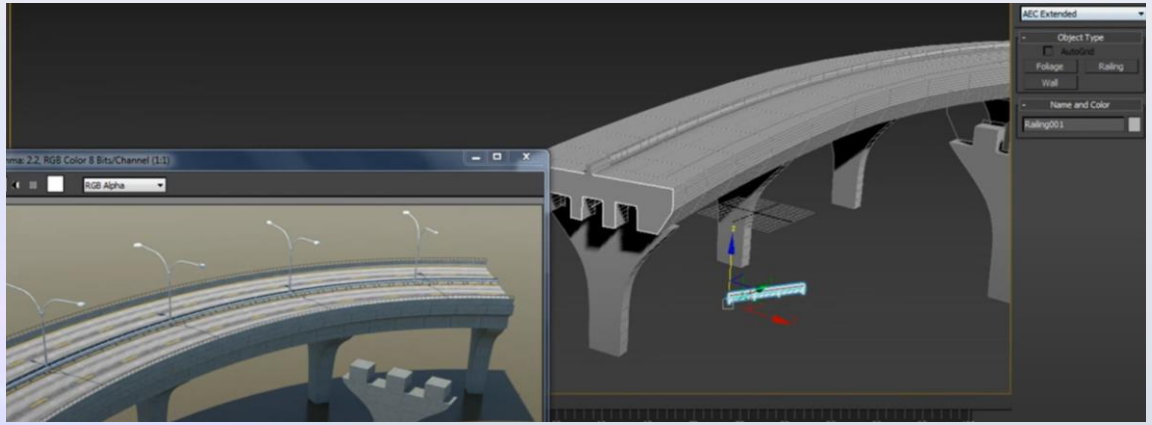
Civil 3D Road Render





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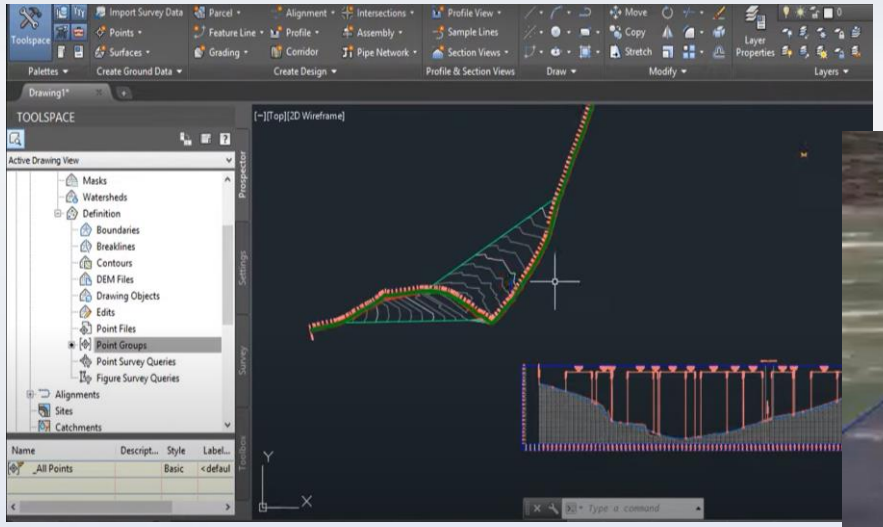
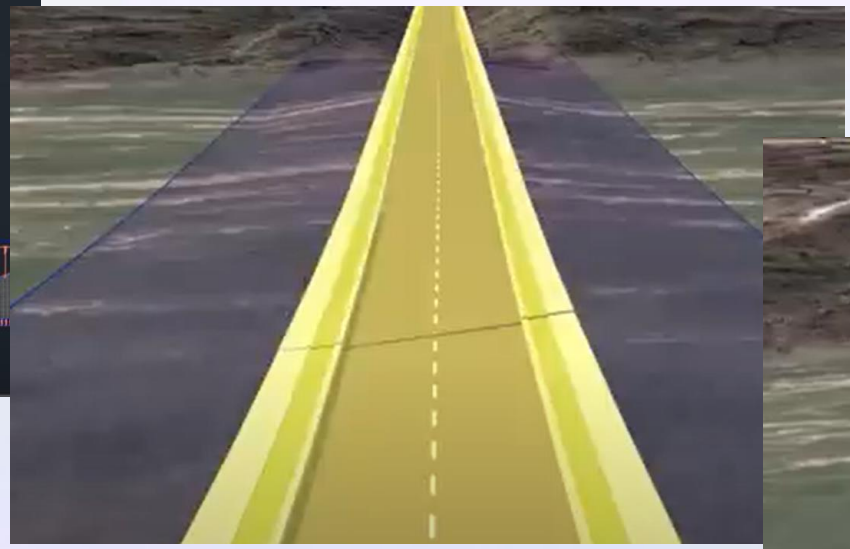
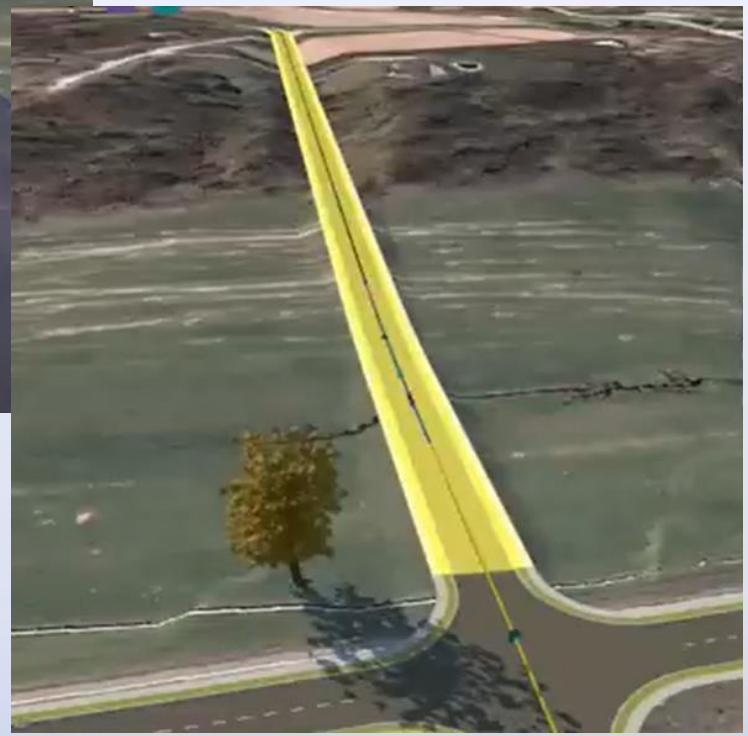
Simple Civil 3D Road Render







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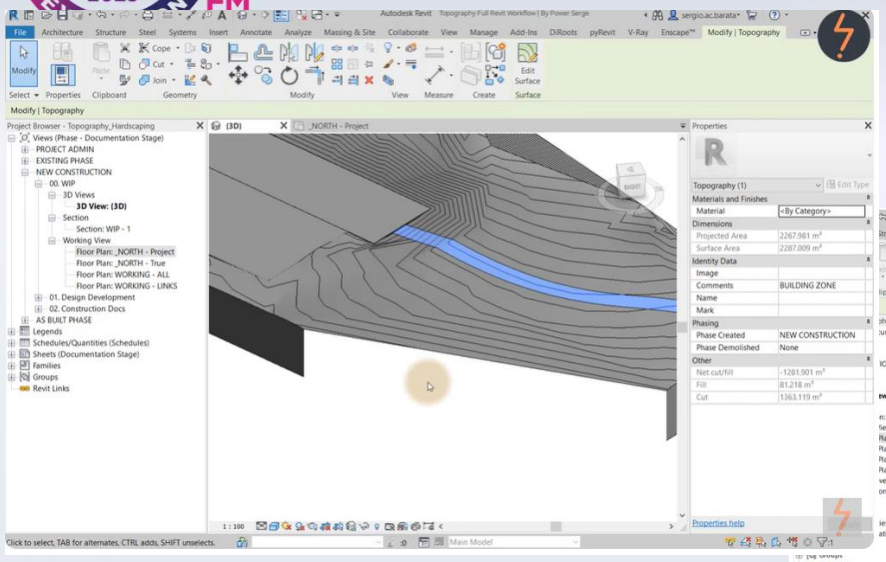
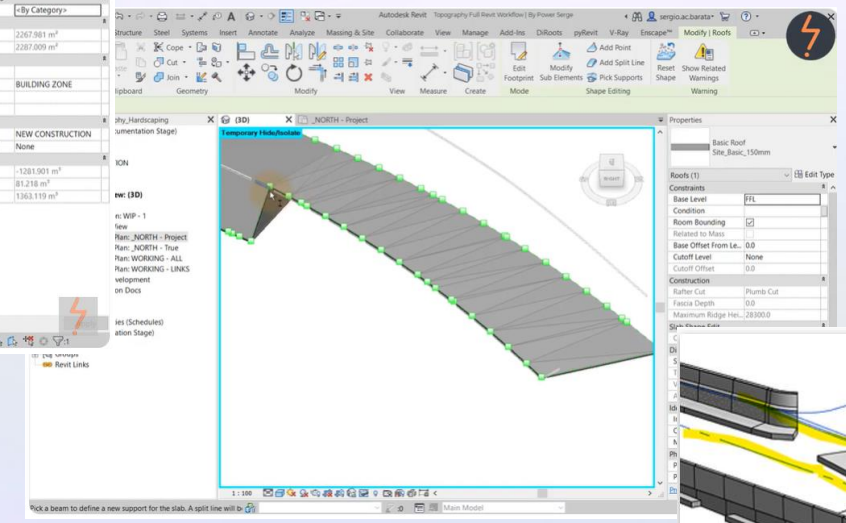
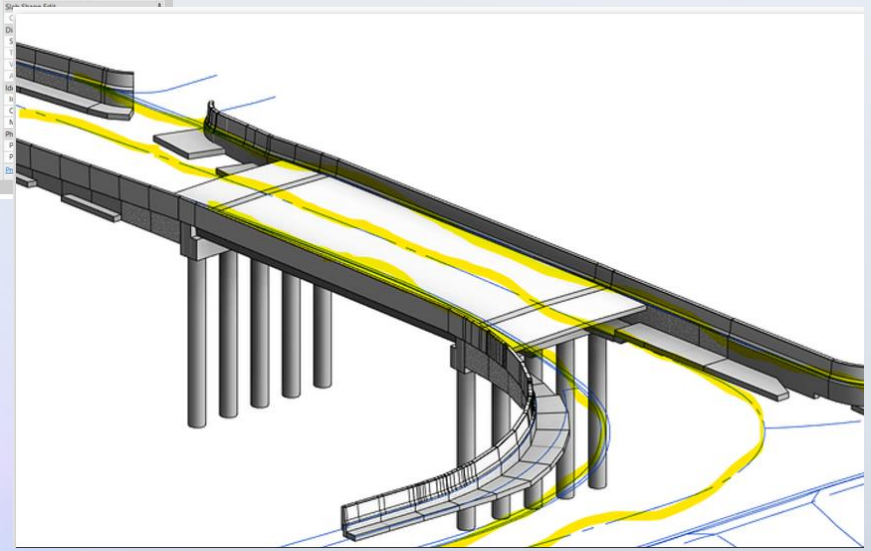
Step 4: Revit Road segment extractions & Render







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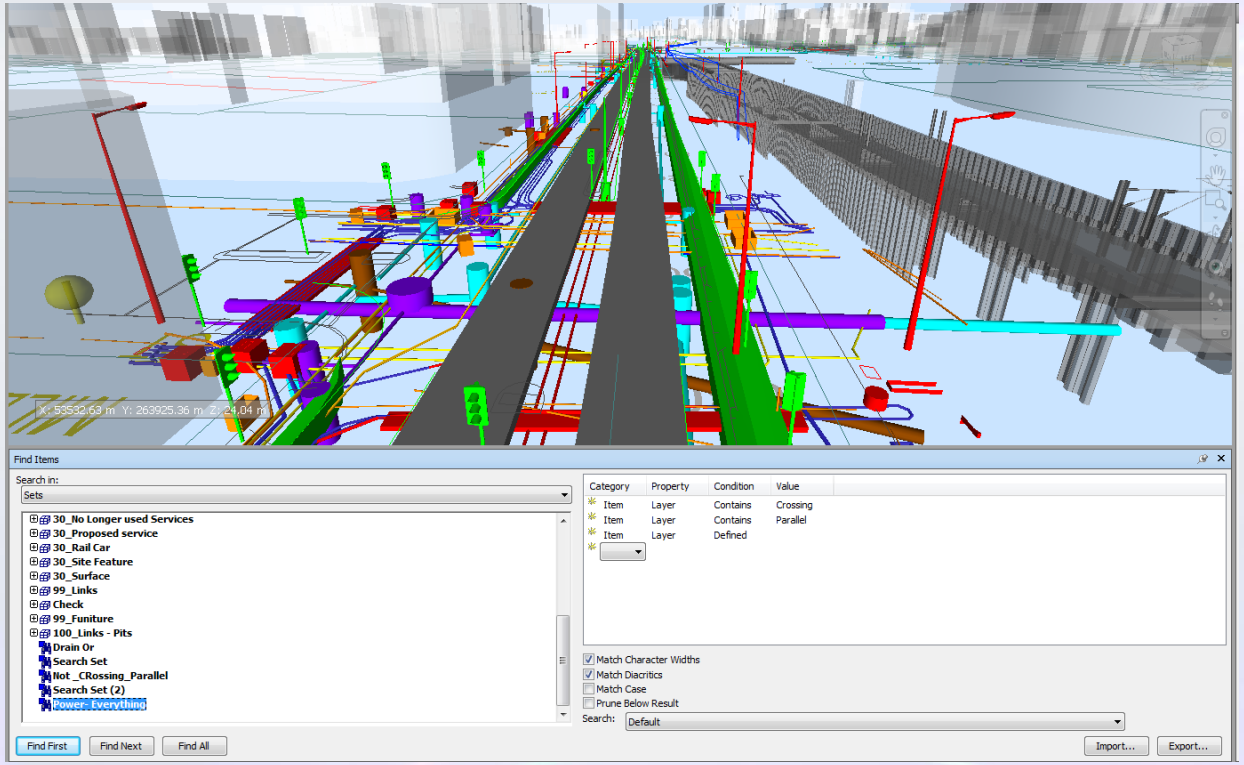
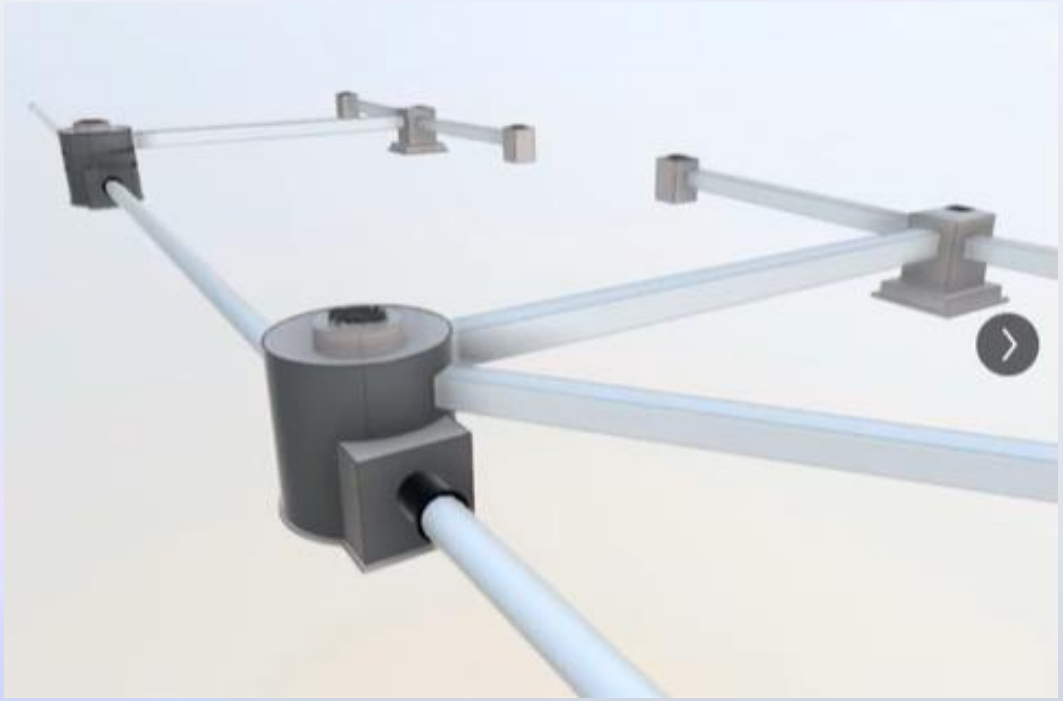
Revit Utility Extraction





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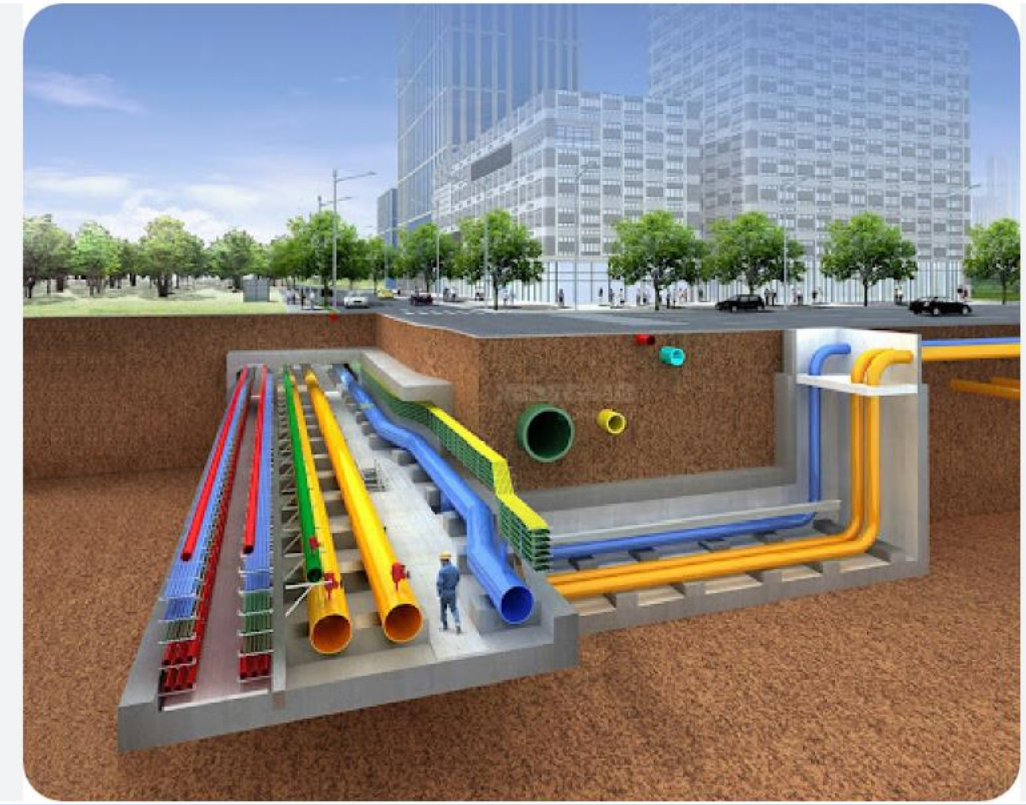
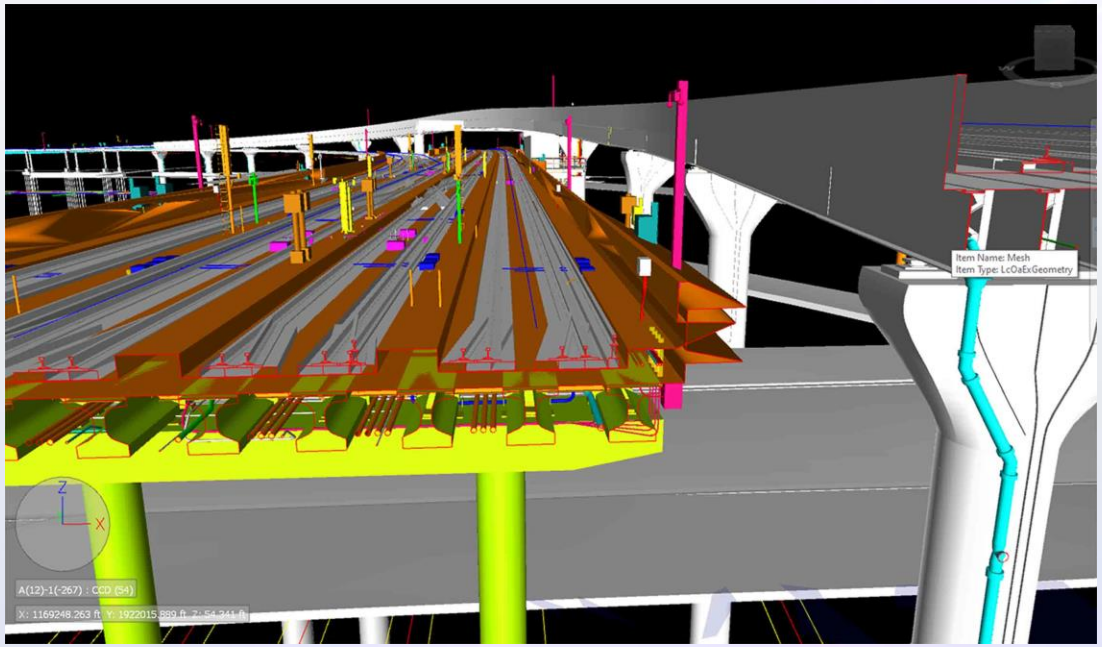
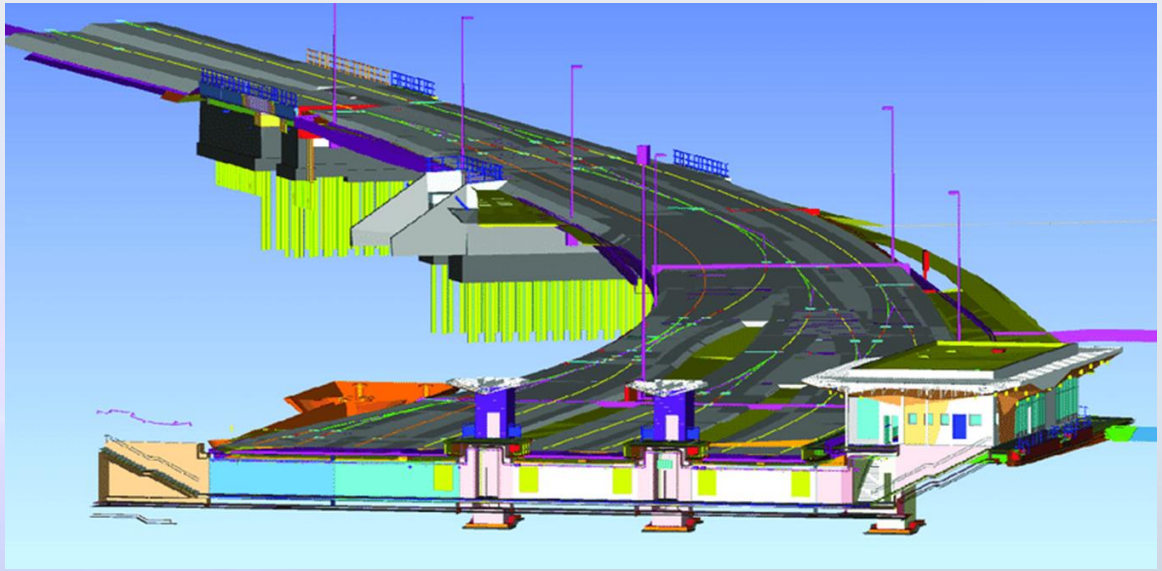
Ultimate target is to develop high Utility Proximities & Revit Modeling with high LOD



- Refine designs and develop rehabilitation alternatives using **LOD (Level of Development) 100–600**, depending on required detail levels.

Step 5: VR using Navisworks animation





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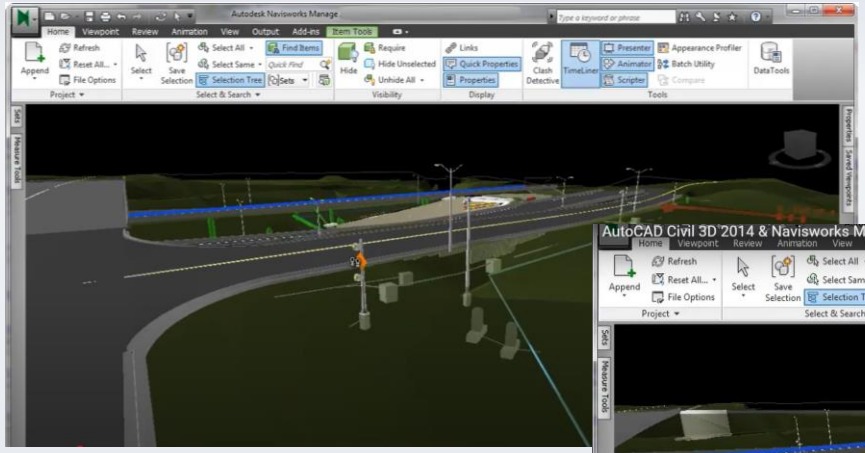

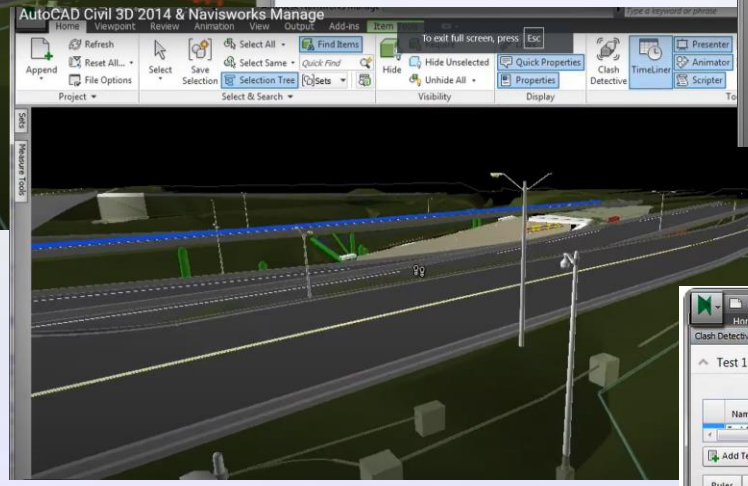

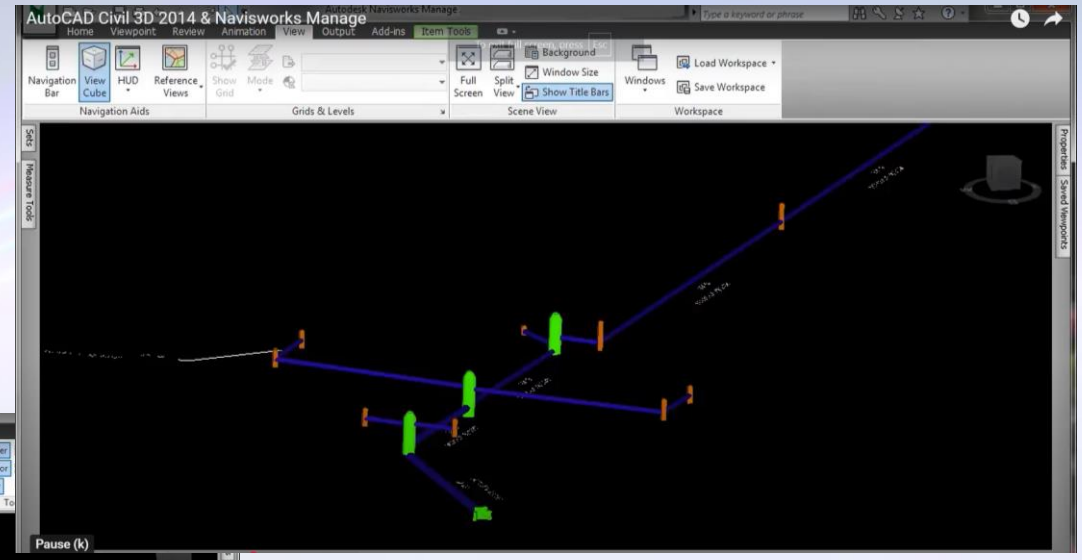

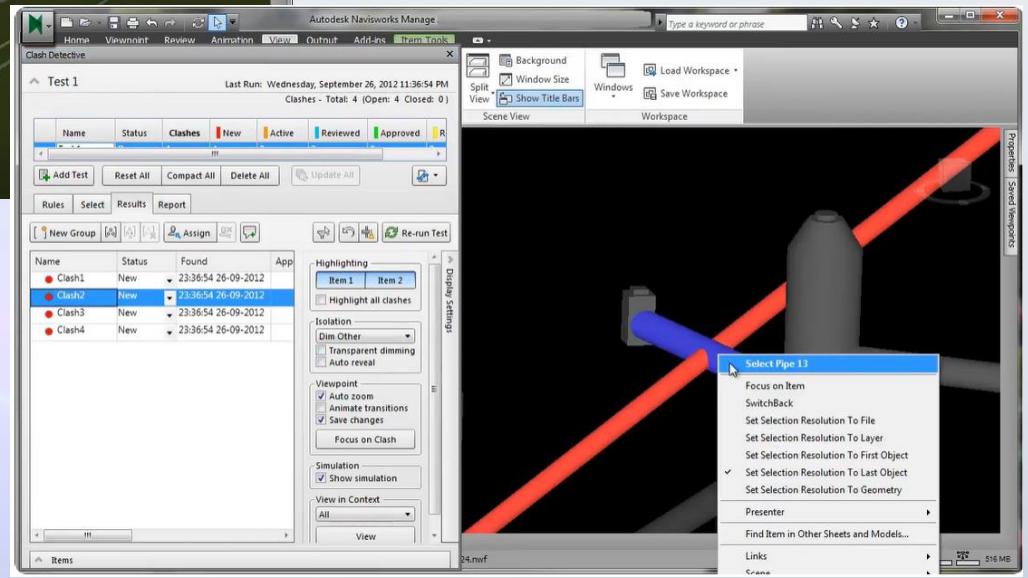

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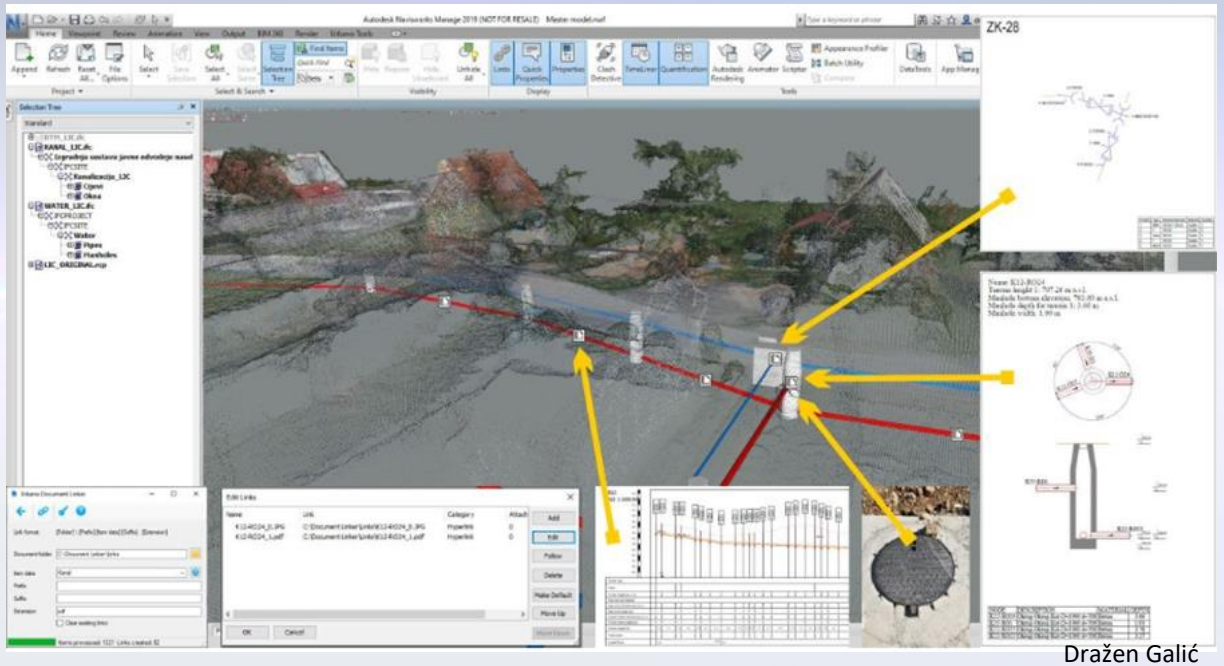

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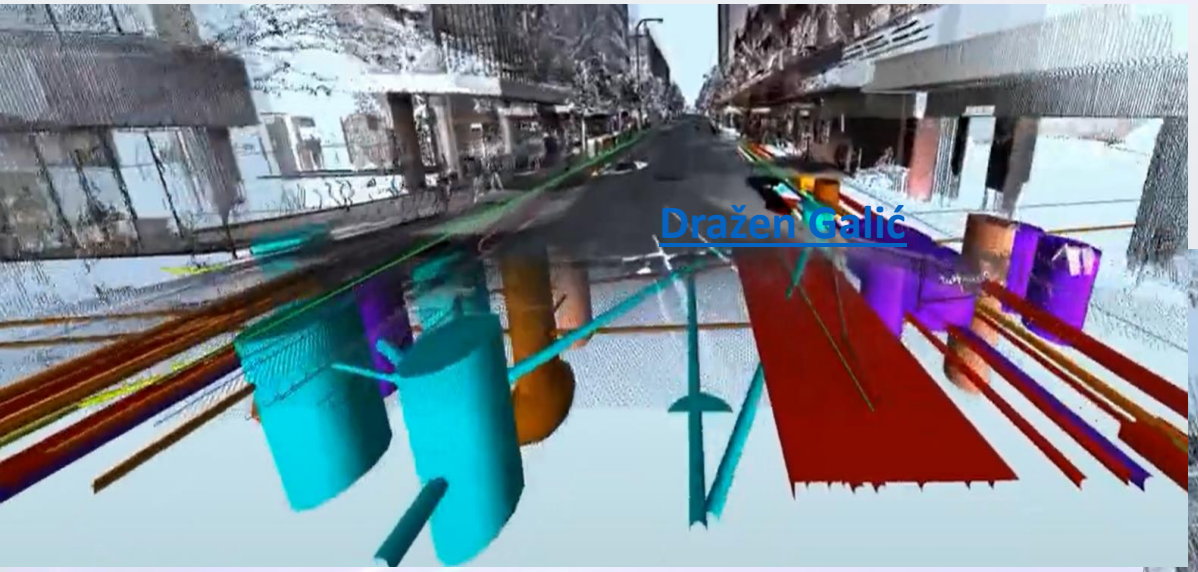

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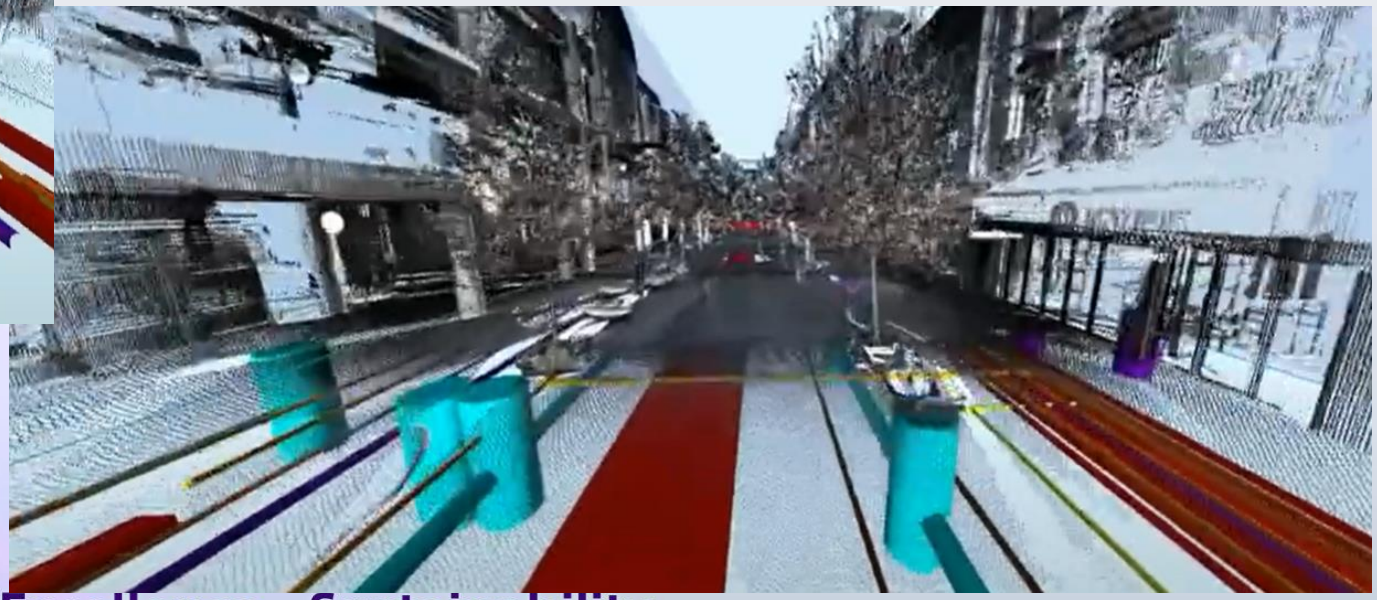

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Developing and Creation of VR with GIS, Civil 3D, Revit & Navisworks

- **GIS Integration**: Incorporates geospatial data to ensure accurate site context and location-specific details.

- **Civil 3D & Revit**: Designs and models roads, utilities, and infrastructure, forming a unified BIM model.

- **Navisworks Animation**: Converts the BIM model into an immersive VR environment for visualization and analysis.

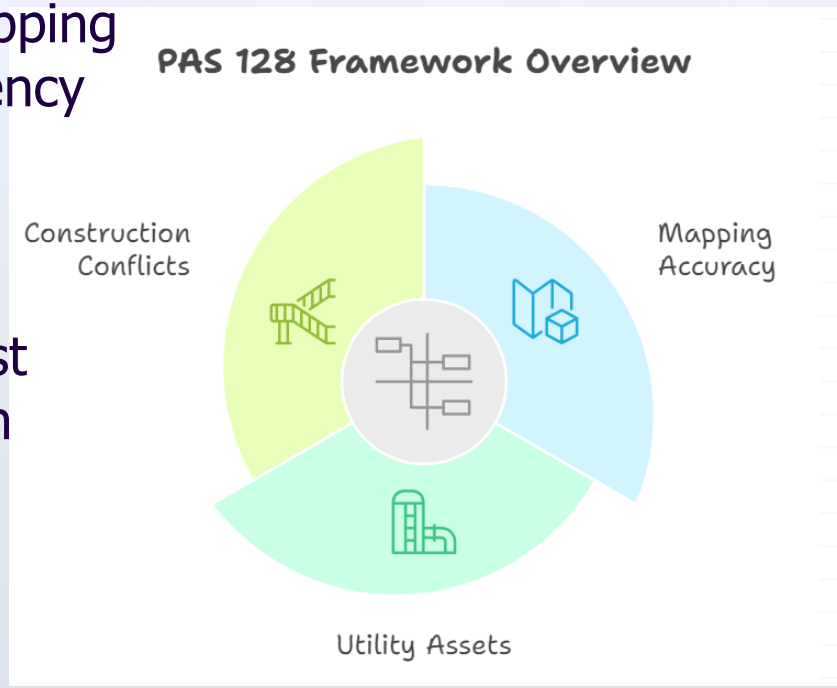
Current Data Challenges

- Infrastructure facilities (e.g., water, sewer, electricity, gas) are often designed as stand-alone systems.
- Limited integration between different utilities and services.
- Lack of standardized data formats across utilities.
- Inconsistent or outdated data availability.
- Challenges in coordinating shared space proximity

Current International Practices

PAS 128 (UK):

A Publicly Available Specification for detecting, verifying, and mapping underground utilities. It ensures accuracy, reliability, and consistency in underground asset data.



ASCE 38-22 (US):

A standard for Subsurface Utility Engineering (SUE), outlining best practices for utility mapping and risk management in construction projects.

CEN/TS 12687 (Europe):

A European technical specification for utility mapping and georeferencing, providing a harmonized approach across countries.

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Needed Modified Practices

- Enforce policies for mandatory data sharing.
- Create a common databased & platform for all infrastructure facilities.
- Enable centralized data sharing across utilities.
- Ensure real-time collaboration for accurate data access.
- Use standard data formats like IFC and COBie for data exchange.
- Ensure interoperability between applications and stakeholders.
- Simplify integration with other systems and tools.

Expected Benefits of the developed VR Model

- **Enhanced Visualization**:
  Real-time 3D views improve understanding of potential conflicts and maintenance strategies.
- **Improved Stakeholder Collaboration**:
  Clear visuals facilitate communication, expedite approvals, and ensure alignment among all parties.
- **Efficient Decision-Making**:
  Predictive analysis of impacts helps optimize rehabilitation interventions while maintaining safety and performance.
- **Future-Ready Workflows**:
  As VR technology evolves, maintenance planning and execution become increasingly streamlined and cost-effective.

•**Clash Detection:** The Navisworks environment allows for the detection of clashes between road elements, buried utilities, and other facilities before construction begins, enabling early resolution of conflicts.

•**Design Modification and Intervention Planning:** It facilitates the modification of designs and interventions during early stages, reducing costly adjustments during later phases.

•**Constructability and Rehabilitation Analysis:** The platform helps identify constructability issues and rehabilitation implementation challenges, ensuring practical and efficient execution strategies.

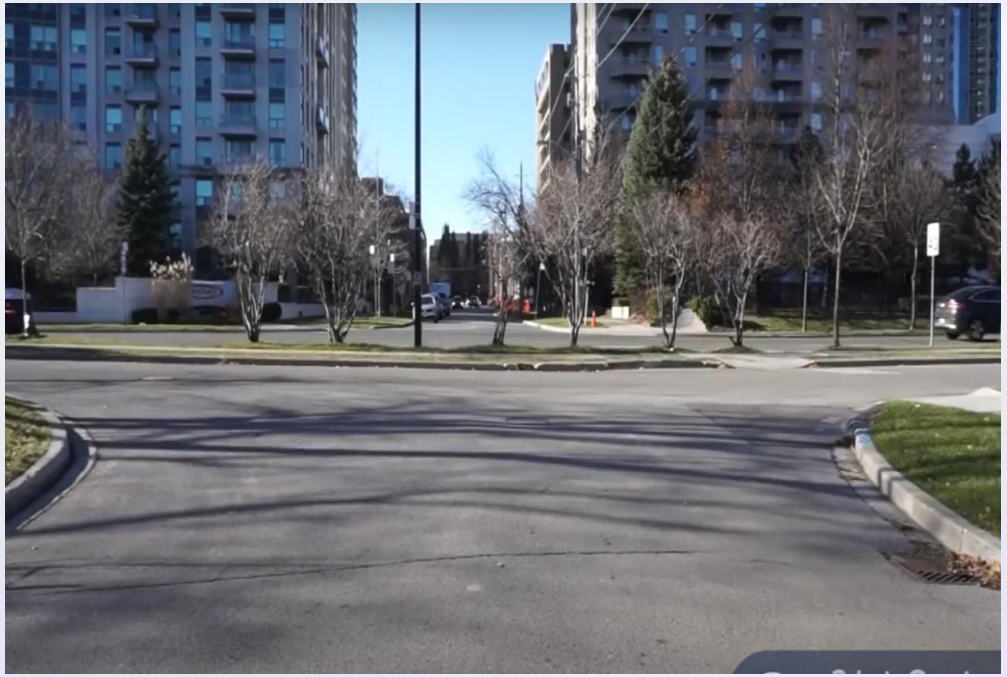
•**Virtual Issue Resolution:** Issues can be resolved virtually through simulations and analyses, minimizing on-site disruptions and delays.

•**Early Warning of Design Errors:** Navisworks provides early warnings for potential design errors, allowing teams to address them proactively.

•**Design Optimization:** Enables early modifications to designs and interventions, reducing costly changes later in the project.

What Next ??

- **Augmented Reality Based Maintenance Models !!!!**



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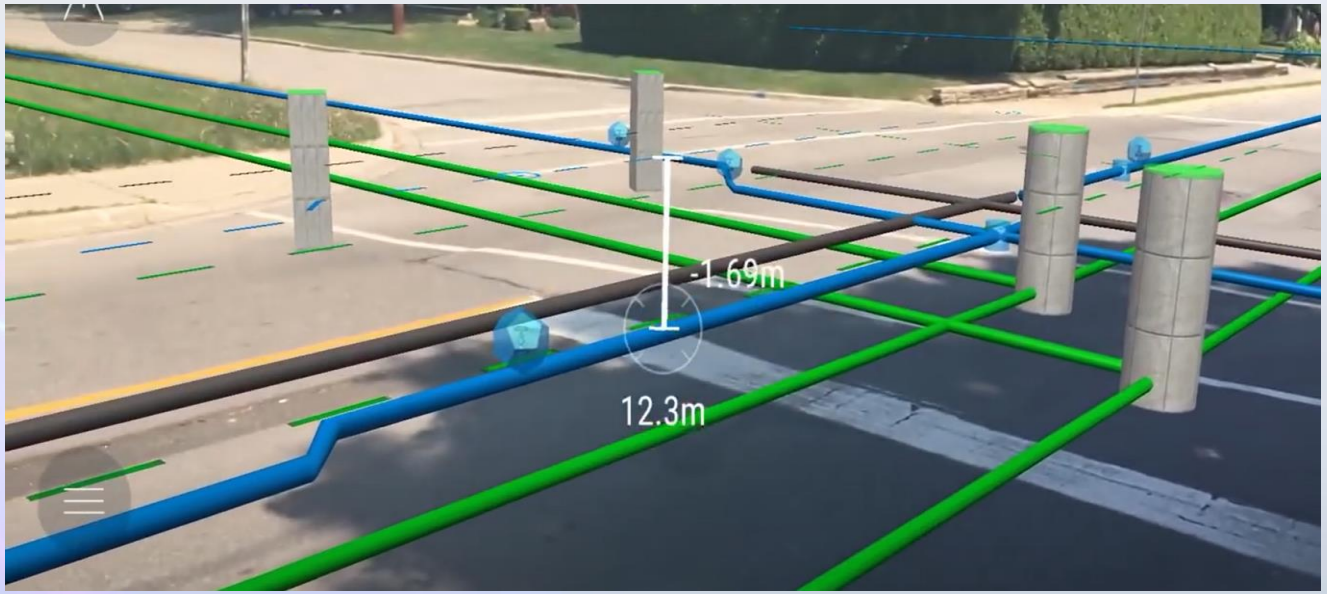

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